UNIVERSITY OF KWAZULU-NATAL

APPLICATION OF KNOWLEDGE MANAGEMENT APPROACHES AND INFORMATION AND COMMUNICATION TECHNOLOGIES TO MANAGE INDIGENOUS KNOWLEDGE IN THE AGRICULTURAL SECTOR IN SELECTED DISTRICTS OF TANZANIA

EDDA LWOGA

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Edda Lwoga (BLIS., P.G. DIP., MSc.)

Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy (Information Studies) in the School of Sociology and Social Studies, Faculty of Humanities, Development and Social Science. University of KwaZulu-Natal, Pietermaritzburg, South Africa.

Supervisor: Prof. Christine Stilwell

. ……………………………..

Co-Supervisor: Prof. Patrick Ngulube

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Submitted: December 2009

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ABSTRACT

This study investigated the extent to which knowledge management (KM) approaches and information and communication technologies (ICTs) can be used to manage agricultural indigenous knowledge (IK), and introduce relevant exogenous knowledge in some local communities of Tanzania. The recognition and management of local practices do not only give confidence to farmers that their knowledge and skills are valued, but also leads to the preservation and continued use of their IK. Managing IK within and across communities can help to enhance cross-cultural understanding and promote the cultural dimension of agricultural development in the local communities.

The current state of managing agricultural IK and access to relevant exogenous knowledge in the selected local communities in Tanzania was investigated. The study used mixed research methods, where the qualitative approach was the dominant method. Both quantitative and qualitative data were gathered simultaneously during a single phase of data collection. The primary purpose was to gather qualitative data through the semi-structured interviews, focus groups, non-participant observation, and participatory rural appraisal tools (information mapping and linkage diagrams, and problem trees). The secondary purpose was to gather quantitative data through closed questions which were embedded in the same semi-structured interviews. Both qualitative and quantitative data analyses were kept separate, and then they were combined or integrated into the meta-inferences. Some of the qualitative themes were also transformed into counts, and these counts were compared with descriptive quantitative data. The study participants included three categories of respondents: local communities (farmers and village leaders), IK policy makers (institutions that deal with intellectual property policies in Tanzania), and knowledge intermediaries (institutions that deal with agricultural KM activities in the rural areas).

The findings indicated that KM approaches can be used to manage IK and appropriately introduce exogenous knowledge in the local communities, and thus the integration of both indigenous and exogenous knowledge can be feasible. The study findings showed that farmers possessed an extensive base of agricultural IK. However, this knowledge was acquired,

developed and shared within a small, weak and spontaneous network, and thus knowledge loss was prevalent in the surveyed communities. Formal sources of knowledge mainly focused on disseminating exogenous knowledge in the local communities, which showed the predominance of the exogenous knowledge system over IK in the surveyed local communities. The study found that most of the farmers' knowledge was tacit and it was created and shared through human interactions, and thus lack of ICTs did not constitute a barrier for KM practices in the rural areas. The study findings showed that radio was the major ICT used to access exogenous and indigenous knowledge in the local communities. There was low use of ICTs to share and preserve agricultural IK in the local communities. Although there was a predominance of the exogenous knowledge system over IK in the local communities, farmers applied IK gained from tacit and explicit sources of knowledge in their farming systems as compared to exogenous knowledge in the surveyed communities. Farmers trusted their own knowledge since it did not challenge their assumptions as would new knowledge from research institutions and universities.

Low use of exogenous knowledge on some farming aspects was attributed to the fact that few knowledge intermediaries had identified and prioritized farmers' knowledge and needs in the local communities. Individual and collective interactions were already used to integrate farmers' knowledge and exogenous knowledge in the local communities, however, they needed to be strengthened through KM practices. The study findings showed that various factors determined access to knowledge in the communities, which included ICTs, culture of a certain locality, trust, status, context and space. The findings also showed that the lack of IK policy and existence of Intellectual Property Rights (IPR) that inadequately recognised and protected IK, limited acquisition, sharing and preservation of IK in the surveyed communities in Tanzania.

The study concluded that unless KM approaches are applied, IK will continue to disappear, and the rural farmers will have nothing to rely on, for their farming practices. Since knowledge is the collective expertise of everyone in the communities, this study recommends that KM practices should be embedded in the community, private and public agricultural actors and other government and private institutions as they currently function in the local communities. The government and private agricultural actors should foster the KM practices in the local communities by engaging the community leaders and rural people in the whole process. Since

IK is site-specific, it can therefore seldom be scaled up without an adaptation, however it can be used to stimulate experimentation and innovation in other communities. With this view, this study recommends that knowledge should not be separated from the individuals who possess it, instead efforts should be made to enable the communities to manage their own knowledge, and to adapt other knowledge systems to suit their local context for effective KM practices.

Indigenous knowledge would be effectively managed and integrated with exogenous knowledge if the government ensures that there are policies and Intellectual Property Rights (IPRs) that recognise and protect the existing knowledge in the country. These policies may include sectoral policies that deal with IK, rural development, agriculture, ICTs, education issues and various other issues. These policies should comprise the following: (i) a shared definition of and vision for KM in the country; (ii) the clear goals/strategies for the innovation initiatives to take place in the rural areas; and (iii) guidance with regard to prioritizing, deciding upon, and taking action to institutionalize KM processes in the rural areas with linkages to gender perspectives. Issues related to the capacity building, culture, content, infrastructure, and leadership should be addressed at this level for effective implementation of KM services in the rural areas. This will enable the communities and agricultural actors (such as research, extension, NGOs, libraries) to establish KM practices and a culture that is conducive for KM activities in their localities.

Further, the study recommends that public and private institutions, knowledge intermediaries (such as research, extension, NGOs, libraries) and village leaders should be involved in the KM practices in the rural areas, and they should ensure that there is a committed leadership for KM activities, knowledge culture, appropriate ICTs, favourable context and space, and mapping to locate knowledge bearers and knowledge resources in the rural areas. However, the absence of ICTs should not constitute a barrier for KM and knowledge integration processes, since the findings showed that communities are more likely to understand, acquire and use knowledge that is shared through indigenous communication channels which are oral in nature rather than other approaches such as ICTs.

ACKNOWLEDGEMENTS

DEDICATION

I dedicate this work to my husband, Adelard Nhunde Saduka, and my daughter, Victoria Karen Nhunde.

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GLOSSARY

Local name		Details
Chibilize	-	Medicinal plant for controlling animal diseases
Aloe vera	-	Medicinal plant (*Aloe Barbadenis)* for controlling animal diseases
Dumuzi	-	Beetle pest in beans
Fuko	-	Rodent pest
Iyari	-	Medicinal plant for controlling animal diseases
Kafai	-	Medicinal plant for controlling plant predators
Kafaya	-	Medicinal plant for controlling plant pests
Kafau	-	Medicinal plant that repels insects
Kajashi	-	Medicinal plant for preserving crops
Kajai	-	Medicinal plant for preserving crops
Kamsokoine	-	Stalk borer pests in maize
Kalabashi	-	Gourds for storing milk
Kaswagala	-	Medicinal plant for preserving crops
Kibirizi	-	Medicinal plant for controlling animal diseases
Kideri	-	Viral disease (Newcastle) in poultry
Kilawe	-	Medicinal plant for controlling animal diseases
Kimatira	-	Leaf minor pests in coffee
Kisori	-	Panama disease in banana
Kitoga	-	Viral disease (Newcastle) in poultry
Lelema	-	Medicinal plant (*Basella alba L)* for controlling animal diseases
Litupala	-	Medicinal plants for controlling animal diseases
Liyangayanga	-	Medicinal plant for controlling animal diseases
Maasa	-	Medicinal plant that repel insects
Mabangi mwitu	-	African marigold (*Tagetes erecta*) medicinal plants for preserving crops, and controlling plant diseases and pests, and animal diseases
Madaka	-	Medicinal plant for controlling animal diseases
Magadi	-	Soda ash for controlling animal diseases
Majani ya maboga	-	Pumpkin (*Cucurbita pepo L.)*
Masaka	-	Medicinal plant for preserving crops
Mavumbazi	-	Medicinal plant for controlling animal diseases
Mbengimbengi	-	Stalk borer pests in maize
Mchaichai	-	Medicinal plant (*Cymbogon citrates*) for controlling plant diseases
Mdonde	-	Viral disease (Newcastle) in poultry
Mfifina	-	Medicinal plant (*Commiphora zimmermannii Engl*) for preserving seeds
Mfongo	-	A network of irrigation furrows in Moshi Rural District
Mfuru	-	Medicinal plant (*Vitex micrantha*) for controlling animal diseases
Mfurufuru	-	Medicinal plant for controlling animal diseases
Mgwino	-	Medicinal plants for controlling animal diseases
Mitoma	-	Medicinal plant (*Ficus thonningii*) for controlling plant pests
Mkono wa mama mkwe	-	Medicinal plant for controlling animal diseases
Mkambala	-	Medicinal plant (*Acacia Mellifera*) for controlling animal diseases

Mkunguni	-	Medicinal plant (*Salvadora persica*) for preserving crops
Mlatangao	-	Medicinal plant (*Calpurnia aurea Ait. Benth*) for controlling animal diseases
Mluku	-	Medicinal plant for preserving crops
Msakasaka	-	Medicinal plant (*Rhus natalensis*) for preserving crops, and controlling plant pests and animal diseases
Msesewe	-	Medicinal plant (*Rauvolfia caffra*) for controlling plant pests and animal diseases
Mshindwi	-	Medicinal plant (*Anisophyllea pomifera*) for preserving crops and controlling plant diseases and pests
Muhenjele	-	Medicinal plant for controlling animal diseases
Mwarobaini	-	Neem medicinal plant (*Azadirachta indica)* for preserving crops and controlling plant diseases and pests, and animal diseases
Msonobali	-	Medicinal plant (*Senna siamea)* for preserving crops
Mtununga	-	Medicinal plant for controlling animal diseases
Mtutu	-	Medicinal plant (*Bridelia micrantha)* for controlling plant pests
Mtundu	-	Medicinal plant for preserving crops
Mubanga	-	Medicinal plant for controlling animal diseases
Mzenge	-	Medicinal plant for controlling animal diseases
Ndigana moto	-	East Coast Fever disease in cattle and goat
Ndigana baridi	-	Anaplasmosis disease in cattle and goats
Ngaponi	-	Medicinal plant for controlling animal diseases
Ohuruka	-	Beetle pests in beans
Olkiloriti	-	Medicinal plant (*Acacia nilotica)* for controlling animal diseases
Omudi	-	Sticks for herding livestock
Orkikanopi	-	Anaplasmosis disease in cattle and goats
Orkuluku	-	Foot and Mouth Disease in cattle
Ortikana losedeli	-	East Coast Fever disease in cattle
Rugwe mwani	-	Medicinal plant for controlling plant pests
Scania	-	Stalk borer pests in sorghum
Shamba darasa	-	Farmer Field School
Shipitiri	-	Vegetable insects
Surenje	-	Stalk borer pests in sorghum
Pilipili	-	Chilli pepper (*Capsicum annum*) medicinal plant for preserving crops, and controlling plant diseases and pests, and animal diseases
Takalang'onyo	-	Medicinal plant for controlling animal diseases
Tumbaku mwitu	-	Wild tobacco (*Nicotiana tabacum*) medicinal plant for preserving crops
Ufori	-	Cattle's urine
Ufuta pori	-	Wild sesame (*Sesamum calycinum*) medicinal plant that repel insects
Urmukatani	-	Medicinal plant for controlling animal diseases
Urutupa	-	Medicinal plant for preserving crops
Usibi	-	Medicinal plant for controlling animal diseases
Utitiri	-	Mites in poultry
Vimungu	-	Stalk borer pests in sorghum

LIST OF ABBREVIATIONS AND ACRONYMS

AFDF	-	African Women's Development Fund
AKIS	-	Agricultural Knowledge and Information System
ALIN-EA	-	Arid Lands Information Network-Eastern Africa
AMSDP	-	Agricultural Marketing Services Development Programme
ASP	-	Agricultural Service Provider
ASDP	-	Agricultural Sector Development Programme
ASDS	-	Agricultural Sector Development Strategy
ASPS	-	Agricultural Sector Programme Support
AU	-	African Union
BIS	-	Business Information Services
BRELA	-	Business Registrations and Licensing Agency
CBD	-	Convention on Biological Diversity
CCM	-	Chama cha Mapinduzi
CIA	-	Central Intelligence Agency
CIRAN	-	Centre for International Research and Advisory Networks
CIDA	-	Canadian International Development Agency
CLF	-	Converged Licensing Framework
COP	-	Community of Practices
COSOTA	-	Copyright Society of Tanzania
COSTECH	-	Tanzania Commission for Science and Technology
CROMABU	-	Crop Marketing Bureau
CSOPP	-	Civil Society Organisations and Participation Programme
CTO	-	Commonwealth Telecommunications Organisations
CWF	-	Canadian Wildlife Federation
DADP	-	District Agricultural Development Plans
DASIP	-	District Agricultural Sector Investment Project
DRD	-	Department of Research and Development
ECA	-	Economic Commission for Africa
ESRF	-	Economic and Social Research Foundation
FADECO	-	Family Alliance for Development and Cooperation
FAO	-	Food and Agriculture Organisation
FFS	-	Farmer Field School
HSRC	-	Human Science Research Council of South Africa
GDP	-	Gross Domestic Product
ICT	-	Information and Communication Technology
IDRC	-	International Development Research Centre
IDS	-	Institute of Development Studies, University of Sussex
IICD	-	International Institute for Communications and Development
IIRR	-	International Institute of Rural Reconstruction
IK	-	Indigenous Knowledge
IKS	-	Indigenous Knowledge Systems
ILO	-	International Labour Organisation Convention
IPR	-	Intellectual Property Rights

ISB	-	Information Seeking Behaviour
ISP	-	Internet Service Providers
ITPGR	-	International Treaty on Plant Genetic Resources
ITU	-	International Telecommunication Union
KAMEA	-	Karagwe Media Association
KAWG	-	Kyanika Adult Women Group
KIRSEC	-	Kilosa Rural Services and Electronic Communication
KM	-	Knowledge Management
LGRP	-	Local Government Reform Programme
LINKS	-	Local Indigenous Knowledge Systems
LITI	-	Livestock Industry Training Institute
LK Cycle	-	Learning with Knowledge Cycle
MAFS	-	Ministry of Agriculture and Food Security in Tanzania
MATI	-	Ministry of Agriculture Training Institute
MCM	-	Ministry of Co-Operatives and Marketing
MCT	-	Ministry of Communication and Transport
MDG	-	Millennium Development Goals
MISA	-	Media Institute of Southern Africa
MLDF	-	Ministry of Livestock Development and Fishing Activities
MSSRF	-	MS Swaminathan Research Foundation
MWI	-	Ministry of Water and Irrigation Development
MUCCOBS	-	Moshi University College of Co-Operative and Business Studies
NARS	-	National Agricultural Research System
NBS	-	National Bureau of Statistics of Tanzania
NGO	-	Non Governmental Organisations
NSGRP	-	National Strategy for Growth and Reduction Poverty
OAU	-	Organisation of African Unity
OECD	-	Organisation for Economic Cooperation and Development
PADEP	-	Participatory Agricultural Development and Empowerment Project
PBR	-	Plant Breeders' Rights
PMA	-	Plan of Modernization of Agriculture
PELUM	-	Participatory Ecological Land Use Management
PLA	-	Participatory Learning and Action
PRA	-	Participatory Rural Appraisal
PROLINNOVA	-	Promoting Local Innovations in Sustainable Agriculture in Tanzania
QDS	-	Quality Declared Seed
RAAKS	-	Rapid Appraisal of Agricultural Knowledge System
RDS	-	Rural Development Strategy
SACCOS	-	Savings and Credit Cooperatives Societies
SECI	-	Socialization, Externalization, Combination and Internalization
SMS	-	Short Message Service
SRISTI	-	Society for Research and Initiatives for Sustainable Technologies and Institution
SNAL	-	Sokoine National Agricultural Library
SSA	-	Sub-Saharan Africa
SUA	-	Sokoine University Of Agriculture

SWOT	-	Strengths, Weaknesses, Opportunities and Threats Analysis
TACRI	-	Tanzania Coffee Research Institute
TAFORI	-	Tanzania Forestry Research Institute
TBC	-	Tanzania Broadcasting Corporation
TCCA	-	Tanzania Chamber of Commerce, Industry and Agriculture
TCRA	-	Tanzania Communications Regulatory Authority
TDT	-	Technology Development And Transfer
TLA	-	Tanzania Library Association
TLSB	-	Tanzania Library Service Board
TOT	-	Transfer of Technology
TIPSAC	-	Tanzania Intellectual Property Service Advisory and Information Centre
TPRI	-	Tropical Pesticides Research Institute
TRIP	-	Trade Related Aspects of Intellectual Property Rights
TV	-	Television
T&V	-	Training and Visit
UMADEP	-	Uluguru Mountains Agricultural Development Project
UN	-	United Nations
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environment Programme
UNESCO	-	United Nations Educational, Scientific and Cultural Organisation
UNU-IAS	-	United Nations University Institute of Advanced Studies
UPOV	-	International Union for the Protection of New Varieties of Plants
URT	-	United Republic of Tanzania
WIDA	-	Wino Development Association
WIPO	-	World Intellectual Property Organisation
WSIS	-	World Summit on The Information Society
WTO	-	World Trade Organisation
WWW	-	World Wide Web
ZANTEL	-	Zanzibar Telecom

CHAPTER ONE: BACKGROUND TO THE STUDY

1.1 Introduction and study rationale

In an economy where the only certainty is uncertainty, the important source of competitive advantage is knowledge (Nonaka 1998). However, knowledge in itself cannot ensure economic growth. To optimize the benefits that knowledge can provide, it is necessary to implicitly manage knowledge (Mostert and Snyman 2007). As the realisation of the importance of knowledge grows, increasing attention has been given to the need to manage homegrown knowledge; the indigenous knowledge (IK) of developing countries on which sustainable economic development depends (Den Biggelaar 1991; Hens 2006; von Liebenstein 2000).

IK is mainly used as the basis for local-level decision-making in agriculture, health care, education, natural-resource management and a host of other activities (Ming 2004; Warren 1991; World Bank 1998a). The literature shows that development efforts that ignore local knowledge and innovations generally fail to achieve their development goals (Brokensha, Warren and Werner 1980; Tella 2007; Warren, Slikkerveer and Brokensha 1995). However, indigenous knowledge in sectors other than agriculture was considered to be beyond the scope of the study. The aim was not to assess IK in various aspects of human life, but to examine the management of IK and its integration into other knowledge systems for the agricultural development in developing countries with a particular focus on Tanzania.

The agricultural sector is the backbone of many economies in Africa. In Tanzania, the economy depends heavily on agriculture, which accounts for more than 25.7 percent of gross domestic product (GDP), provides 30.9 percent of exports, and employs 70 percent of the work force (URT 2009a). However, the vast majority of Africans including Tanzanians depend on resource-poor agriculture, without modern inputs, and they rely almost exclusively on locally available resources for their livelihoods (HSRC 2005). Yet it is estimated that they produce as much as 20 percent of the world's food, largely without the benefit of modern agricultural research (IDRC 2003). This production is mainly due to their utilisation of IK and their ability to adapt to changing circumstances by virtue of local innovations (Hart and Mouton 2005; Reintjies, Haverkort and Waters-Bayer 1993; Van Veldhuizen *et al.,* 1997). It is thus evident that farmers'

knowledge, innovations and practices have provided the basis for thousands of years of agricultural development.

Despite the potential of IK for sustaining local farming, farmers do not earn high incomes because their innovations and practices are mostly organised, accumulated and embedded in a context through experience, and these indigenous technologies are applied in isolation (Akiiki 2006; Hart and Vorster 2006; Mascarenhas 2004:4; Warren 1993). Hence, IK has been a system that is not fully utilised for agricultural development purposes. The dominant information management model in most developing countries has been based on acquiring, organising and preserving recorded and codified knowledge, which is largely generated by researchers, laboratories and universities (Ngulube 2002). At the same time, the dominant approach to research and extension still follows the pattern of transfer-of-technology, based on the assumption that knowledge is created by scientists, to be packaged and spread by extension and to be adopted by farmers (Assefa *et al.,* 2009; Waters-Bayer 2000; Waters-Bayer and van Veldhuizen 2005). These approaches leave little room for the IK resources of the community to be incorporated or merged with rural knowledge and information systems (Karlsson 1995; Thrupp 1989). There is thus an urgent need to document and preserve IK so that it can be available for agricultural developmental initiatives before much of it is completely lost.

When managing IK, there is an emphasis that IK is not in itself capable of addressing all the issues related to sustainable agricultural development (Garforth 2001; Grenier 1998). Sustainable agricultural development may better be served by a system that incorporates both endogenous and exogenous knowledge systems (Behera and Nath 2005; Brodt 2001; Gorjestani 2000; Mchombu 2002; Meyer 2003; Millar 2004; Scoones and Thompson 1994a; Shiruma 2004). Research shows that the more the local people experiment with exogenous elements, the more they strengthen their own knowledge and practices (Dove 2000; Lemma and Hoffmann 2005; Mundy 1993; Vivekanandan *et al.,* 2004). There is thus a need to manage IK and integrate indigenous knowledge with the conventional knowledge to improve farming activities in the local communities.

2

To manage IK more efficiently, some authorities have emphasized the development of a holistic approach namely, knowledge management (KM), with its theories, principles and practices (Kaniki and Mphahlele 2002). Yet, KM has been gradually established as a strong approach to support business viability, competitiveness and growth (Diakoulakis *et al.,* 2004). However, by its very nature IK has traditionally not been viewed in the business sense as "capital" (Kaniki and Mphahlele 2002). It is community based, embedded in local cultural traditions, and its distribution is fragmented, widely shared according to gender, age or specialist status, and may reflect political or cultural power (Sillitoe, Dixon and Barr 2005:3). Nevertheless, some schools of thought have argued that KM should not be restricted to closed business systems with formal structures. KM can also be practiced in the local communities or open systems (Mosia and Ngulube 2005; Noeth 2004; 2006). Although open systems comprise different stakeholders with different organisational allegiances, isolated information, experiences, skills and know-how can be harnessed for sustainable development (Mosia 2002). Thus, the applicability of these KM models to manage agricultural IK and to appropriately introduce the needed exogenous knowledge in local communities was called into question.

Further, the developments of information and communication technologies (ICTs) have contributed significantly to growing interest in the potential of knowledge management (Davis, Subrahmanian and Westerbeg 2005; Davenport 2007; Lwoga *et al.,* 2006). Unfortunately, resource poor farmers are mainly affected by the digital divide which is a gap between groups or individuals in their ability to use ICTs effectively due to differing literacy, technical skills, and useful digital content (Ghatak 2007). Nevertheless, the emergence of low cost ICTs (such as radio, cell phones, and telecentres) may bridge the digital divide (COSTECH 2005a). Yet, the management of knowledge through ICTs is mainly found in the corporate business environment (Noeth 2006). So how can ICT be used to manage IK in the rural societies in a similar way as it does with the organisational knowledge? Given the situation on the ground that IK is inadequately managed to such an extent that it is rapidly disappearing, the usage of the KM approach and ICTs to manage agricultural IK, and to appropriately introduce relevant exogenous knowledge in local communities were imperative issues to be addressed in this study.

1.2 Definition of key terms and concepts

This section provides the definition of key terms and concepts that were used in this study. This includes the following: knowledge, classification of knowledge, indigenous knowledge, endogenous knowledge, exogenous knowledge, knowledge management, and information and communication technology (ICT).

1.2.1 Knowledge

The terms "knowledge", "information" and "data" are often used inter-changeably in the literature but a distinction between the terms is helpful. It is therefore important to define them in order to show the differences that exist between these terms. Data is a representation of observations or facts out of context, and therefore, they are not directly meaningful (Zack 1999a). Data also refers to unorganised and unprocessed facts (Awad and Ghaziri 2004). Davenport and Prusak (1998) viewed data as the raw material for creating information that by itself carries no judgment or interpretation, and no meaning.

Unlike data, information has a meaning, purpose and relevance. Information is an aggregation of data that makes decision making easier (Awad and Ghaziri 2004). Information is also the result of placing data within some meaningful content, often in the form of a message (Zack 1999b). Davenport and Prusak (1998) described information as data that makes a difference. Wiig (1999) also illustrated information as facts and data organised to characterise a particular situation. Joia (2000) was also of the opinion that information is data with attributes of relevance and purpose, usually having the format of a document or visual and/or audible message.

In contrast to information, Wiig (1999) defined knowledge as a set of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how (Wiig 1999). Nonaka, Toyama and Konno (2000) further illustrated knowledge as a dynamic human process of justifying personal belief in the truth. Alavi and Leidner (1999) also viewed knowledge as information possessed in the mind of an individual. It is personalized or subjective information related to facts, procedures, concepts, interpretations, ideas, observations and judgments (which may or may not be unique, useful, accurate, or structurable). Davenport and Prusak (1998:5) described knowledge as a fluid mix of framed experience, values, contextual

information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. Knowledge also refers to an understanding gained through experience. It is "know-how" or familiarity with how to do something that enables a person to perform specialized tasks (Awad and Ghaziri 2004:33). Similarly, Joia (2000) linked knowledge to the capacity for action. It is intuitive, and therefore it is hard to define. It is linked to the users' values and experience, being strongly connected to pattern recognition, analogies and implicit rules.

The observation can therefore be made that there is no smooth, linear passage from data to information and knowledge. Data can be viewed as a set of discrete facts which are not directly meaningful, information as processed data which has meaning, purpose and relevance, and knowledge as contextualized information which guides action. Embracing a wider sphere than information, this study has adopted Maier's (2004:73) definition that knowledge is all cognitive expectancies and observations that have been meaningfully organised, accumulated and embedded in a context through experience, communication or inference that an individual or organisational actor uses to interpret situations and to generate activities, behaviour and solutions no matter whether these expectancies are rational or used intentionally.

1.2.2 Classification of knowledge

There are different kinds of knowledge and each kind requires a different approach when it comes to KM interventions. It is suggested that different knowledge classifications help to develop one's understanding regarding the complexity of knowledge as a construct (Alavi 2000). When considering KM, the awareness of various types of knowledge helps the knowledge developer to know how to manage each type of knowledge during knowledge capture processes (Awad and Ghaziri 2004:42).

Knowledge can be classified in different ways. A common distinction is that between tacit and explicit knowledge. Tacit knowledge is defined as non-verbalized, intuitive and unarticulated (Polanyi 1962). It resides in people's minds, behaviour and perception and evolves from social interactions (Nonaka and Takeuchi 1995). On the other hand, explicit knowledge can be expressed in formal and systematic language and shared in the form of data, scientific formulae,

specifications and manuals (Nonaka, Toyama, and Konno 2000). In contrast, Ein-Dor (2006) questioned Nonaka and other authors' classification of knowledge. This author argued that tacit and explicit knowledge are opposite poles of a single dimension along which there may be types of knowledge that are combinations of the extreme points. Ein-Dor (2006) further identified the dimensions of knowledge as follows:

- Tacit – explicit: tacit knowledge is possessed by an individual but it cannot be expressed verbally, while explicit knowledge can be externally verbalized and recorded;

- Individual – social: individual knowledge is that is created by and inherent in the individual, while social knowledge is created by and inherent in collective actions of a group;

- Procedural - declarative: declarative knowledge consists of facts and figures ("know-what"), while procedural knowledge is about the means for achieving goals ("know-how");

- Commonsense - expert: commonsense includes acquaintance with the physical world and the laws governing it, social behaviours and procedures for everyday life, while expert knowledge is possessed by individuals who have acquired deep knowledge in some particular field by training and experience;

- Task - contextual: task knowledge is the knowledge required to perform a task, while contextual knowledge is the contexts in which organisational tasks are performed;

- True - false: much knowledge lies between the extremes of truth and untruth and may be closer to one extreme or the other;

- Certain - uncertain: knowledge can have different degrees of certainty from accurately measured to estimations of an opponent's intentions based on evaluation of relevant facts which may themselves be subjected to high uncertainty and low veracity; and

- Private - public: public deals with the way knowledge is constructed, while the private is the current state of construction.

Firestone and McElroy (2003:22) also disagreed with Nonaka and other authors' classification of knowledge. Firestone and McElroy (2003:22) argued that another type of knowledge had been overlooked by these authors, namely implicit knowledge. Implicit knowledge refers to cognitions

and beliefs that while not focal or explicit, are expressible, given the environmental conditions effective in eliciting them. Having highlighted the three types of knowledge (tacit, implicit and explicit), Firestone and McElroy (2003:26) presented their own knowledge taxonomy: (i) World 1 (material) knowledge; (ii) World 2 (situational, tacit, implicit, or potentially explicit) knowledge; (iii) World 2 (pre-dispositional) knowledge; (iv) World 3 (explicit) knowledge, where 24 types are listed by the authors; and (v) World 3 (implicit) knowledge; potentially for them, they see 24 types but dependent on derivation from explicit types.

In agreement with Firestone and McElroy (2003:22) argument, Civi (2000) also asserted that tacit knowledge can be further split in two sectors: on one hand embracing informal personal skills and crafts referred as know-how, while on the other hand considering an implicit cognitive dimension including beliefs, values and mental models. However, the distinction between explicit and tacit knowledge seems to be accepted by the majority of academics and practitioners (Diakoulakis *et al.,* 2004; Martennson 2000; Nonaka and Takeuchi 1995; Polanyi 1966).

It is evident that there are various types of knowledge which need to be considered when managing IK in the local communities. For this study, the knowledge typology of tacit and explicit by Martennson (2000), Nonaka and Takeuchi (1995) and Polanyi (1966) was suitable. This choice was based on the nature of indigenous knowledge which is predominantly tacit, orally communicated and it is also people centred as it is preserved in people's minds.

1.2.3 Indigenous knowledge

The term, indigenous knowledge (IK) is used interchangeably by various scholars from different school of thoughts to either refer to one of the following concepts, that is traditional knowledge, indigenous knowledge, community knowledge, traditional ecological knowledge, local knowledge, traditional environmental knowledge, aboriginal tradition, cultural patrimony, folklore, expressions of folklore, cultural heritage, traditional medicine, cultural property, indigenous heritage, indigenous cultural and intellectual property rights, indigenous intellectual property, customary heritage rights, innovations and practices, and popular culture or intangible component (WIPO 2002). The term local knowledge is often used to refer to indigenous knowledge. Local knowledge refers to the knowledge possessed by any group living off the land

in a particular area for a long period of time (Langill 1999). IK on the other hand, tends to emphasize the knowledge internal to a particular setting and thus differing from local knowledge, which embraces exogenous knowledge, which entered into the local community over time (van Vlaenderen 2000). In this situation, it is not important whether the people under the study are the original inhabitants of an area or not. The major aim is to learn how people interact with the environment to improve their knowledge base and farming activities. Thus, this study used two terms (indigenous and local knowledge) interchangeably to encompass all the above mentioned terms.

IK is defined as the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area (Grenier 1998). Kaniki and Mphahlele (2002) viewed IK as a cumulative body of knowledge generated and evolved over time, representing generations of creative thought and actions within individual societies in an ecosystem of continuous residence, in an effort to cope with an ever-changing agro-ecological and socio-economic environment. Payle and Lebakeng (2006) described IK as a local knowledge, which is born out of the environment and a result of people interacting with their environment.

IK is also described as the information, wisdom and technical know-how of a particular group of people developed over a long period of time and bequeathed to successive generations through oral and other forms of cultural self-perpetuation (Mchombu 1995a:124). IIRR (1996:7) defined IK as the knowledge that people in a given community have developed over time, and continue to develop. It is based on experience, often tested over centuries of use, adapted to local culture and environment, and dynamic and changing environment. Various scholars (Abrahams 1987; Munyakho 1994; Warren 1991) described IK as knowledge which is used as the basis for local-level decision making in socio-economic, engineering, health, food preparation, education, natural resource management, political, agriculture, sports and a host of other activities in rural communities.

For the purpose of this study, IK definition was taken from the most agreed definition that IK is largely tacit, orally communicated, experiential, unique and embedded in the heads, activities and practices of communities with long histories of close interaction with the natural environment across cultures and geographical spaces. It is largely used by local communities for decision-making (Ngulube 2002:95; Ellen and Harris 2000:3; World Bank 1998a). For the agricultural sector, solutions to farmers' problems are developed by farmers themselves and their technological knowledge is specific to their farms' environmental conditions and their own needs.

1.2.4 Endogenous knowledge

Endogenous knowledge refers to the historical experience, and a knowledge that is specific to a given cultural set-up, and the knowledge that is free from any external or foreign influence. Endogenous knowledge can become indigenous knowledge if it is only under the influence of globalization (Hountondji 1997:18).

1.2.5 Exogenous knowledge

Exogenous knowledge is often referred to by various authors (Brodt 2001; Karlsson 1995:45; Mchombu 1995a; Stevenson 1996:280) as external information and knowledge, exogenous knowledge, exotic knowledge, nontraditional knowledge, global knowledge, international science, and industrial science. However, for this study, the term exogenous knowledge is used.

Exogenous knowledge is defined as an extensive base of non-traditional knowledge that local people derive from their interaction with non-local people and institutions; television and other modern media; formal schooling in numeracy and literacy; the adoption of western scientific thinking; and exposure to foreign values, attitudes and philosophies (Karlsson 1995:50; Stevenson 1996:280). Brodt (2001:101) also referred to exogenous knowledge as the knowledge produced by professional scientists usually at universities, research laboratories, and so on, whose sole occupation is the production and dissemination of knowledge and who, in connection with this endeavor, participates in a global culture of scientific communication. On the whole, all these definitions are basically similar, but they differ in the sources from where the exogenous knowledge originates. This study adopted Mchombu's (1995a) definition that exogenous

knowledge is the information made available to the rural community from the sources outside its boundaries as part of the information transfer process to support development.

1.2.6 Knowledge management

Knowledge management (KM) is rooted in many disciplines, including business, economics, psychology and information management. While, it contributes to the ultimate competitive advantage for today's business environment, researchers as well as practitioners have yet to agree on a definition for KM. To some, KM is defined as a process that creates or locates knowledge and manages the dissemination and use of knowledge within and between organisations (Darroch 2003). Similarly, KM contains the following integral parts: using accessible knowledge from outside sources; embedding and storing knowledge in business processes, products and services; representing knowledge in databases and documents; promoting knowledge growth through the organisation's culture and incentives; transferring and sharing knowledge throughout the organisation; and assessing the value of knowledge assets and impact on a regular basis (Awad and Ghaziri 2004:3).

Parallel to other authors, Morden (2004:560) also viewed KM as a process by which knowledge and experience of the organisation (its "intellectual capital") is systematically accumulated, formalized, disseminated and applied as key value – adding corporate assets. In a similar vein, though broadly defined, KM is what the organisations do to accomplish their goals faster and more effectively by delivering the right knowledge to the right person at the right time and in the right context (Eknowledgecentre 2005). For others, KM is defined as the art of creating value from an organisation's intangible assets (Sveiby 2001). Robertson (2003) also defined KM as a conscious strategy of harnessing tacit and explicit knowledge into action by creating context, infrastructure and learning cycles that facilitate finding and using the collective intelligence of society. KM is also defined as the strategic management of people and knowledge representation along with associated content and information in an organisation, using technology and processes, so as to optimize knowledge sharing and utilisation, by transferring knowledge directly between people or indirectly through systems, to derive overall benefits in all aspects of the functioning of the organisation (Suresh and Mahesh 2006).

Consequently, Firestone and McElroy (2003:71) viewed KM as a management discipline that seeks to enhance organisational knowledge processing. They further defined the KM process as an ongoing, persistent and purposeful interaction among human-based agents through which the participating agents manage (handle, direct, govern, control, coordinate, plan, organize, facilitate, enable and empower) other agents, components, and activities participating in basic knowledge processing (knowledge production and knowledge integration), with the purpose of contributing to the creation and maintenance of an organic, unified whole system, producing, maintaining, enhancing, acquiring, and transmitting the enterprise's knowledge base. Supporting this viewpoint, Maier (2004:55) described KM as the management function responsible for the regular selection, implementation and evaluation of goal-oriented knowledge strategies that aim at improving an organisation's way of handling knowledge internal and external to the organisation in order to improve organisational performance.

Having highlighted these definitions, it was concluded that all these KM definitions provided a framework that builds on past experiences and create new approaches for managing knowledge within a community or an organisation. It was also concluded that most of these definitions emphasized the processes of discovering, capturing, sharing, preserving and utilising the available knowledge for the organisational achievements over its competitors. The major factors that were emphasized for organisational knowledge are people (workforce), technology (ICT infrastructure) and organisational processes. Thus, for the purpose of this study, the definition by Lai (2005) was adopted which described KM as a system of actions upon knowledge, which includes the establishment of strategies and procedures, with proper utilisation of technologies, so that the acquisition, storage, conversion, sharing, application and generation of knowledge can be effectively performed, with the aim of effectively using the available knowledge for problem solving and decision making. In this context, the thesis will seek to show that KM can be an effective function for managing not only the organisational knowledge, but also farmers' knowledge in a rural setting.

1.2.7 Information and communication technology

The term, information and communication technology (ICT) has been defined differently by many authors. UNDP (2001:30) defined ICT as the combination of microelectronics, computer

hardware and software, telecommunications, and optoelectronics such as microprocessors, semiconductors and fibre optics, which enable the processing, and storage of huge amounts of information, and its rapid dissemination through computer networks. ICT also encompasses all those instruments, modes, and means through which information or data is captured, processed, stored and transmitted or communicated from one person to another or from place to place (Etta and Parvyn-Wamahiu 2003; Greenberg 2005; Heeks 1999:3).

This study adopted the definition by Chapman, Slaymaker and Young (2005) that ICTs do not only include tools and instruments through which information in processed, but also methods that enable people to access and use ICTs. These ICTs are further categorised as either new ICTs or old ICTs. New ICTs encompasses computers, satellites, wireless one-on-one communications (including mobile phones), the Internet, e-mail, multimedia and telecentres. Old ICTs include radio, television (TV), land-line telephones and telegraph (Etta and Parvyn-Wamahiu 2003; Greenberg 2005; Heeks 1999:3).

1.3 Background to the statement of the problem

The potential use of IK for agricultural development is widely acknowledged (Akiiki 2006; Hart 2007; Hart and Mouton 2005; IIRR 1996; Nwonwu 2008; Warren 1993). As the realisation of the potential contribution of IK to agricultural developmental activities increases, the need for building the local communities' capacity to develop, share and apply their traditional knowledge also grows proportionally (Hens 2006:29-30; von Liebenstein 2000:3). The question is therefore not whether the potential of IK should be examined for agricultural developmental purposes but rather, how effective approaches for managing agricultural IK for the same purpose should be developed.

However, the marginalisation of IK as a result of colonial rule led some people to question their utility and the need to manage them (Goduka 1999). Nevertheless, there is a growing interest in IK due to its potential economic value in medicines, agriculture and other useful properties of endemic flora and fauna (Njoku 2005). Nonetheless, as outsiders are becoming increasingly attentive to the value of IK, so has the awareness increased that IK is threatened with extinction in the developing countries (Grenier 1998; Mascarenhas 2004:10). Notwithstanding the fact that

some IK is lost naturally as techniques and tools are modified or fall out of use, the recent and current rate of loss is accelerating because of what Chisenga (2002:17) termed, "modernisation, urbanisation and globalisation". It is estimated by Food and Agriculture Organisation (FAO) that 30% of animal genetic resources are at high risk of loss (Muyungi and Tillya 2003).

Despite the fact that IK is disappearing, inadequate efforts to share and document IK are made, and thus indigenous technologies are applied in isolation in developing countries including Tanzania (Akiiki 2006; Dube and Musi 2002; Magara 2002:72; Mascarenhas 2004; Mshana 1992; Rouse 1999; Warren 1993). The current international and national systems which manage and share IK seem to target the scientific community and persons at higher social and economic levels. The only access to IK systems that indigenous communities may have is through an intermediary who has access to these systems, such as a development expert, researcher, information professional or extension agent (Kaniki and Mphahlele 2002). Hence, lack of efforts to share and manage IK has led to the loss of valuable resources that could have been used for agricultural development (Akiiki 2006; Brokensha, Warren and Werner 1980; Magara 2002:72).

Presently, IK is stored in people's minds (Mundy and Compton 1995:120). However, the human memory has a limited capacity and stored information may be eroded by failing memories (Meyer 2003:31). The little that is remembered may be distorted or completely changed over time (Phiri 2004). More often, IK is stored in the memories of elders who disappear with this knowledge when they die because of old age (Onyango 2002:250). IK is also not equally shared with all local residents due to the political dimensions that exist when it is shared (Scoones and Thompson 1993:16). Differences in social status affect perceptions, access to knowledge and, crucially, the importance and credibility attached to what someone knows. It is the knowledge of the most marginalized people that is likely to be disregarded (Warburton and Martin 1999:2). It is thus important to develop an approach that will manage this knowledge since, as Charyulu (1999) puts it, "there is a risk that within one generation the knowledge could be lost forever".

With regard to managing IK, there are well-founded concerns that documenting and sharing of knowledge may leave the door open for commercial exploitation by outsiders ("biopiracy",

"bioprospecting"), giving little or no benefits back to the communities from which the material originated (FAO 2000). The existing intellectual property rights (IPR) systems are oriented to the concept of private ownership and thus they are at odds with indigenous cultures, which emphasize collective creation and ownership of knowledge (Mashelkar 2002:190). That is why IK has largely remained undocumented, making its accessibility and management more or less debatable.

Further, despite the fact that the integration of endogenous and exogenous knowledge improves agricultural activities, research and extension have failed to understand and involve farmers in problem definition and solving in sub Saharan African countries including Tanzania (Davis 2008; Friis-hansen 1999). Although, there is a growing attention to IK through participatory technology development, public agricultural research and extension are still characterised by top-down non-participatory approaches in sub Saharan African countries including Tanzania (Friis-hansen 1999; Rutatora and Mattee 2001). The top-down information transfer or transfer of technology (TOT) approach to rural people implies that farmers become less knowledgeable, which is not an appropriate means for empowerment (Chambers 1994a; Mariam and Galaty 1993:26; Mchombu 1995a:125; Warburton and Martin 1999). It is thus important to formulate an approach for managing agricultural IK before much of it is completely lost, and to determine ways to integrate the indigenous and exogenous knowledge for agricultural development in the local communities.

The question is therefore, how can tacit IK, which is very valuable for decision making in the agriculture sector, be captured, shared and preserved within the community for future use? How can exogenous knowledge be linked to IK for improved agricultural problem-solving strategies in the rural communities? The answers are linked to the utilisation of knowledge management (KM) principles and information and communication technologies (ICTs).

1.3.1 Knowledge management principles

The effective management of knowledge is a critical strategy for the development of Africa (Mchombu 2007). KM promotes the development and application of tacit, explicit and embedded intellectual capital by leveraging understanding, action capabilities, and other intellectual assets

to attain organisational growth (Wiig 2004). Effective KM approach must be focused on people, since better performance is attained through knowledge-based people-actions, and the effectiveness of actions results from knowledge utilised to handle situations (Wiig 2004). By using a people - centred approach, KM can thus be used to manage IK, since IK is predominantly tacit and it is also people centred as it is stored in people's heads (Mundy and Compton 1995; Meyer 2003:31; Onyango 2002:250).

However, KM draws from a wide range of disciplines and technologies with several principles and models (Barclay and Murray 1997; Kakabadse, Kakabadse and Kouzmin 2003; McAdam and McCreedy 1999; Prat 2006). Each of the KM models adds new insights to a crucial, but nebulously defined field (Kakabadse, Kakabadse and Kouzmin 2003). Despite the fact that an overarching theory of KM has yet to emerge, the need to use KM for managing knowledge of the community is well documented (Kaniki and Mphahlele 2002; Lwoga and Ngulube 2008; Ngulube 2003; Noeth 2006). Although communication and learning processes in rural regions take place in a less structured way via social networks and loose groups or between individuals, it is important to promote KM processes by strengthening the interaction between local networks and organisational structures (Bode 2007). It thus becomes imperative to assess the applicability of KM principles for managing IK in the context of the local community.

1.3.2 The application of information and communication technology in rural areas

Information and communication technologies (ICTs) are now available to combat corporate amnesia and facilitate knowledge creation, capture, organisation and transmission to the right people at the right time for the right job (Arora 2002:240; Davis, Subrahmanian and Westerbeg 2005; Davenport 2007). Despite the fact that technology can process and transfer information and knowledge, it is still people who turn knowledge into timely and creative decisions (Awad and Ghaziri 2004:13; Brown and Duguid 2000; Kaniki and Mphahlele 2002:7; Lwoga *et al.,* 2006; Wiig 2004). ICTs can thus be used as enablers to manage IK, while farmers can play a key role in making knowledge available and functional to carry out their agricultural activities.

However, resource poor farmers are prevented from fully exploring ICTs due to the digital divide. The root cause of the digital divide is the lack of economic, social and political

development (Mutula 2008; Paliwala 2003). Despite the fact that Africa has the highest mobile cellular growth rate of all continents, there are still major gaps amongst national economies and between rural and urban settings. ITU (2004b) indicated that Africa had close to 100 million telephone subscribers, 76 million of which were mobile subscribers which was the highest ratio of mobile to total telephone subscribers of any world region. At the same, the continent had some 54.2 million Internet users in 2009, for an Internet penetration of just 3.4 percent. Europe's Internet penetration is twelve times higher (Internet World Stats 2009). Of the estimated 800,000 villages without any kind of connection to ICTs, more than half were in Africa (ITU 2004b). For the rural farmers to reap the benefits of ICTs, Mutula (2008) suggested a need to improve the quality of networks, enhancing access to relevant content, and taking advantage of the proliferation of mobile phones in African countries. Thus, if these issues are not addressed, African countries including Tanzania will continue to be digitally isolated, particularly rural, regional and remote areas.

Nevertheless, apart from mobile phones, the telecentres and community radio investments in the rural areas have created great concern about the survival of IK at the grassroots' level (Chisenga 2002; Emmanuel and Lwoga 2007; Sife, Lwoga and Chilimo 2004). For instance, telecentres have been increasingly established in the rural areas of developing countries due to the massive investments that have been made by various organisations such as the International Telecommunication Union (ITU 1998). Community radio has also been the most prevalent mass media in Africa because it is directed specifically at rural people and their information needs (FAO 1998). For example, there is one radio receiver for every five people, or at least one per household in sub-Saharan Africa (Buckley 2000). In particular, ICTs can address the essential information, knowledge and communications dimensions of persistent poverty and low agricultural growth in developing countries since they can enable rapid and efficient exchange of information and knowledge across distance (McNamara 2003). That is why various scholars have noted that ICTs can provide a window of opportunity to harness and utilize indigenous and exogenous knowledge for improved agricultural activities in developing countries (Emmanuel and Lwoga 2007; Sife, Lwoga and Chilimo 2004). It is evident that ICTs can be used as an enabler to manage IK and provide access to exogenous knowledge in the local communities.

However, Davenport (2007) argued that we know very little about how knowledge workers actually use ICTs, and how their jobs have been affected. Most KM initiatives have not investigated the benefits of KM and ICTs, which is one reason why the KM concept has suffered. Kozma (2006) asserted that there is a need for the development of a supporting social structure that would take the local community from information enthusiasts to knowledge producers. There is thus a need for a systematic inquiry of how ICT together with KM principles can be applied to manage agricultural IK and to appropriately introduce relevant exogenous knowledge in the local communities.

1.4 Problem statement

Despite its overwhelming potential in agricultural development, IK is not accorded the same recognition as conventional knowledge and consequently farmers are not recognised as formal sources of knowledge in developing countries including Tanzania (Kilongozi, Kengera and Leshongo 2005). Transfer of IK from generation to generation is mostly done through the oral tradition and demonstrations. IK is not equally shared in the communities due to issues related to power relationships and cultural differences (Mudege 2005; Wall 2006). IK is also commonly stored in the minds of elderly people who die and their knowledge is lost. In addition, most of IK has remained undocumented in developing countries including Tanzania (Dube and Musi 2002; Magara 2002; Mascarenhas 2004:4; Mshana 1992; Nwonwu 2008; Rouse 1999; Warren 1993). Nevertheless, Probst, Raub and Romhardt (1999:32) argued that knowledge must be selected, stored and regularly updated for potential future value. It is thus pertinent to determine a model for managing agricultural IK before much of it is completely lost.

Further, the existing global intellectual property regimes inadequately protect indigenous culture and knowledge from development, and often exploitation (Britz and Lipinski 2001:234). These regimes are largely derived from European concepts of the individual which seldom articulate the communal rights within its design (Britz and Lipinski 2001:234; Kabudi 2004). In the absence of a legal framework that protects IK, pharmaceutical companies have misappropriated genetic resources and IK that originate from African countries including Tanzania through the

patent system (McGown 2006). It is thus imperative to investigate how IK can be protected when managing IK in the local communities.

Despite the fact that the integration of indigenous and exogenous knowledge systems can improve agricultural productivity, the exogenous knowledge systems are characterised by inadequate attempts to integrate with IKS (Davis 2008; Friis-hansen 1999; Karlsson 1995:50; Rutatora and Mattee 2001; Thrupp 1989). Davis (2008) and Lemma and Hoffmann (2005) call for a move from "best practice" - imported standardized models to "best fit" where location specific, participatory, and sustainable models are used in order to improve farmer's knowledge system and practices. This situation does not only necessitate a need to determine a model to manage only IK, but also ways to strengthen the linkages between exogenous and indigenous knowledge for improved agricultural activities.

Various studies recognise the need for a methodology to manage IK for rural community development (Akiiki 2006; Chambers 1994b; Motteux *et al.,* 1999:261; Ngulube 2003; Noeth 2004; 2006; Sukula 2006). Within this context, there are many theoretical studies that discuss the extent to which IK can be managed by using KM approaches (Dlamini 2005; Kaniki and Mphahlele 2002; Kok 2005; Ngulube 2003). For example, Dlamini (2005) and Ngulube (2003) proposed that the Nonaka and Takeuchi (1995) knowledge creation model can be used to manage IK in the local communities. Kaniki and Mphahlele (2002) concluded that most KM principles can be used to manage IK, although the issue of ownership and responsibility for IK needs to be addressed. Lastly, Kok (2005) suggested that the Barclay and Murray (1997) KM model can be useful to manage IK. Supporting Kaniki and Mphahlele (2002) viewpoint, Kok (2005) also proposed that the issue of ownership needs to be addressed for effective IK management.

However, few studies have been conducted to assess the extent to which IK can be managed through KM approaches in the developing countries (Boateng 2006; Ha, Okigbo and Igboaka 2008; Mosia and Ngulube 2005; Noeth 2004; 2006). Other studies did not assess the application of KM approaches, but they investigated the management of IK in the local communities, and thus they were found relevant to the current study (Mudege 2005; Wall 2006). For example,

Boateng (2006) revealed that the circular KM model can be used by agricultural extension officers to inform farmers' decisions regarding improved technologies, and to incorporate farmers' knowledge in the design and development of such technologies in Ghana. Ha, Okigbo and Igboaka (2008) found that the Nonaka's (1994) knowledge creation model was partially fulfilled in their study of knowledge creation amongst farmers in Nigeria, and suggested that the collaborative model of knowledge dissemination can be partially effective among farmers in knowledge creation activities. Noeth (2004; 2006) found that the available information and knowledge was not managed effectively, and suggested that a generic KM model can be an effective way to improve KM activities and delivery of services in the rural communities of South Africa.

Mosia and Ngulube (2005) revealed that knowledge sharing activities of the communities in the Eastern Cape, South Africa were fragmented, and they suggested that communities of practice and storytelling can be effective ways to facilitate knowledge sharing. Mudege (2005) established that agricultural knowledge was primarily social and its production was a social process, and thus gender dynamics, politics, power, conflicts, resistance, religious beliefs and government policies determined the production and socialization of this knowledge. In Guatemala village, Siebers (2003) found that culture and power determined the knowledge sharing processes and the integration of the exogenous knowledge (*q'eqchi*) into the local knowledge system (*na'leb*). Wall (2006) also found that power and culture determined creation, sharing and use of agricultural knowledge in the rural Uzbekistan.

Certainly, it is evident that there are notable theoretical studies to better understand the application of KM principles and ICTs in managing IK in the local communities. It is also apparent that empirical findings on the management of IK, and integration of exogenous and indigenous knowledge in the Tanzanian context and elsewhere is lacking. Most of these studies have focused on the social construction of knowledge, and its embedded nature in socio-cultural and power relationships (Mudege 2005; Siebers 2003; Wall 2006). Few studies (Boateng 2006; Ha, Okigbo and Igboaka 2008; Mosia and Ngulube 2005; Noeth 2004; 2006) have attempted to analyze the role of KM approaches in managing farmers' knowledge with little attempt to

examine the integration of indigenous and exogenous knowledge, and role of ICTs in managing IK and providing access to exogenous knowledge in the local communities. It is also evident that the issues of ownership were inadequately addressed in the reviewed studies. In this regard, it is imperative to conduct a phased inquiry on these issues in order to provide empirical evidence of how KM principles and ICTs can be applied to manage IK, and introduce the relevant exogenous knowledge in the local communities for improved agricultural activities in Tanzania.

1.5 Purpose of the study

The aim of the study was to find out the extent to which KM principles and information and communication technology can be used to manage agricultural indigenous knowledge, and introduce the relevant exogenous knowledge in some local communities of Tanzania.

1.5.1 Objectives of the study

The specific objectives for this study were as follows:

1. To identify various types of agricultural indigenous knowledge and to establish the role of indigenous and exogenous knowledge in the farming systems in the local communities;
2. To study the current status of managing agricultural IK in the local communities;
3. To identify the agricultural information and knowledge needs of farmers in the local communities;
4. To determine the role of ICTs in managing agricultural IK in the local communities;
5. To find out how farmers accessed the agricultural exogenous knowledge in the local communities;
6. To identify the role of ICTs in providing access to agricultural exogenous knowledge in the local communities;
7. To assess the approaches that were used to facilitate the integration of agricultural indigenous and exogenous knowledge in the local communities;
8. To investigate the policies and legal frameworks that were relevant for protecting agricultural IK in Tanzania;
9. To determine the barriers that hindered the effective management of agricultural IK and access to exogenous knowledge in the local communities; and

10. To propose a KM model that could be used to manage agricultural IK in the local communities.

1.6 Significance and contribution of the study

This study sought to assess the application of KM approaches and ICTs in managing agricultural indigenous knowledge and introducing relevant exogenous knowledge in the local communities of Tanzania. The study findings were thus of significance by providing the empirical evidence of how KM principles and ICTs can be applied to manage IK and integrate exogenous knowledge to the rural knowledge system for improved agricultural activities. A further discussion about the significance and contribution of the study is presented in Section 7.3 of Chapter Seven.

1.7 Originality of the study

The originality of the study involved making an original contribution to knowledge in the following ways: carrying out empirical work that has not been done before in Tanzania; bringing about a synthesis that has not been made before in the country; using already known material such as previous literature but with a new interpretation for IK and KM studies; bringing new evidence to bear on old issues in IK studies; and looking at areas that people in the discipline have not looked at before such as IK and KM issues (Dunleavy 2003:27; Philips 1993 cited in Phillips and Pugh 2005:63). Further, originality in this study was found in the following: trying out something in Tanzania that has previously been done in other countries; taking a particular technique such as KM and applying it in the local communities of Tanzania; and being cross-disciplinary (Philips 1993 cited in Phillips and Pugh 2005:63). A further discussion about the originality of the study is presented in Section 7.4 of Chapter Seven.

1.8 Assumptions of the study

This study was also based on the following assumptions:

- The effective application of KM principles were instrumental for the successful IK management in the agricultural sector;

- The application of KM principles and ICT alone could not necessarily assure the effective management of IK; and

- The clear understanding of the barriers to the application of KM principles and ICT in managing IK provided a starting point for the effective management of IK and its integration to other knowledge systems in the rural areas.

1.9 Methodology

The purpose of the study was to explore the extent to which KM principles and ICT can be used to manage agricultural indigenous knowledge, and introduce exogenous knowledge in some local communities of Tanzania. This study used mixed methods in order to triangulate various data collection instruments with the intention that they will all converge to support the research objectives of the study (Leedy and Ormrod 2005:99). The study collected both qualitative and quantitative data from the rural areas of six selected districts in Tanzania. The dominant-less-dominant model (Creswell 1994; Tashakkori and Teddlie 1998) was used in this study where the qualitative approach was the dominant research method. This study was mainly dominated by a qualitative approach because it is a useful method to study human action in a natural setting, attempting to make sense of, or interpret, phenomena in terms of meanings people bring them (Creswell 2003:181; Denzin and Lincoln 2005:3; Patton 2002:40).

This study used concurrent design (also called parallel or simultaneous) of mixed methods research to collect both qualitative and quantitative simultaneously in a single data collection phase (Creswell and Plano-Clark 2007). The primary purpose of this study was to gather qualitative data. This qualitative data was collected through the following: semi-structured interview items, focus groups, non-participant observation, and participatory rural appraisal tools (information mapping and linkage diagrams, and problem trees). The secondary purpose was to gather quantitative data through closed questions which were embedded in the same semi-structured interviews. Both quantitative and qualitative data analyses were kept separate, and then they were combined or integrated into meta-inferences (Creswell and Plano-Clark 2007:118; Teddlie and Tashakkori 2009). Some of the qualitative themes were also transformed into counts, and these counts were compared with descriptive quantitative data (Creswell

2009:214). A further discussion about the research methodology is explored in greater detail in Chapter Four.

1.10 Scope and delimitation of the study

Scope and delimitation of the study 'builds a fence' around the research findings that are additional to the limitations and key assumptions established in the definition of terms (Perry 2002). For example, the explicit boundaries of the research problem can be described, and other implicit boundaries such as the industries chosen, the locations chosen, environmental factors, and variables that could not be controlled (Perry 2002). This study was set to assess the application of KM approach and ICTs in managing agricultural IK in the local communities in Tanzania. Accordingly, this study did not only focus on IK as entirely endogenous, but also sought to determine ways to synergically link exogenous and indigenous knowledge in order to strengthen farmers' knowledge base.

This study used the mixed methods where qualitative research technique was the dominant approach. The study mainly adopted qualitative approach because it was an effective method in studying and understanding human action in its natural settings (Babbie and Mouton 2001:278). The scope of the study was restricted to the rural areas of six regions from six zones out of seven research zones in Tanzania. These regions were selected due to their high agricultural production and the existence of ICTs such as telecentres. These criteria were used because the study sought to establish the role of ICTs in managing agricultural IK in the rural areas of Tanzania. The southern research zone was not included in the study because its telecentre was still at the planning stage and thus it was not yet operational.

Following the findings, the study recommended a KM model and appropriate ICTs that can be used to manage agricultural IK in the local communities in Tanzania. The testing of the model was beyond the scope of the study. However, areas for further research were suggested in order to examine the applicability of the developed KM model in managing indigenous knowledge, and integrating exogenous and indigenous knowledge in the local community context.

1.11 Ethical issues

Ethics refers to a code of conduct or expected societal norm of behaviour while conducting a research (Sekaran 2003:17). Any research needs to consider the following research ethics: protection from harm, informed consent, privacy and confidentiality of research data, honesty with professional colleague, and accuracy (Christians 2005; Cohen, Manion and Morrison 2007; Leedy and Ormrod 2005:101; Powell and Connaway 2007). Ethics pervades each stage of the research process, which are data collection, data analysis, reporting and dissemination of research results (Sekaran 2003:18). Creswell (2003:63) further described that ethical issues arise when specifying the research problem, purpose statement and research questions, and collecting, analyzing and writing up the results of data. This study adhered to the University of KwaZulu-Natal research ethics policy (UKZN 2009). The research complied with the University's code of conduct throughout the study. Further, all sources used in the study were acknowledged. The collected data were aggregated to reflect categories of responses, rather than individual responses in order to ensure confidentiality and privacy of respondents.

1.12 Outline of the thesis

The structure of the thesis was based on the guidelines and suggestions from the literature (Babbie and Mouton 2001; Cohen, Manion and Morrison 2007; Creswell and Plano-Clark 2007; Dunleavy 2003; Leedy and Ormrod 2005; Neuman 2006; Philips and Pugh 2005; Teddlie and Tashakkori 2009). The thesis is divided into seven chapters. Chapter One laid the foundation for other chapters by providing the general background information of the study, the statement of the problem, objectives of the study, the significance and assumptions of the study, scope and delimitations of the study, a brief outline of the methodology and ethical issues.

Chapter Two and Three dealt with literature related to the area of the study. Chapter Two described the area where the study was carried out and the reasons for selecting such a specific area for the study. On the other hand, Chapter Three dealt with the literature related to the study by revealing what had previously been done on the topic and what was proposed in this study. This chapter also provided the theoretical foundation of the study. In addition, Chapter Four presented the research methods that were used in the study. Chapter Five presented the findings

pertaining to each research question. The results were presented in the form of figures, tables and narrations. Chapter Six presented the interpretation of the findings in the light of the research questions. Chapter Seven presented the conclusions, recommendations of the study for the field. Further, the chapter proposed areas for further research. Finally, appendices were placed at the end of the thesis and they included data collection instruments, information maps, and letters to subjects.

1.13 Summary
This chapter introduced the core research problem and then laid the foundation for other chapters in the thesis. This chapter mainly presented the general background information of the study, the statement of the problem, objectives of the study and research questions. Further, this chapter discussed issues related to the significance and assumptions of the study, scope and delimitations of the study, a brief outline of the methodology and ethical issues.

The key theme emerging from this chapter was that it is important to manage agricultural IK because many of the farming systems which guarantee food security at the community level evolve from IK in developing countries including Tanzania. However, IK particularly in the agriculture sector is becoming extinct due to the lack of an approach to manage it. IK is largely tacit, stored in people's minds and unequally shared in the communities. The dominant information management system mainly acquires, shares and preserves knowledge generated by the universities, research institutes and so on. This model leaves little room for the management of the IK of the rural communities in developing countries including Tanzania. Further, there are little efforts to integrate exogenous and indigenous knowledge in order to strengthen the farmers' knowledge base. Nevertheless, many studies in Tanzania have recommended a need to quickly recognise and manage agricultural indigenous knowledge. Thus, it became imperative to investigate the application of KM approach and ICT in managing agricultural IK, and providing access to exogenous knowledge in the local communities of Tanzania. The following chapters provided answers to the research objectives in order to expand the knowledge base on the application of KM approach and ICT in managing agricultural IK, and providing access to exogenous knowledge in the rural areas in general and Tanzania in particular.

CHAPTER TWO: CONTEXT OF THE STUDY

2.1 Introduction

This chapter discusses the literature on the management of indigenous knowledge (IK) and access to exogenous knowledge for agricultural development in the Tanzanian context. Firstly, the chapter provides a short description of Tanzania. Secondly, it presents an overview of the agricultural sector, and the management of IK for agricultural development. Thirdly, the chapter discusses the role of exogenous knowledge for agricultural development, and its accessibility in the rural communities of Tanzania. Fourthly, it provides an overview of the ICT sector and its role in managing agricultural IK and disseminating exogenous knowledge in the rural areas. Finally, the chapter provides an overview of the six districts involved in the study.

2.2 Overview of Tanzania history, politics and economy

The United Republic of Tanzania is located in Eastern Africa. Tanzania is a union of two countries namely, Tanganyika (Tanzania mainland) and Zanzibar (Tanzania Islands). It covers an area of approximately 945,087 square kilometres (CIA 2009). Its neighbouring countries are Kenya and Uganda to the North, Burundi, Rwanda and Zaire to the West, Zambia, Malawi and Mozambique to the South and Indian Ocean to the East (URT 2006a). Administratively, the mainland of Tanzania is divided into 21 regions, and the island of Zanzibar into five regions. The country is further subdivided into 129 districts (URT 2005a).

According to 2002 census, Tanzania has a population of 34.6 million, where 16.9 million people are males and 17.7 million are females. The growth rate of the population is 2.9 percent per annum (URT 2002b). Although the population is still predominantly rural, the proportion of urban residents has been increasing steadily, from 6 percent in 1967 to about 23 percent in 2002 (NBS 2006). There are approximately more than 130 ethnic groups. Each ethnic group has its own language, but Swahili and English are both official languages and Arabic is widely spoken in Zanzibar (Ramonyai and Konstant 2006). In terms of literacy rate, the adult literacy rate is 82 percent for the whole population. Females constitute 87 percent of the total population, while males are 77 percent (CIA 2009).

Tanganyika became a German colony in 1884, and after World War I, Germany's surrender brought Tanganyika under a League of Nations mandate with the United Kingdom acting as the administering power (Dahlgren 1994). This situation lasted until December 9, 1962, when Tanganyika became a republic with Julius Nyerere as the first president (Dahlgren 1994). Tanganyika and Zanzibar united in 26 April 1964 to form the United Republic of Tanganyika and Zanzibar, which was renamed as United Republic of Tanzania in 29 October 1964. From the independence in 1961 until the mid-1980s, Tanzania was a one-party state, with a socialist model of economic development. Beginning in the mid-1980s, Tanzania undertook a number of political and economic reforms. In 1992, the government decided to adopt multiparty democracy which led to the registration of 11 political parties. Chama Cha Mapinduzi (CCM) has been the ruling party before and after the introduction of the multi party system. Currently, elections are held every five years (URT 2006a).

Economically, Tanzania is still regarded as a developing country, with 36 percent of its population living below the poverty line (ITU 2004a). The total gross domestic product (GDP) for 2008 was $ 54.26 billion, and the GDP per capita income was $1,300 (CIA 2009). The Tanzania economy largely depends on agriculture, which accounts for 25.7 percent of the GDP, provides 30.9 percent of exports and employs about 70 percent of the total work force (CIA 2009). Tanzania's GDP growth rate for 2008 grew by 7.4 percent compared to 7.1 in 2007. The growth was mainly contributed by the increase in agriculture, fisheries, and service activities (URT 2009b).

Tanzania has come a long way in its efforts towards socio-economic development. Under socialism and the self-reliance path which was chosen soon after the independence, all major means of production and businesses were directly controlled by the State. As a response to the economic crisis during 1980s, the Government went through the implementation of a number of economic adjustment programmes such as the National Economic Survival Program (NESP) of 1981, the Structural Adjustment Program (SAP) of 1983, the 1986 Economic Recovery Programmes (ERP) I and II, and the 1996/97–1998/99 ERP, now called the Poverty Reduction and Growth Facility (URT 2005a; Wobst 2001). These programmes started to shift production,

processing and marketing functions away from the public sector to the private sector. Through the establishment of the Parastatal Sector Reform Commission (PSRC) in 1993, a total of 329 out of 425 parastatals entities have been privatized (Ngasongwa 2007:69). This process is still underway. The Government now retains responsibility for policy, the regulatory framework and the maintenance of law and order (MAFS 2005b).

Furthermore, a number of strategies have been put in place to strengthen and widen the contribution of various sectors for socio-economic development. These strategies include the Tanzania Development Vision 2025, and its implementation tools, the National Strategy for Growth and Reduction Poverty (NSGRP), and various sectoral strategies (URT 2005a). In particular, the Vision 2025 sets the goal for Tanzania of converting from a least-developed country to a middle-income country by 2025, and to transform from a low productivity agricultural economy to a semi-industrialized one (URT 2001a). On the other hand, the NSGRP is informed by the aspirations of Tanzania's Development Vision 2025. NSGRP is also committed to the Millennium Development Goals (MDGs), as internationally agreed targets for reducing poverty, hunger, diseases, illiteracy, environmental degradation and discrimination against women by 2015 (URT 2005b).

2.3 Agriculture sector in Tanzania

Despite the importance of the agricultural sector for economic development, low agricultural growth has been a major factor in the Tanzania's slow progress towards poverty reduction. For instance, the agricultural sector in Tanzania grew by 4.8 percent in 2008 and 4.0 percent in 2007 despite the projected growth of 5 percent per annum, and the actual growth rate of 5.1 percent in 2005 (URT 2009b). However, agricultural sector is supposed to grow by ten percent for a year in order to contribute towards poverty reduction (URT 2008a). Thus, this performance falls short of the needed growth.

Low agricultural productivity is caused by various factors. In reality, Tanzanian agriculture is dominated by smallholder farmers (approximately 85 percent of the arable land) who cultivate an average farm size of between 0.2 and 2.0 hectares and keep an average of 50 head of cattle (URT

2001b). About 44 million ha is arable, but the cultivated land is only about 11.9 million ha, where about 93 percent of arable land is dominated by small scale farmers (URT 2006b). There is also high potential for irrigation in Tanzania, whereby about 29.4 million ha are suitable for irrigation but only about 289,245 ha are under irrigation (URT 2008b). Further, about 70 percent of Tanzania's crop area is cultivated by hand hoe, 20 percent by ox plough and 10 percent by tractor, and women constitute the main part of the agricultural labour force (URT 2005a). Other factors include: impediments to food market access; limited capital and access to financial services; inadequate technical support services; poor rural infrastructure; infectious and outbreaks of plant and animal pests and diseases; and erosion of national resource base and environmental degradation (Sife, Lwoga and Chilimo 2004; Ramonyai and Konstant 2006; URT 2001b; 2005a).

In response to poor agricultural performance, the Tanzania government developed the Agricultural and Livestock Policy, and the Cooperative Development Policy in 1997 as guidelines of agricultural activities in a free market environment (URT 1997a). The Agricultural and Livestock Policy of 1997 proposed the liberalisation of agricultural markets and removal of state monopolies in the export and import of agricultural goods and produce; stressed government responsibility for industry regulation through commodity boards; and emphasised on food security at the national and household levels (URT 1997a). The Cooperative Development Policy provides a framework for the restructured cooperatives to operate on the basis of independent, voluntary and economically viable principles (URT 1997b). The government also formulated various policies related to agriculture, which include the Local Government Reform Programme (LGRP) of 1998, Land Policy of 1995, National Water Policy of 2002 and the National Forestry Policy of 2002.

The formulations of the Agricultural Sector Development Strategy (ASDS) of 2001, Agricultural Sector Development Programme (ASDP) of 2006 and Rural Development Strategy (RDS) of 2002 were a major step in implementing these policies and national strategies (URT 2006b). The ASDS aims to achieve better profitability and sustainability including improved management of agricultural resources, efficiency in managing inputs and outputs, and adoption of new

technologies and extension of use of existing technologies (URT 2001b). The RDS focuses on the development of the entire rural sector, including agriculture, non-farm economic activities, social services, and economic and social infrastructures (URT 2002a).

On the other hand, an Agricultural Sector Development Programme (ASDP) which began in 2006 provides the overall framework and processes for implementing the ASDS to contribute to the higher level agricultural growth and poverty reduction (URT 2006b). The main objectives of the programmes are: (i) to enable farmers to have better access to, and use of, agricultural knowledge, technologies, marketing systems and infrastructure; all of which contribute to higher productivity, profitability and farm incomes; and (ii) to promote agricultural private investment based on an improved regulatory and policy environment (URT 2006b). The ongoing projects/programmes implemented under the umbrella of ASDP include:

- District Agricultural Development Plans (DADPs) is implemented in all districts in the country. This component focuses on the local agricultural investments (such as rural infrastructure, agricultural inputs, and equipments), local agricultural services (research and extension services), and local agricultural capacity building and reform;

- Participatory Agricultural Development and Empowerment Project (PADEP) is implemented in 28 districts in the country. It focuses on community agricultural developments subprojects (community and farmers group investments and capacity building) and institutional strengthening and capacity building at district and national level.

- Agricultural Sector Programme Support (ASPS) is implemented in all 10 districts of Mbeya and Iringa Regions;

- District Agricultural Sector Investment Project (DASIP) is implemented in 25 districts in five regions. Project components includes the following: support to farmer groups formulations and enterprises managements, (capacity strengthening, training and technology dissemination), support the community to develop plans for agricultural activities, formulations of micro finance institutions and provision of credits and marketing and project managements;

- Agricultural Marketing Services Development Programme (AMSDP) covers eight regions. Its components are agricultural marketing policy developments, products empowerment and

market linkages (facilitates access to credits), financial market support, rural markets infrastructures (roads and markets) and programme organisation (Mlaki 2006).

These policies and strategies have opened up the agricultural sector to private investment in the production and processing, input importation and distribution, and agricultural marketing. The Government now retains the regulatory and public support functions or facilitation role in the agricultural sector (URT 2005a). Despite the government efforts to create the right conditions for sustainable agricultural development, the development and management of IK for agricultural activities have received low priority. For instance, the implementation of ASDP programmes which focus on demand driven and client oriented research and extension services is constrained by the low rate of local community's contribution and participation, poor supervision of funds allocated for the projects, and poor infrastructure (URT 2008a). Muyungi and Tillya (2003) also observed that the local communities which offer IK are not formally represented in various set-ups and research efforts. Research and documentation of IK is a sector which is not adequately coordinated in Tanzania.

However, farmers' knowledge has been responsible for improving agricultural productivity and ensuring food security for centuries in Tanzania. Statistics show that more than 90 percent of seeds planted in Tanzania are obtained from the informal system (Mushi 2008). The requirement of improved seed in the country is about 100,000 metric tons per annum, but actual sales are less than 13,000 tons annually (Mushi 2008). It is thus important to recognise and manage IK for improved agricultural productivity in the country. Otherwise, interventions in agricultural development will continue to fail if indigenous skills and knowledge are not adapted to improve farming activities (Brokensha, Warren and Werner 1980:7-8; Ogen 2006).

2.3.1 Agricultural knowledge and information services

The agriculture sector falls within the mandate of four ministries: Ministry of Agriculture and Food Security (MAFS), Ministry of Co-operatives and Marketing (MCM), Ministry of Water and Irrigation Development (MWI) and the Ministry of Livestock Development and Fishing Activities (MLDF) (URT 2001b). The agricultural knowledge and information services include

research, library and documentation services, extension and training. Apart from the government, the private sector is also allowed to deliver these services (URT 2005a).

2.3.1.1 Agricultural research system

Agricultural research has a major role to play in increasing productivity and profitability of the sector through development of conventional knowledge to generate improved technologies for the production systems (Kapange 2002). The Tanzanian National Agricultural Research System (NARS) comprises public organisations (Department of Research and Development (DRD), Tropical Pesticides Research Institute (TPRI), Sokoine University of Agriculture (SUA), Tanzania Forestry Research Institute (TAFORI)), and the private sector such as Non Governmental Organisations (NGOs), and crop research institutes for tobacco, coffee and tea. The DRD of the Ministry of Agriculture and Food Security is the lead institution of Tanzanian NARS and has the public role of conducting, coordinating and directing agricultural research in the country. DRD controls 22 research institutes which are organised under seven lead institutes in each of the seven agro-ecological zones. In February 2001, the Government relocated the livestock research institutes under the Ministry Livestock Development, although these institutes at field level remained under the responsibility of DRD (MAFS 2005b).

Zonal structures secure demand-driven and cost-effective participatory research programs (Kapange 2002; Shao 2007). However, the research institutes still face problems in technology development, which include limited trained and experienced human resource (specialists); poor infrastructure and equipped laboratories; irregular/ unsustainable financing which disrupts experiments (discontinuity); changing mind set of research staff and communities towards client-oriented research programs and demand-driven services (Shao 2007). Thus, there are still gaps in carrying out demand-driven research approaches, which recognise farmers as both creators and disseminators of knowledge.

2.3.1.2 Agriculture extension services

The agricultural extension services transfer agricultural technologies developed by NARS to rural communities in the country. Since 1988 to date, the major extension providers in Tanzania include public, private and donor supported projects. Public extension services includes the

Ministry of Agriculture and Food Security (MAFS) which is involved in policy and regulatory functions for the implementation of extension services, and the local authorities which are concerned with the implementation of agricultural policies, guidelines and procedures (MAFS 2000). The decentralization has put extension under local government authorities to enhance greater client participation in Technology Development and Transfer (TDT), and making these processes participatory as opposed to the previous centralized, top-down set up (Banzi and Mahava 2009). According to 2008 statistics, about 1,965 farmer field schools were established throughout the country with a total of 51,623 farmers (URT 2009a). The Ministry of Agriculture and Food Security also organizes agricultural shows annually in all seven research zones to create awareness of the available knowledge sources to rural farmers (URT 2009a).

Despite the fact that the participatory approaches are already introduced under ASDP, research shows that the agricultural extension officers are still deficient in participatory problem-solving skills because they are too used to the Training and Visit (T&V) system (Isinika 2000; Rutatora and Mattee 2001:157). Further, most farmers have very limited access to extension advice. The farmer-extension officer ratio presently ranges from 10,000-20,000:1 in the country (Concern Worldwide 2008). This fact shows that there are still gaps in the implementation of extension services that are participatory oriented in the country.

On the other hand, private extension services supplement public extension services and they comprise NGOs, donor-supported projects, private agri-businesses and farmer-led initiatives. Currently, they are 99 private extension service providers in the country (URT 2009a). Most NGOs and donor-supported projects use participatory approaches. Few of them have combined elements of the T & V system with participatory methods. Most private agri-businesses on the other hand do not have their own extension methodology as they are dependent on public extension staff (Rutatora and Mattee 2001:157).

Farmer-led initiatives include farmer groups, cooperatives, and savings and credit cooperative societies (SACCOS). Most farmer groups (FGs) in Tanzania are networked by a National Network of Farmer Groups, which in Swahili acronym is known as "MVIWATA". This network

was established in 1993 and it represents around 60,000 farming households in Tanzania (Kaburire and Ruvuga 2006). These farmer groups provide a better atmosphere in which new or improved technical information can be introduced and evaluated (Kaburire and Ruvuga 2006). However, they also face various problems that hinder the agricultural innovation and sharing. These problems include: poor coordination mechanisms within and between groups; lack of leadership skills, credits, and markets; low level of education; conflict of interest among members; high dependency on external support; and limited coverage due to their small numbers and expertise (Kaburire and Ruvuga 2006:85; Lema and Kapange 2006; Ngendello, Mgenzi and Schrader 2003:144). Indications are that there are still gaps in the provision of extension services in the country. It is thus important to consider all these factors for the extension services to have tangible impacts in integrating indigenous and exogenous knowledge in the local communities.

2.3.1.3 Agricultural library and documentation services

There is no single agricultural library that is specialized in serving the local communities in the country. The rural communities depend on the public library system to access information and knowledge services in the country (Manda 2002). The public libraries are organised under the Tanzania Library Services Board (TLSB), which is a national institution that operates under the Ministry of Education and Vocational Training. The TLSB has a mandate to promote, establish, equip and develop libraries, information centres, and documentation centres in Tanzania (TLSB 2009). Currently, there are 18 regional libraries, six district libraries and two divisional libraries (TLSB 2009). However, these public libraries are located in regional and district headquarters, and thus the target group is still the urban or peri-urban communities and not the local communities (Manda 2002). Originally, bookmobiles provided library services to rural areas; however, the services were halted due to lack of resources in terms of finance, human resources and information materials, and negligence of the rural borrowers to return books (Ilomo 1985; Kaungamno 1985). Lack of funds has also limited TLSB to establish a public library at every region and district within the country (Mcharazo 2000).

The Sokoine National Agricultural Library (SNAL) which is a university library of the Sokoine University of Agriculture (SUA), also serves as a national agricultural library (SUA 2009). However, SNAL has not been effective in serving farmers needs due to its poor communication

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with other partner libraries within the country (Dulle 1999). Further, nearly all agricultural libraries have inadequate resources in terms of acquisition, storage and dissemination of Information which limit access to relevant information and knowledge to rural farmers in Tanzania (Tanzania Department of Research and Training 1991). A study of six public libraries also revealed that lack of reading materials, reading space and high user fees were major barriers that limited access to information in the public libraries (Mcharazo 2000). Similar observations were made by Lwoga and Chilimo (2003), that high user fees prevented access to knowledge for some users in the university public libraries of Tanzania. Lack of current awareness/selective dissemination information services and absence of resource sharing among libraries are other major barriers that limit access and use of libraries in Tanzania (Dulle *et al.,* 2001). Thus, the information and documentation systems that exist within the country have been considered to be poor (Dulle *et al.,* 2001; Lwoga and Chilimo 2003; 2006; Lwoga and Sife 2006; Manda 2002), which contributes to low agricultural production in the country.

2.3.1.4 Agricultural training and formal education system

The public institutions including the Ministry of Agriculture Training Institutes (MATIs), the Livestock Industry Training Institutes (LITIs), the Sokoine University of Agriculture (SUA), the Moshi University College of Co-operative and Business Studies (MUCCOBS) and other public institutes normally conduct training to extension staff, farmers and other agricultural professionals (URT 2001b). Private extensions services such as NGOs also conduct training for farmers and farmer groups on various issues such as leadership and financial management (Heemskerk and Wennink 2004:38).

However, IK is not considered as important as other knowledge systems in the formal education system in the country. Although the educational system in Tanzania provides for the re-appropriation of IK into the formal education (URT 1996c), it has not been mainstreamed into the formal education (Hogan 2007). Only few agricultural universities, training institutes and schools have incorporated IK into their curriculum in the country, such as the Sokoine University of Agriculture, Morogoro Livestock Training Institute (Minja 2002), and Noonkodin Secondary School which is located in Northern Tanzania (Aang Serian 2008). Thus, more efforts are needed to develop and include IK in the curriculum of primary and secondary education and higher

education in Tanzania to ensure that IK is preserved for future generations. For instance, a study by Hogan (2007) demonstrated that the integration of local knowledge in primary education improved the relevance and quality of teaching and learning in school-community contexts, and provided a conduit for integrating conventional education into the formal school curriculum in Tanzania.

2.4 Indigenous knowledge in Tanzania

The physical/biological diversity and cultural diversity that embraces more than 130 tribes represents a wide variety of IK systems in Tanzania (Koda 1999; 2000; Mascarenhas 2003). IK is an important part of the various fields, including agriculture, health, veterinary, and arts and crafts. However, IK is still underestimated and under-valued for many reasons, including the disappearance of local cultures, a prevailing colonial mentality, increasing control by government, inadequate incentives, an institutional framework that is heavily tilted against creativity, diversity and IK, and a bureaucratic system that promotes the conventional knowledge from the west (Mascarenhas 2004:8). For instance, Tanzania has not formulated a specific policy which deals with IK. Currently, IK is covered in various national strategies and sectoral policies as indicated in Table 2.1.

Table 2.1: Relevant sectoral and cross-sectoral policies and strategies

Policies and strategies	Details
1990 Health Policy	It recognises the importance of traditional healers and birth attendants in delivering health services.
1995 Land policy	IK is not mentioned
1996 Community development	IK is not mentioned
1996 Education and training policy	It seeks to strengthen the integration of formal and non-formal relationship, by instituting points to knowledge comparability and inter-mobility within the two sub-sectors of education
1996 National Science and Technology Policy	IK issues were implied without explicit mention to ensure that they are protected.
1996 Sustainable Industrial development policy	It addresses IK in terms of copyright and patents acts. However, IPR does not adequately recognise and protect IK.
1997 Agriculture and Livestock Policy	IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It recognises the relationship between IK and agricultural research.
1997 Cooperative development policy	IK is not mentioned

1997 Cultural policy	IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It stresses the need to identify, preserve and disseminate environment friendly traditional knowledge and technologies.
1997 Environment policy	A policy statement with reference to IK issues without elaboration, but enough to warrant distinct implementation. It addresses the development of biotechnology by allowing fair and equitable sharing of the results and benefits arising out of utilisation by foreign recipients, and of genetic resources originating from Tanzania.
1997 Fisheries policy	IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It recognises the need to promote acquisition and documentation of traditional fisheries knowledge.
1998 Forest policy	A policy statement and strategies on community involvement for sustainable forest management.
1998 Wildlife policy	IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It recognises the use of IK in the conservation and management of natural resources.
2001 Agricultural Sector Development Strategy (ASDS)	It focuses on incorporating IK at the district level through District Agricultural Development Plan (DADP) as part of the District Participatory Plan (DPP).
2003 ICT policy	IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It emphasizes the use of ICTs to collect and disseminate relevant local knowledge and content in local languages.
2005 National Strategy for Growth and Reduction Poverty (NSGRP)	It acknowledges the use of IK for agricultural development and wildlife management.
2025 Tanzania Development Vision	IK issues implied without explicitly being mentioned.

Sources: (Kabudi 2003; Kaiza-Boshe 2003; URT 1990; 1995; 1996a; 1996b; 1996c; 1997a; 1997c; 1997d; 1997e; 1998a; 1998b; 2001a; 2001b; 2003a; 2005b).

Few policies have placed high importance on IK issues while the rest either did not mention IK, or it was acknowledged implicitly. Only the policies in wildlife, fisheries, ICT and agriculture and livestock prioritized IK issues but other key policies (community development and land policy) did not mention IK. Other policies (such as wildlife, environment, forestry, science and technology, education, health and culture) acknowledged IK but at a low level as observed by various scholars (Kabudi 2000; 2003). Overall, IK issues receive inadequate treatment in the entire policy framework in Tanzania. Most of these policies are not backed by implementation instruments, such as strategies and laws (Kabudi 2003). Kaiza-boshe (2003) noted that the government capacity to formulate laws is highly dependent on external support for funding and technical assistance. Thus, the development of policies and laws that are attractive to donors are

formulated at a faster pace, while policies that are not attractive to donors may never have implementation instruments installed (Kaiza-boshe 2003). For instance, the comprehensive program for food security never got implemented due to donors influence on funding and technical assistance (Kaiza-boshe 2003).

Further, the key policy institutions which are concerned with IKS do not have the necessary capabilities to install and oversee policy implementation mechanisms in Tanzania due to the lack of a functioning and effective coordination mechanism. Kaiza-Boshe (2003) reviewed eleven institutes that deal with agricultural IK issues in Tanzania and revealed that all institutions were planning on, working on, otherwise reviewing action plans for the implementation of their respective policies due to lack of financial support. It is thus important to sensitize policy makers in relevant sectors on IK issues, with the view of getting them to install mechanisms to recognise, protect, promote and support use of IK for agricultural development.

Despite the fact that IK does not receive adequate treatment in the entire policy framework, there are various initiatives within the country that promote the integration of IK in the developmental programmes. For instance, in October 2004, the Tanzanian president endorsed a six-point action plan to raise the profile of IK, mainstream IK in country development programs, and secure additional funding from development partners (World Bank 2009a). Further, the FAO-LinKS Project in collaboration with the Tanzania government has been instrumental in promoting IK through capacity building, research and advocacy activities. By 2005, the FAO-LinKS Project had achieved the following: 400 trained researchers and extension officers; developed curriculum on IK issues at the Sokoine University of Agriculture; sixteen research studies on IK; and the establishment of Trust Fund in 2005 to promote the development and implementation of IK policies, strategies and intellectual property rights in Tanzania (FAO 2007a). However, the momentum for formulating a national strategy and action plan for IK is yet to be built. Given the fact that IK does not receive adequate treatment in the sectoral and national policies, there is thus a need to develop a comprehensive policy, strategy and action plan that will specifically deal with IK issues in the country.

2.4.1 Indigenous knowledge and agricultural development in Tanzania

The agricultural practices have increasingly proved to be productive, sustainable and ecologically sound, even under extraordinarily difficult conditions due to the utilisation of IK in Tanzania (Mugurusi 2001). Most farmers practice low input agriculture (approximately 80 percent of the agriculture) in the country (Mella *et al.,* 2007). The traditional sector accounts for about 99 percent of the country's cattle, 85 percent of the poultry (Hill 2003:1), and more than 90 percent of the seeds planted in Tanzania (Mushi 2008). In reality, the potential of IK in improving agricultural production, conserving environment and ensuring food security at the local level in Tanzania can be gauged by the following: the matengo pits practiced in Ruvuma region, the ufipa mound system, the traditional terracing systems of the Iraqw, and the rotational fallowing systems in Mufindi District (Kauzeni and Madulu 2003; Mattee 1998; Mugurusi 2001; Naess and Missano 2000).

However, many of the traditional farming systems were sustainable only under low-input–low-output regimes. The introduction of mechanization, fertilizers and phytomedicines has turned some of these systems into high-input–high-output systems, most of which were either not sustainable or did not produce high outputs that were expected (Aluma 2004:24). The major causes for this problem is the market restrictions, land use rights, inappropriate technology transfer, poor communication infrastructure and poor access to rural finance (Kaburire and Ruvuga 2006:85; Lema and Kapange 2006; Ngendello, Byabachwezi and Schrader 2003:144). The modernization of agriculture has also reduced genetic variability of crops and livestock. It is estimated by FAO that 30 percent of animal genetic resources are at high risk of loss due to negligence of IK in favour of conventional scientific findings (Muyungi and Tillya 2003).

Researchers and producers are now counteracting this trend by re-introducing indigenous species back into the gene pool of domestic crops and livestock (Aluma 2004:24). Further, due to ongoing campaigns on environmental conservation, farmers in Tanzania, like other parts in the world are becoming more aware of the hazardous effects of industrial agro-chemicals, and thus they are reverting to indigenous inputs (Mgumia 2001). Many African communities also revert to indigenous plants and crops in the event of severe shortages of the major staples (Aluma

2004:25). However, indigenous farming has received but a fraction of the research attention of the major crops in developing countries including Tanzania (Aluma 2004:25). For example, the crop research policies in Tanzania emphasize research to be conducted on crops with export potential. As a result, research institutes and extension agents in Tanzania neglect crops that are vital for food security such as traditional crops (Manda 2002:185). Thus, the development of indigenous farming methods in Tanzania rely on the farmers' observation, experimentation, adaptation and propagation of new ideas gained through experience (Koda 2000:22; Mugurusi 2001). There is thus a need to continuously recognise, identify, validate, preserve and disseminate indigenous skills and practices for improved agricultural activities.

2.4.2 The management of agricultural indigenous knowledge in Tanzania

Despite its potential for agricultural development, IK is not properly managed in Tanzania and thus it is not effectively replicated in other communities (Koda 1999; Mgumia 2001; Sempeho 2004). Instead, IK is threatened by erosion in Tanzania on account of a lack of proper documentation and exchange of IK information; inadequate awareness of the importance of IKS, innovations and practices; and issues of benefit-sharing (Mugurusi 2001). Most of the traditional structures for packaging and sharing IK in Tanzania have disappeared while attempts to replace them have been futile (Koda 1999:6). Even when IK is documented, in most cases, such information is neither made available to farmers in a usable form nor relates to the targeted groups' own surroundings and culture (Mgumia 2001; Sempeho 2004). For instance, even where IK is promoted, the tendency has been for its content to be commercialized and hence there is decreased accessibility for the majority of non-affording users (Koda 1999:6).

Due to inadequate documentation efforts, agricultural IK is mostly stored in people's minds and often expressed and shared through individual and collective interactions. The older members of the villages are the major custodians of this type of knowledge (Kauzeni and Madulu 2003). IK is mainly shared through face-to-face interactions, folklore activities, artefacts, deliberate instructions and direct observation and practices (Akullo *et al.,* 2007; Ihucha 2006; Ikoja-Odongo 2006; Owuor 2007; Rao 2006; Sen and Khashmelmous 2006). The existing structures or set norms are also used to safeguard and ensure further development of IK in Tanzania (Kauzeni

2000). In particular, IK is shared through its three basic categories, which include the "public" knowledge to which access is unrestricted, "discretionary" knowledge which is usually clan-based and is hence accessed along clan lines (such as tin smithery/pottery knowledge) and "secretive" knowledge which is usually accessed through inheritance such as medicinal knowledge (Kauzeni 2000). As a result, IK is not equally distributed in the local communities. There is thus a need to determine an approach to enable the acquisition, sharing, preservation and use of IK in the communities for the improved agricultural practices in the country.

Further, men and women hold different types of agricultural knowledge, reflecting their roles and responsibilities in the household (Kaiza-boshe 2003:5; Koda 2000; Naess and Missano 2000). Women often form the major workforce in agriculture as compared to men in most developing countries including Tanzania (Kaiza-boshe 2003:5; Koda 2000; Naess and Missano 2000). Men tend to be more involved in, and have control over, income-generating activities, and hence more oriented towards conventional agricultural techniques and practices (Naess and Missano 2000). Thus, women are the major custodians of knowledge pertaining to farming and food security since they contribute most of the labour in agricultural activities in Tanzania (Kaiza-Boshe 2000; 2003; Kessy 2006:21; Mattee 1998). However because of gender, women's local knowledge is marginalized due to the generally inferior position accorded to women in many ethnic groups. The result of all this is relatively low productivity, worsening poverty and increasing food insecurity (Kaiza-Boshe 2000; 2003; Koda 1999). Thus, any intervention aimed at improving the management of IK in Tanzania cannot be effective if the linkages between gender and IK are not taken into consideration.

There are very few initiatives that have focused their attention on the management of IK in Tanzania, which include farmer groups and donor funded projects. For example, the national farmer groups network known as MVIWATA facilitates the exchange of farmers' knowledge through a bottom-up participatory approach (Kaburire and Ruvuga 2006: 84). The Uluguru Mountains Agricultural Development Project (UMADEP) in Morogoro region is another initiative in Tanzania which uses participatory approaches to document farmer's knowledge on natural crop protection. This knowledge is shared with other farmers through local and relevant

educational printed materials and farmer-led training workshops (Mgumia 2001). There is thus a need to strengthen the existing initiatives to ensure that IK is managed for improved agricultural practices in the local communities in Tanzania.

2.5 Legal framework relevant to the protection of agricultural indigenous knowledge in Tanzania

Intellectual Property Right (IPR) is an important legal instrument by which indigenous people can be protected from exploitation (Kauzeni and Madulu 2003). IPR refers to creations of the mind, which include inventions, literary and artistic works and symbols, names, images, and designs used in commerce (Akabogu 2002). In Tanzania, there are various government institutions that are responsible for different aspects of IPRs. Among others, these institutions include the Business Registrations and Licensing Agency (BRELA) which is an Executive Agency with an authority to regulate businesses and administer intellectual property laws (BRELA 2007a). Copyrights Society of Tanzania (COSOTA) is another statutory corporation which is responsible for copyright administration (COSOTA 2007). Plant Breeders Rights office under the Ministry of Agriculture is responsible for the legal protection of new plant varieties (URT 2005a). The Tanzania Intellectual Property Advisory Service and Information Centre (TIPSAC) is another initiative under the Commission of Science and Technology (COSTECH) which disseminates patented innovations in Tanzania through ICTs (BRELA 2007b).

Tanzania also has a number of acts which govern IPRs within the country. These acts include the Copyright and Neighbouring Rights Act of 1999, the Patents Act of 1987, the Trademarks and Services Act of 1986, and the Protection of New Plant Varieties (Plant Breeders' Rights) Act of 2002 (URT 1986; 1987; 1999; 2002c). For instance, the Copyright Act protects the expression of folklore against illicit exploitation (URT 1999). Although folklore has been included in the copyright legislation of Tanzania, that aspect needs to be expanded to cover IK issues that are not expressly mentioned in the Act (Kabudi 2004:40). Further, the Patent Act stipulates that an invention must be novel, show inventive steps and industrial application or be of practical use (URT 1987). These requirements make the law more limited in terms of protecting agricultural

indigenous innovations, such as genetic resources because IK is collectively generated and owned (Davis 1998; Simeone 2004).

Similarly, the Plant Breeders Rights provide protection for biological resources of the plant varieties if the standard conditions of distinctness, uniformity, stability and novelty (must be new) are met (URT 2002b). However, IK cannot be new since it is developed cumulatively and it is collectively owned. Thus, this law is at risk of accelerating IK loss by undermining traditional values of farmers' knowledge through its exclusively commercial bias. In addition, the trademarks and Services Act is a means of protecting medicinal plants and traditional medicinal knowledge. However, this act is limited in terms of protecting IK because it is there to address the following: (i) protect the public by preventing mistakes, deception and confusion with regard to origin; (ii) protect sellers' goodwill; (iii) indicate origin; (iv) guarantee equality; and (v) serve as a marketing and advertising device (Kabudi 2004:42).

Further, there are some international conventions and treaties that recognise IKS in natural resources management and their value in agriculture such as the Convention on Biological Diversity (CBD, *sui generis,* Organisation of African Unity (OAU) model, and the Global Plan of Action on Plant Genetic Resources for Food and Agriculture (Kaiza-Boshe 2000:52; 2003:17). However, few international conventions and treaties that recognise IKS have been domesticated in Tanzania to the extent of becoming legally enforceable (Kaiza-Boshe 2000:52; 2003:17). International regulatory instruments are inadequately implemented in Tanzania due to inadequate human resources, technical capacity, financial resources, and the absence of well-defined institutional frameworks capable of ratifying and formulating laws (Kaiza-Boshe 2003:18).

In the absence of a legal framework, a wide range of plants and animal genetic resources from Tanzania have been pirated under the auspices of patent laws in the developed world. For example, Minja (2002) reported that the Maasai red sheep from Tanzania, known to be resistant to disease, is now being patented and cross-bred in Australia. Further, an analysis of the British patent taken out by the multinational biotech giant Syngenta revealed that the Busy Lizzie garden

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plant came from the rare *Impatiens usambarensis*, which grows in the Usambara mountain range in Tanzania (Barnett 2006). There is still a growing debate about whether profits from these patented resources should be shared with the local communities of Tanzania or not.

On the whole, IPRs that are available in Tanzania protect the rights of biotechnology companies, but they provide inadequately in terms of protection for the agricultural IK in the local communities. IK is usually considered as not "new" (lacks novelty) and it is cumulatively developed and collectively held and shared in the community. There is thus a need to review the current legislation in order to protect IK and access to genetic resources, and to ensure approval of and benefit sharing with the local communities. There is also a need to domesticate the international conventions and treaties that recognise IKS in Tanzania

2.6 Exogenous knowledge and agricultural development in Tanzania

Indigenous farming alone cannot ensure sustainable agricultural productivity. Studies have shown that the integration of indigenous and exogenous agricultural techniques can allow better results in the farming practices in Tanzania (Kilongozi, Kengera and Leshongo 2005; Mascarenhas 2003; Naess and Missano 2000). Exogenous knowledge is a key component in improving small-scale agricultural production and linking increased production to remunerative markets, thus leading to improved rural livelihoods, improving quality and yield, food security and national economies (Asaba *et al.,* 2006; Kaaya 1999:317).

Despite its potential for improving agricultural production, there is still a low rate of adoption of conventional technologies in Tanzania which contributes to low agricultural productivity (Ngendello, Mgenzi and Schrader 2003:143). Many factors contribute to the low adoption rate and implementation of the relevant agricultural innovations in the rural areas of Tanzania, these include: inadequate linkages between research, extension and farmers (Shao 2007); poor attitude of farmers toward new technology; inadequate understanding of the socio-economic organisation of farmers on the part of scientists who develop innovations; lack of credit for agricultural inputs (Manda 2002); limited scale of production; low producer prices; poor functioning; partial collapse of the seed multiplication system; and high input prices (Limbu 1999). For exogenous

knowledge to make any significant contribution to the agricultural development in Tanzania, certain critical constraints that hinder the adoption of agricultural technologies must first and foremost be addressed. This fact shows that access to relevant exogenous knowledge is one of the important factors for improving adoption of new technologies and agricultural productivity.

2.6.1 Access to agricultural exogenous knowledge and information in Tanzania

The improved information flow to and from, and within the agricultural sector is a prerequisite for effective agricultural development (Kaaya 1999; Manda 2002). The agricultural policies and strategies in Tanzania (that is, Agricultural and Livestock Policy, Agricultural Sector Development Strategy and Agricultural Sector Development Programme) also emphasize the need to enable farmers to have better access to agricultural knowledge and technologies in order to ensure higher productivity, profitability and farm incomes within the country (URT 1997a; 2001b; 2006b).

The Tanzanian public extension services play a great role in the provision of agricultural technologies to rural farmers through participatory programmes, including the application of farmer field schools or 'shamba darasa' (MAFS 2005a). Agricultural shows have also been organised by the Ministry of Agriculture and Food Security at regional, zonal and national levels in order to bring together scientists, districts, NGOs, CBOs, and farmers to exhibit and share technologies (Byabachwezi *et al.,* 2003:16; Lema *et al.,* 2003). Private extension services such as NGO, private agribusiness companies, and donor-funded projects are also involved in the dissemination of agricultural technologies to the smallholders in Tanzania (Rutatora and Mattee 2001:164). Farmers' groups (FGs) also play a role in collecting and disseminating practical and technical information through formal and informal networks within their structure. For example, the National Farmer groups Network (MVIWATA) documents and disseminates agricultural technologies from research institutes and extension services to the farmers through written materials, radio programmes and newsletters (Kaburire and Ruvuga 2006). Further, the agricultural research institutes have also been instrumental in organising various extension services to disseminate useful agricultural knowledge and technologies to farmers, such as: training, open days, farmer field days, technology market, and stakeholder tours (Byabachwezi *et al.,* 2003:16; Kaaya 1999:318; Ngendello, Mgenzi and Schrader 2003:148).

In spite of various initiatives associated with rural information provision, farmers still face problems when accessing agricultural information in Tanzania. The lack of an enabling environment in terms of the financial and/or labour requirements of the proposed options has contributed to poor extension services in the country. For example, in 2007, the Government recruited 306 extension officers which falls short of the real target of employing 2500 extension officers due to the problem of getting qualified ones (URT 2008a). Further, the extension services are poor due to weak coordination and linkages between research organisations, public and private extension services, and farmers; weak integration of livestock and crop specialists; insufficient level of farmer involvement; lack of proper prioritizations of problems; technology may not be adapted to farmer conditions; research outputs are not available in appropriate usable and accessible form to farmers; lack of awareness of available technologies; and farmers may be aware of a certain innovation, but do not know how to implement it due to lack of training (MAFS 2001; Ngendello, Mgenzi and Schrader 2003:144; Rutatora and Mattee 2001:164; Sempeho 2004; Shao 2007). Despite these problems, extension services are still the main method used for disseminating information to farmers in Tanzania (Dulle and Aina 1999). Indications are that there are still gaps in the provision of extension services in Tanzania.

2.7 The integration of indigenous and exogenous knowledge systems in Tanzania

As much as local people need IK which exists in their communities, they also need exogenous knowledge and information which may be irrelevant to their immediate needs, but some of it is important (Kozma 2006:10). For instance, the use of some indigenous practices has led to soil infertility due to ineffective farming practices, overgrazing, deforestation and bushfire which limit the increased agricultural productivity in Tanzania (Mwinuka 1999:10). It is estimated that overgrazing causes soil erosion at around 71 hectares annually in Mbalali district in Tanzania (Lukumbo 1998). Nevertheless, if some of these weaknesses can be modified, farmers' decisions and skills can be improved. IK can be used as a starting point for a process in which indigenous and exogenous knowledge can merge into an effective development strategy which is controlled by the local people rather than the development agent (Van Vlaenderen 2000:3).

There are few initiatives in the country that have spearheaded the recognition and prioritization of IK in the rural areas, in the areas of extension services, research, rural fairs and farmer groups. Under the Agricultural Sector Development programmes (ASDP), the public extension services use participatory approaches and demand driven techniques to integrate farmers' knowledge into the conventional technologies (URT 2009a). Further, the research institutes under the Ministry of Agriculture and Food Security and the Sokoine University of Agriculture (SUA) conduct the participatory research in order to incorporate farmers' knowledge into the mainstream knowledge system, and inform farmer's decisions when adopting new technologies in their farming systems (Mascarenhas 2003:4). Further, farmer groups (FGs) such as MVIWATA have also been active in changing farmers' attitudes towards adapting new technologies in order to build their own knowledge base. MVIWATA also encourages formal research to improve IK in order to make agriculture more rewarding (Kaburire and Ruvuga 2006:83).

Rural seed fairs are another initiative organised by research institutes in Lake Zone, Southern Zone (such as Naliendele Agricultural Research Institute) and other zones to create awareness of and accessibility to additional alternative seeds and planting materials from research institutions, seed companies and farmers (Mponda and Kafiriti 2002; Naess 1999). Promoting Local Innovations in Sustainable Agriculture (PROLINNOVA) is another international initiative in Tanzania spearheaded by NGOs that use participatory innovation processes to integrate the dynamics of IK and exogenous knowledge where mutual learning is based on joint action and analysis. This programme started to operate in Tanzania in 2005 through PELUM (Participatory Ecological Land Use Management) (PROLINNOVA 2009).

Despite the existence of various initiatives that build on farmers' knowledge, the convergence of exogenous and traditional agricultural production systems seems to be fragmented in Tanzania. Although, they have adopted a more participatory approach since 1996, agricultural research and extension are largely continuing with top-down non-participatory approaches (Hill 2003:1; Maeda-Machang'u *et al.,* 2000; Rutatora and Mattee 2001:159). This fact is mainly due to insufficient numbers of extension officers with adequate participatory problem-solving skills in the country (Friis-hansen 1999; Isinika 2000; Rutatora and Mattee 2001). Further, the Tanzania's

public extension service mainly involves contact farmers [1](mostly men) when disseminating technologies in the rural communities instead of involving both nodal and contact farmers (Kessy 2006:21). Nodal farmers (mostly women and elders), have more IK on various agricultural aspects since they are more involved with agricultural activities (Kessy 2006:21). Thus, the extension services are more supply-driven rather than demand-driven and hence issues of relevance, cost effectiveness, ownership, and sustainability are not adequately addressed (Rutatora and Mattee 2001).

The failure of farmers to influence research priorities is another factor contributing to the lack of collaboration between research and traditional agricultural production systems in Tanzania. Although, farmers and farmer group's representatives are increasingly involved in the priority setting of research programmes, they have so far failed to really influence the research agenda directly. In reality, researchers still decide on the area of intervention since they dominate the planning agenda (Heemskerk and Wennink 2004:88). Further, the research institutes' managers select farmers on the basis of proposals written by the government's regional agricultural office rather than farmers themselves deciding who should represent them. Many of these selected farmers largely represent their own personal interests and concerns, and contribute little to real downward accountability of district agricultural service providers (ASPs). Another problem is that not all farmers are yet organised into groups; those who are organised are not yet formally recognised, and all face an across-the-board capacity problem (Lema and Kapange 2006). Indications are that there are still gaps in the integration of exogenous and indigenous knowledge systems in the local communities in the country.

2.8 Information and communication technology sector in Tanzania

ICTs are important enablers for accelerating socio economic development and a catalyst for achieving set goals more expeditiously (Lwoga *et al.,* 2006; Temba 2005). Formally, the ICT issues used to be coordinated by the Ministry of Communication and Transport (MCT) in

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[1] The Tanzanian national system (extension services) identifies contact farmers to produce seeds of improved varieties for their villages. Contact farmers follow production packages and guidelines under the supervision of agricultural extension officers (Kessy 2006:21).

Tanzania. Since February 2008, the ICT issues have been coordinated by the Ministry of Information and Communication Technologies. The government also formulated various policies related to ICTs, which include: Information and Communication Technology Policy (2003), Postal Policy (2003), National Information and Broadcasting Policy (2003), Tanzania Communications Regulatory Authority (TCRA) Act (2003), Converged Licensing Framework (CLF) (2005) and Telecommunications Policy (1997). These policies guide the development or use of ICTs in the country. They also reflect national goals, objectives and aspirations as expressed in Tanzania Development Vision 2025, setting out digital opportunities that Tanzania can exploit towards meeting the Vision 2025. These policies also reflect the National Strategy for Growth and Reduction of Poverty (NSGRP) goal of supporting the increased access and application of ICTs in order to accelerate productivity in all fields of work (URT 2001a; 2005b). However, there are mixed feelings about the impact of ICT policy in the country. A study of 26 agricultural institutions in Tanzania revealed that despite the removal of taxes on ICTs, the cost of acquisition and use of ICT was still high (Shetto 2008).

The development of these ICT policies and laws made it possible that in 2006, licenses for 47 radio stations were issued (TCRA 2009a). The Tanzania Broadcasting Corporation (TBC), the national radio station remains the major source of developmental information to rural communities due to its wide coverage on the rural areas as compared to other radio stations in the country (Development Associates Ltd 2004b; Shetto 2008). Although, more than 85 percent of Tanzanians own a radio (Batchelor, Scott and Eastwick 2005:14), there are only eleven community radio stations that ensure media pluralism, diversity of content, and the local representation (UNESCO 2009). There is a low number of community radio stations due to the high costs of registration (between $500 and $2500) and the annual fee (between $1000), as well as the energy requirements to run a station are very high. There are no special concessions for the establishment of community radio stations in the country (MISA 2006). Further, the information and broadcasting policy limits broadcasts to Swahili and English, in order to reduce tribalism and maintain unity in the country (URT 2003b). This language restriction limits the use of vernacular languages which would promote better penetration of knowledge and ownership in the rural communities.

In terms of TV, there are increasing numbers of TV stations in the country, with 29 television transmission stations (TCRA 2009a). However, approximately 90 percent of the televisions broadcasting services are concentrated in big cities (Dar es salaam, Mwanza, and Arusha). People in small towns and rural areas have to use satellite dishes to receive television signals, which prevents a large number of people accessing the service due to high initial cost (Isamuyo 2006:11; MISA 2006). Further, in 2006, only six percent of households in the country owned a TV set due to limited provision of electricity, with only 11 percent of households having access to power (TCRA 2007). Indications are that there is limited TV viewership especially in the rural areas due to lack of electricity.

The enactment of policies and laws on the telecommunications sector has also facilitated market entry, customer services, costs reduction and increased productivity of the telecommunication services. Currently, statistics show that there are six voice telecom operators (TCRA 2009a). The number of mobile subscribers and fixed telephones lines also increased from 126,646 and 173,591 in 2000 to 13.9 millions and 181,900 in March 2009 (TCRA 2009b). The voice telecommunication penetration stood at 33% of the population in the country as of March 2009 (TCRA 2009b). These statistics indicate that the number of Tanzanian mobile subscribers is high as compared to fixed line services. It is thus important to take the advantage of the phenomenal use of cell phones to enhance KM activities in the rural areas.

Access to Internet and email services has been widened in urban areas through the introduction of Internet cafes where Internet Service Providers (ISPs) exist. Statistics show that there are 60 application services (internet and other data) in the country (TCRA 2009a). With the help of different international and local stakeholders through the Commission for Science and Technology (COSTECH), the Tanzania government has introduced Telecentres into some of the rural areas. Currently, there are nineteen telecentres in Tanzania that offer various ICT services (COSTECH 2005a). Despite these achievements, the use of internet across the country is very low as compared to mobile phones. It is estimated that the total number of Internet users grew from 115,000 in 2000 to 400,000 (one percent) in 2009 (Internet World Stats 2009). High cost of internet services has contributed to the low use of internet especially in the rural areas. A study

of telecentres in Morogoro, Tanzania revealed that an urban ICT centre paid 400 US $ per month for a 128 kbps connection (which equals 3.13 US $ kbps), while the rural ICT centre paid 206 US $ for a 64 kbps (which equals 3.26 US $ per kbps) (Kora 2006:15). The ownership of computers is also very low. According to 2005 estimates, the number of personal computer per 100 inhabitants was 0.73, as compared to 0.36 per 100 persons in 2001 (TCRA 2006).

While ICT facilities are growing very fast in the country, the level of infrastructural development is not moving at a similar pace to the real demand especially in the rural areas. Many factors act against rural communities, which include high cost of ICT services in rural locations compared to urban locations (Sheriff 2007:2), low literacy rates, low incomes and limited number of service providers, inappropriate legal and regulatory framework for the expanding market, inadequate telecom infrastructure and ICT expertise (Lwoga *et al.,* 2006; URT 2005b). These factors have adversely affected the penetration and use of ICTs in the rural areas. Until, these factors are addressed, rural communities will still be isolated from participating in the knowledge era to accelerate their developmental activities.

2.8.1 ICTs and agricultural indigenous knowledge in Tanzania

The importance of ICTs in managing IK in the local communities for sustainable agricultural development is well documented in Tanzania (Lwoga and Ngulube 2008). The Tanzania ICT policy recognises the potential of ICT not only to unlock distant expertise, knowledge and markets, but also as an important tool to allow local people to interact and communicate with each other, expressing their own ideas, knowledge, heritage and culture in their own languages (URT 2003a:20). However, this policy does not stipulate the power of the community to allocate resources in order to access and use ICTs such as community telecentres (URT 2003a:20). Further, there is no formal structure or organisation which deals with the use of, or access to ICT to manage IK in the rural areas in Tanzania. Instead, agricultural IK is documented and shared through ICTs by some telecentres, community radio, and international and local NGOs through the internet in Tanzania.

Community telecentres have empowered communities to manage their own development through access to appropriate facilities, resources, training and services in Tanzania (Lwoga and Ngulube

2008; Massawe 2004). For instance, the Sengerema telecentre in Western Tanzania is an example of a telecentre that recruits several sectoral experts to collect local content in various fields including agriculture and shares this knowledge through its community radio and a website (COSTECH 2005b). However, the impact of telecentres in the management of IK in Tanzania is very low. A study by Chilimo (2008) in four telecentres in the rural areas of Tanzania showed that limited ICT skills, language barriers and poor infrastructure inhibited farmers in acquiring and sharing their knowledge through telecentres. On the other hand, few community radios have proved effective in transmitting locally relevant knowledge that affects the communities they serve in Tanzania, such as FADECO (Karagwe), Orkonerei (Simanjiro), Kwizera (Ngara) and Sengerema (Mwanza) which display as models (Development Associates Ltd 2004a; Sekiku 2009). The community radio has not diffused well in the country due to high operation costs in terms of local content development, human resource, equipment, electricity and other resources (Development Associates Ltd 2004a).

The Tanzania Development Gateway is another initiative which was established by the Economic and Social Research Foundation (ESRF) in Tanzania to document and share IK through the internet (Tanzania Development Gateway 2007). Other international agencies, such as the World Bank, CAB International, FAO LinKS project, Canadian International Development Agency (CIDA), have established research centres and websites to preserve and share IK (CIDA 2002; FAO 2007a; World Bank 2009b). However, the impact of these databases in the management of IK is low due to various factors, which include: language barriers, inappropriate packaging, poor ICT infrastructure in the rural areas, and low ICT literacy on the part of the farmers (Lwoga and Ngulube 2008).

2.8.2 ICTs and exogenous knowledge and information in Tanzania

There have been deliberate national efforts to enable the rural masses to reap the potential benefits of agricultural exogenous knowledge through the use of ICTs in Tanzania (Manda 2002; Massawe 2004). These initiatives include government projects, public-private partnerships and private initiatives. For instance, the telecentres (both government projects and private initiatives) have been influential in equipping the local communities with useful agricultural information, such as Sengerema telecentre and Crop Marketing Bureau (CROMABU) telecentre in western

Tanzania (COSTECH 2005b). The Tanzania Chamber of Commerce, Industry and Agriculture (TCCA) and Agricultural business information services (BIS) in Tanzania have also enabled rural farmers to access information on crop prices via the web to increase their profit and thus intensifying their agricultural livelihoods (TCCA 2007; IICD 2005).

Community radio has also been effective in disseminating agricultural knowledge and information to the local communities in Tanzania, such as the Orkonerei Radio Station in northern Tanzania, and the Tanzanian's Northern agricultural research institute (Byabachwezi *et al.,* 2003:15; Development Associates Ltd 2004a). The review of the Orkonerei Radio programmes revealed that Maasai pastoral people were able to sell their livestock, and to report their livestock's diseases breakouts to facilitate quicker attendance from responsible parties (Development Associates Ltd 2004a).

Short message services have also enhanced access to market information that improved choices for the sale of farmers' produce and strengthened farmers own capacities when negotiating input and output prices in Tanzania. This cell phone project was implemented by the Ministry of Industry, Trade and Marketing, and Vodacom since 2005 in Tanzania. Although, there has been no impact evaluation of this initiative as yet, evidence shows that many people utilize the service to request for information (ESRF 2007). A study of Tanzanian fishermen also revealed that the use of a mobile phone increased fishermen's bargaining power and improved access to knowledge about market opportunities and a possibility to work more efficiently (Myhr 2006). However, Tanzania's rural farmers still face some challenges in relation to the use of cell phones, which include: high cost of mobile phones (the most basic phone costs US $18), low level of knowledge in the use of SMS, inadequate coverage of mobile networks, and lack of electricity supply (Kora 2006). It is thus important to improve the infrastructures, build the capacities and generate relevant content to enable the communities to fully exploit ICTs to improve their agricultural livelihoods.

2.9 The profile of the districts involved in the study

This section introduces the six districts involved in the study. These districts were selected from six zones out of seven agricultural research zones in Tanzania. These districts included the following: Karagwe, Kasulu, Kilosa, Moshi rural, Mpwapwa and Songea rural districts.

2.9.1 Rationale for selecting the districts involved in the study

Six districts were selected due to their high agricultural production and their possession of telecentres. These criteria were used in order to establish the role of ICTs in managing agricultural IK in the rural areas of Tanzania. The southern zone was not included in the study because its telecentre was still at the planning stage and thus it was not yet operational. High agricultural productive areas were identified based on their diversity in agro-ecology, ethnicity, population density and infrastructure which influence local agricultural knowledge and information systems (Röling 1989). The same criteria were also used by Adedipe, Okuneye and Ayinde (2004) to select areas in Ogun State when assessing the relevance of IK for Nigerian agriculture. Lemma and Hoffmann (2005) also used the same criteria to select the Central and Eastern zones of Tigray when examining the agricultural knowledge systems in Ethiopia.

The criteria which were used to select telecentres included the following: (i) it should operate in rural areas in order to get IK knowledgeable people who access and use ICTs; (ii) it should offer a variety of services including internet and email services, printing and photocopying. Community radio and computer training will be an added advantage; and (iii) telecentres should be those ones that have been in operation for more than 12 months. The same criteria for selecting telecentres were also used by Etta and Parvyn-Wamahiu (2003) to select thirty six telecentres from Uganda, Mali, Mozambique, South Africa and Senegal to study the socio-economic benefits of ICTs in the local communities. Maepa and Mphahlele (2004) also used the same criteria to select three telecentres in Limpopo Province, South Africa to assess the ICT needs, use patterns and barriers. The following sections present a description of each district where this study was conducted.

2.9.1.1 Karagwe district

Karagwe is one of the five districts in Kagera region, which lies in the lake zone of Tanzania. Other districts include Biharamulo, Muleba, Ngara and Bukoba. The district has 7,558 square

kilometres or 26 percent of the Kagera region and a population of 425,476 (URT 2002b). Administratively, Karagwe district consists of four divisions. The divisions are divided into 28 Wards and 117 registered villages (Karagwe District Council 2009). The dominant ethnic group is Wanyambo. Other tribes include Wahaya, Wasubi, Wakiga, Wanyarwanda and Wahima (Karagwe District Council 2009). The economy is dominated by subsistence smallholders who constitute 85 percent of the total population (NBS 2004). Major crops that are grown in the district include coffee, bananas, beans, cassava, Irish potatoes, maize, sorghum and sweet potatoes. Livestock keeping is the second most important activity, where cattle, goats, sheep and pigs are the main farm animals in the district (URT 1998d). However, improvement in the production of these key crops is constrained by a serious decline in soil fertility, poor extension services, very low level of investment in the farms, and low use of chemical fertilizers and improved maize seeds (URT 1998d). Despite the introduction of agricultural programmes such as ASDP, DADP and DASIP, the district faces the following problems: low rate of response of the local community in project design has slowed down the implementation of these programmes; little amount of money is allocated for supervision; lack of transport (such as a car) hinders quick response of officers to supervise activities in the field; lack of funds allocated for fuels; and poor understanding of supervision committee members and other village leaders (Kamuhabwa 2009). Thus, most farmers depend on their indigenous skills and practices to improve their farming activities.

Only 1.4 percent of Karagwe's most centralized homes and businesses are electrified by the regional utility grid, while 0.6 percent is electrified with solar power (Gale Group 2006). The district also has one telecentre, namely Family Alliance for Development and Cooperation (FADECO) which was established in 2004. FADECO is privately owned and it offers a range of services, which includes community radio, email, internet, computer training, secretarial services and CDROM libraries (UgaBYTES Initiative 2006). The district has another radio station, namely Karagwe Community Radio which is owned by Karagwe Media Association (KAMEA), a Non Governmental Organisation. The Karagwe Media Association (KAMEA) community radio was established by the KAMEA NGO in 2006. However, it went on air in April, 2008 due to the delay in starting operations and several setbacks including licensing procedures, lack of

trained human resources and equipments (KAMEA 2008). Thus, the KAMEA community radio station was not involved in the study since it had just started its broadcasting services, and thus its impact could not be evaluated.

2.9.1.2 Kasulu district

Kasulu district is located in Kigoma region which lies in the western zone of Tanzania. Kasulu is one of the three districts in Kigoma region. Other districts include Kibondo, Muleba and Kigoma. The district has 9,324 square kilometres with a population of 628,677 (URT 2002b). Administratively, the district is divided into seven divisions, 30 wards and 83 villages. The indigenous ethnic group in the district is the Waha tribe (URT 1998e). About 90 percent of the district's population is engaged in subsistence agriculture farming (NBS 2004). The major crops grown include maize, beans, cassava, bananas, coffee, cotton and tobacco, and indigenous animals such as cattle, goats, poultry and sheep predominate.

However, there is low agricultural productivity due to over-dependency on rain, poor husbandry, lack of market for cash crops, low use of farming inputs (fertilizers, pesticides, improved seeds), predominance of the indigenous animal breeds, rundown livestock and irrigation infrastructure, high level of animal diseases, poor animal nutrition, unreliable markets, and poor extension services (URT 1998e; URT 2008c). For instance, Kasulu district has 48 agricultural public extension officers, while it is supposed to have 137 officers (URT 2008c). Although participatory approaches are already introduced in the district through ASDP, DADPS and DASIP programmes, low response in the identification of project activities by the village population has slowed down the implementation of these programmes (URT 2008c). Thus, most farmers largely depend on indigenous knowledge to improve their agricultural activities.

The district has a Kasulu Teachers College telecentre which was established in 2002 with financial support from the United States Global Catalyst Foundation, Tanzania Commission for Science and Technology (COSTECH) and United Nations Development programme (UNDP). There is also no electricity available to 99 percent of the people in the area. Thus, the telecentre depends on a biogas system to generate power. The projects provide ICT services to refugees

from Burundi/Rwanda, and the rural poor in the Tanzanian host communities (COSTECH 2005a).

2.9.1.3 Kilosa district

Kilosa district is located in Morogoro region which lies in the eastern zone of Tanzania. Kilosa is one of the five districts in Morogoro region. Other districts include Morogoro Urban, Morogoro Rural, Kilombero, and Ulanga. The district has 14,918 square kilometres of land area with a population of 489,513 (URT 2002b). Administratively, the district is divided into nine divisions, 37 wards and 164 villages (URT 2008d). The district is dominated by the Wasagara and Wakaguru ethnic groups (URT 1997f). The district's agricultural sector is dominated by peasant farmers. About 79 percent of the district's total population depends on agriculture for its livelihood (NBS 2004). Major food crops grown in the district are: maize, rice, sorghum, beans, cassava, peas, bananas, sweet potatoes and millet. Cattle, goats, sheep and pigs are the main livestock in the district (URT 1997f). The district experiences low agricultural yields due to limited use of agricultural inputs (improved seeds, in-organic fertilizers and pesticides), lack of reliable markets for cash crops, high incidence of livestock diseases, and insufficient number of cattle dips (URT 1997f). Indications are that IK is the dominant knowledge system in the district due to the high use of traditional farming techniques and inputs.

The district is partly connected to the national electricity grid (4.03 percent), and it is linked to the telephone, both fixed and cellular networks such as VODACOM, CELTEL, TIGO, ZANTEL and TTCL (NBS 2004; URT 2008d). The district also has two telecentres, which include Kilosa Rural Services and Electronic Communication, and Ilonga Youth Training Centre which provide access to internet, secretarial services, and computer training since 2004. The district has a public Kilosa Telecentre which has been offering basic computer training and operating a community radio station since March 2006 (URT 2008d).

2.9.1.4 Moshi Rural district

Moshi rural district is located in Kilimanjaro region which lies in the north-eastern zone of Tanzania. Moshi Rural is one of the six districts in Kilimanjaro region. Other districts include Moshi Urban, Hai, Mwanga, Rombo, and Same. The district has a land area of 1,713 square kilometres with a total population of 401,369 (URT 2002b). The district is dominated by the

Wachagga ethnic group, and it is divided into four divisions, 27 wards and 150 villages (URT 1998c). The agriculture sector is the main economic activity of the district, where 73.16 percent of the population is engaged in farming activities (NBS 2004). Main crops in the district include coffee, sunflower, banana, beans and maize. Subsistence farmers experience low crop production due to late delivery of inputs, high prices of farm inputs, short supply of inputs, and inadequate and poor storage facilities. Despite scarcity of grazing land, livestock keeping could still be ranked the second most predominant economic activity after crop farming. Modern dairy farming is practiced in the highlands and intermediate zones, while traditional ranching is carried out in the lowlands (URT 1998c). Only 11.87 percent of the district is provided electricity (NBS 2004). The district has two telecentres (Marangu Village Internet Service and Guerba computer centre) at the Marangu East Ward which provide internet and secretarial services to farmers. Guerba computer centre was established in 2005, and Marangu Village Internet Service was established in 2006 (ESRF 2007).

2.9.1.5 Mpwapwa district

Mpwapwa district is located in Dodoma region which lies in the central zone of Tanzania. Mpwapwa is one of the four districts in Dodoma region. Other districts include Dodoma Urban, Dodoma Rural, and Kondoa. The district covers 11.52 square kilometres of land, with a population of 253,602 (URT 2002b). The district is divided into six divisions, 26 wards and 128 villages (URT 1998f). It is populated by the Wagogo and Wahehe ethnic groups, while Wabena, Wanyasa and Wachaga are the minor ethnic groups (URT 1998f). The district economy depends on agriculture which employs 84.87 percent of the labour force in the district (NBS 2004). However, the district experiences low agricultural yields due to the semi-arid climate, and over-grazing. The major crops grown in the district include bullrush millet, millet, maize and Irish potatoes. Cattle, goats, sheep, donkeys and pigs are the main farm animals in the district. The use of traditional farming techniques and input such as seeds is very high due to the poor extension services and high cost of farming inputs (URT 1998f). The district is partly provided with electricity (3.8 percent), telephone lines, and cellular networks (NBS 2004). There is a Teachers College Multipurpose Telecentre which has been offering internet, email, computer training and secretarial services since 2005 (Mpwapwa Teachers College 2008).

2.9.1.6 Songea Rural district

Songea Rural district is located in Ruvuma region, at the southern highlands zone of Tanzania. It is one of the four districts in Ruvuma region. Other districts include Songea Urban, Mbinga and Tunduru. The district covers 33,825 square kilometres, with a population of 156,930 (URT 2002b). Administratively, the district is divided into seven divisions, 22 wards and 116 villages (URT 1997g). Agriculture is the main economic activity which employs 91 percent of the total population (NBS 2004). The Wangoni are the predominant ethnic groups, while Wayao, Wabena and Wanindi are the minor ethnic groups. Ruvuma region is among the "Big Four" regions as far as maize production is concerned in the country. However, the maize production has been declining due to difficulties in securing conventional farm inputs, and high fertilizer prices. Other food crops are rice, cassava, beans, sweet potatoes, millet and sorghum, while the major cash crops include coffee, tobacco and cashew nuts. Cattle, goats, sheep and pigs are the main farm animals in the district (URT 1997g). There is a low use of conventional farming techniques and poor use of conventional farm implements in the district. The introduction of mechanized farming has been fruitless due to the low level of awareness and education on conventional farming techniques (URT 1997g). Indications are that farmers mainly depend on indigenous techniques to improve their agricultural livelihood. The district is partly provided with electricity (0.4 percent), telephone lines, and cellular networks (NBS 2004). There is a multipurpose telecentre, which is called Wino Development Association. This telecentre was established in 2002 with the financial support from the Embassy of Sweden. The centre offers email and facsimile services to the rural communities in the district (Chanzi 2003).

2.10 Summary

Chapter Two provided an overview of Tanzania's history, politics, and economy. Other issues discussed in this chapter included the state of agricultural production in the country, the role of indigenous and exogenous knowledge in agricultural activities, and an overview on the management of agricultural IK and access to exogenous knowledge in the rural areas of Tanzania. It further provided an overview of the role of ICT in managing agricultural IK and disseminating exogenous knowledge in the country. Finally, the chapter provided an overview of the six districts involved in the study. Key themes which emerged in this chapter are that rural farmers have limited opportunities to share their IK and access exogenous knowledge in the rural

areas of Tanzania. Most of IK is preserved in the human mind, and is therefore impermanent. Although participatory approaches are already introduced in the extension and research services, there are still some elements of top-down approaches which tend to ignore farmers' knowledge and needs. IK issues also receive inadequate treatment in the existing macro and sectoral policies, and the legal regime governing IK in Tanzania. Nevertheless, with improved infrastructure, content and capacity, ICTs can play a role in improving the management of agricultural IK and dissemination of exogenous knowledge to rural farmers in the country. This chapter therefore gave an overview of the context of the current study, providing the way for the next chapter, the theoretical framework and the literature review.

CHAPTER THREE: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

3.1 Introduction

This chapter provides the theoretical foundation for the study as well as a review of the literature. The literature review is discussed in relation to the objectives of the study, which include the following issues: the current state of IK and KM practices in the agricultural sector, an overview of knowledge needs and their identification, information seeking behaviour, the role of intellectual property rights and policies in protecting agricultural IK, access to exogenous knowledge, and the integration of agricultural indigenous and exogenous knowledge for improved farming activities in the local communities. Lastly, the chapter analyzes the role of ICTs in managing agricultural IK and disseminating exogenous knowledge in the local communities.

3.2 Significance of reviewing related literature

A literature review provides a comprehensive summary by identifying and evaluating a body of writings in relation to one's research study (Kaniki 2006:19; Knopf 2006:127). The literature review is used to synthesize the literature in the topic in question, to engage critically with it, and to show the relevance of findings in relation to the existing body of literature (Henning, van Rensburg and Smit 2004:27). Thus, the literature review puts the research study into context by showing how it fits into a particular field (Henning, van Rensburg and Smit 2004:19; Kaniki 2006:19).

The importance of reviewing literature in any study is highlighted by various authors (Bryman 2004:527; Kaniki 2006; Knopf 2006; Sekaran 2003; Welman, Kruger and Mitchell 2005:38). The literature review can be used to identify inconsistencies, knowledge gaps and to develop a research problem with precision and clarity (Blaxter, Hughes and Tight 2006; Kaniki 2006:19; Sekaran 2003:65; Welman, Kruger and Mitchell 2005:39). It can also be used to identify a theoretical framework upon which to base a research study (Bryman 2004:527; Kaniki 2006:20; Sekaran 2003:97). The review of literature also ensures that issues and variables related to the

research topic and which are likely to influence the problem situation are included in the study (Blaxter, Hughes and Tight 2006; Bryman 2004:527; Kaniki 2006:21; Sekaran 2003:64; Welman, Kruger and Mitchell 2005:39). It further identifies different methodologies and approaches that have been used by others to study similar problems (Bryman 2004:527; Kaniki 2006:22). The literature review ensures that the problem investigated is perceived by the scientific community as relevant and significant. This evidence may even persuade other scientists to conduct research on the same topic (Sekaran 2003:65; Welman, Kruger and Mitchell 2005:38). In addition, the review of literature can also generate definitions of key concepts that need to be operationalized in the research (Kaniki 2006:21). It may further be used to avoid duplication of research results by studying what is already known in relation to the research topic (Bryman 2004:527; Knopf 2006:127; Blaxter, Hughes and Tight 2006; Sekaran 2003:65; Welman, Kruger and Mitchell 2005:39).

There are a number of standard types of literature reviews, each of which gives a particular reading of a body of literature (Kaniki 2006). Various scholars have proposed various ways of discussing literature reviews (Cooper 1994 cited in Creswell 2003:32; Kaniki 2006; Neuman 2006). For instance, Cooper (1994) cited in Creswell (2003:32) proposed that literature reviews can be described as integrative, which comprises summaries of broad themes in the literature. Second type is a theoretical review, which focuses on theories that relates to the problem of the study. Last type is a methodological review, which focuses on methods and definitions. Almost similar to the Cooper's (1994) typology, Kaniki (2006) proposed four types of literature review. These include: historical review, which considers chronological development of the literature; thematic reviews, which is structured around different themes and focus on debates between different schools; theoretical review, which traces theoretical developments in a particular area and how each theory is supported by empirical evidence; and empirical review, which summarizes the empirical findings. Neuman (2006) added another two types, which include: context review, which links a specific study to a larger body of knowledge; and self-study review, which demonstrates author familiarity with a subject area.

This study used a mixed methods approach, where the qualitative approach was the dominant method. In this context, the literature review for this study was presented at the beginning of the study to convey an inductive design by narrowing the research problem, highlighting possible methodologies, and providing the extent to which data was interpreted. This study adopted a combination of the thematic, methodological, theoretical, and empirical approaches to present the literature related to the study. In this background, the literature review was presented as follows:

- The literature review discussed various KM models as they relate to IK management and access to exogenous knowledge in the local communities in order to build the theoretical foundation of the study;

- The review of literature was also done to identify various methods that have been used by previous studies to study similar problems;

- Different literatures that are closely related to the study were reviewed thematically by structuring the literature around different themes that emerged from the research questions and objectives; and

- Various empirical studies as they relate to the current study were reviewed.

3.3 Theoretical framework

A theoretical framework refers to a general theoretical system with assumptions, concepts and specific social theories (Neuman 2006:74). It guides research to determine what things it will measure, and what statistical relationships it should look for (Sekaran 2003:97). It is a logically developed, described and elaborated network of association among the variables deemed relevant to the problem definition situation and identified through such processes as interviews, observation and literature survey. Experiences and intuition also guide in developing such a framework (Sekaran 2003:97). Thus, the theoretical framework provides an orientation to the research study, and positions the research in the discipline or subject to reflect the research goals (Henning, van Rensburg and Smit 2004:25).

However, more often, the term model is used instead of, or interchangeably with, theory. Theory is defined as a set of interrelated constructs (variables), statements, definitions, and propositions

that presents a systematic view of phenomenon by specifying relations among variables, with the purpose of explaining natural phenomenon (Kerlinger 1979:64; Welman, Kruger and Mitchell 2005:21). Embracing a wider sphere, theory is defined as a well-substantiated explanation of some aspect of the natural world; an organised system of accepted knowledge that applies in a variety of circumstances to explain a specific set of phenomena. Theories can incorporate facts, laws and tested hypotheses (Parker 2007). Theories therefore gather together all items of empirical data into a coherent conceptual framework for a wider applicability. Theory is an essential source for new hypotheses and areas for further investigation, and thus it enables a researcher to postulate the existence of previously unknown phenomenon (Cohen, Manion and Morrison 2000:11). Theory thus consists of empirically tested propositions that, if not yet tested are at least potentially testable. Such propositions may be associative or causal (De Vos, Strydom and Fouche 2005:37).

On the other hand, the term model refers to a hypothetical description of a complex entity or process (Parker 2007). A model is also viewed as a simplified representation of relationships between and among concepts (Sekaran 2003:98). In a larger context, a model is viewed as a representation of reality, it delineates those aspects of the real world the scientists consider to be relevant to the problem investigated, it makes explicit the significant relationships among those aspects, and it enables the researcher to formulate empirically testable propositions regarding the nature of these relationships (Frankfort-Nachmias and Nachmias 1996:44). A model can be of great help in achieving clarity and focusing on key issues in the nature of phenomena (Cohen, Manion and Morrison 2007:13).

Arguably, it can be asserted that a model is descriptive, and a theory is an explanation. In other words, a model does not answer the question as to why something occurs, while a theory does explain why things take place *(Encyclopedia of public administration and public policy 2005)*. A model incorporates hypotheses to be empirically tested whereas theory integrates tested hypotheses *(Encyclopedia of public administration and public policy 2005)*. In social science, a model is deliberately used to simplify and abstract, while a theory postulates real relationships

between real phenomena or variables and thus, it must be empirically testable (Mouton and Marais 1990). Thus, models and theories bear different meanings.

However, Case (2001:114) was of the opinion that both theories and models are simplified versions of reality, but models typically make their content more concrete through diagrams. Actually, models typically focus on more limited problems than do theories, however sometimes it may precede the development of a formal theory. Further, Creswell (2003:121) pointed out that theory may be explained as a series of hypotheses, "if……then" logic statements, or visual models. Similarly, Hitchcock and Hunges (1995) cited in Cohen, Manion and Morrison (2007:13) noted that theory uses concepts, systems, models, structures, beliefs, ideas and hypotheses in order to make statements about specific types of actions, events or activities, so as to make analyses of their causes, consequences and processes. Hence, models and theory could be regarded as one term. Broadly, models can be used to present theories. This study treated both model and theory as one, where models were used to explain theories more concretely.

3.3.1 The use of theoretical frameworks in quantitative, qualitative and mixed methods studies

The aim of theoretical frameworks is to make research findings meaningful and generalizable. They help to stimulate research and the extension of knowledge by providing both direction and impetus (Polit and Beck 2003:119). In a quantitative study, theory is used to provide an explanation or prediction about relationships among variables in the study. It is deductively used at the beginning of the study with the objective of testing or verifying a theory rather than developing it. The researcher advances a theory by collecting data to test it, and reflects on confirmation or disconfirmation of the theory by the results (Creswell 2003:125). This paradigm does not take into consideration how people make meaning or how culture influences interpretation (Henning, van Rensburg and Smit 2004:19).

Theories in qualitative studies are used as broad explanations as in a quantitative study. They are also used as a theoretical lens or perspective to guide the study and raise questions that the study would like to address. Theory appears at the end of the study that emerges inductively from data collection and analysis (Creswell 2003:140; 2007). Thus, the types of frameworks that shape the

meaning, and drive society become key role players in the qualitative research (Henning, van Rensburg and Smit 2004:19).

On the other hand, mixed methods use theories either deductively or inductively. However, the use of theories may be directed by the emphasis on either quantitative or qualitative approaches in the mixed methods (Creswell 2003; 2009:140). In the mixed methods, theories are found at the beginning sections as orienting lenses that shape the types of questions asked, who participates in the study, how data are collected, and the implications made from the study (Creswell 2009:208). This study used a mixed methods approach where qualitative method was the dominant method. The theoretical framework was specifically used to provide a broad explanation and as a theoretical lens or perspective that guided the study. Therefore, the theoretical framework was placed at the beginning of the study. Nine KM models were used to provide the theoretical lens or perspective that guided the study. The study proposed a KM model which was placed at the end of the study. This KM model was based on lessons learned from the theoretical framework and the empirical findings of the study (see section 7.7 of Chapter Seven).

3.3.2 Theoretical perspective that guides the study

This study used KM models to provide the theoretical guidance for the research. There are many KM approaches for managing organisational knowledge. However, it is argued that focusing on a single approach may limit organisations to a range of possible solutions for KM practices (Probst, Raub and Romhardt 2000). Each approach has its characteristics and limitations. Selecting a suitable approach for KM practices needs an understanding of available KM approaches and a knowledge problem (Probst, Raub and Romhardt 2000). Thus, the theoretical framework of this study was guided by nine KM models (Boisot 1987; Bouthillier and Shearer 2002; Davenport 1998; Earl 2001; Kruger and Snyman 2005; McAdam and McCreedy 1999:2000; Nonaka and Takeuchi 1995; Probst, Raub and Romhardt 2000; Rowley 2001; Small and Tattalias 2000).

Nonaka and Takeuchi's (1995) model emphasized the creation of knowledge through the conversion of tacit and explicit knowledge and vice versa. Boisot's (1987) knowledge category

model supported Nonaka's model by regarding organisational knowledge as either codified or uncodified, and as diffused or undiffused. In contrast, McAdam and McCreedy (1999), Rowley (2001), and Bouthillier and Shearer (2002) put major emphasis on KM processes, though they vary in the number and sequence of KM processes they identify. While supporting the KM processes perspective, Probst, Raub, and Romhardt (1999:30) further identified two building blocks (knowledge goals and knowledge assessment) which influence KM processes in organisations. Similarly to Probst, Raub, and Romhardt (1999), Small and Tattalias's (2000) KM model insisted that the second dimension elements (that is, strategy, measurement, policy, content, process, technology, culture) can enable or influence the knowledge creation activities in the first dimension perspective, which include knowledge exchange, knowledge capture, knowledge reuse, and knowledge internalization. Correspondingly, Davenport (1998) provided ten principles that guide the KM processes in organisations. Earl (2001) also proposed schools of KM that ought to help corporate executives to understand the sorts of KM initiatives that make sense in their context. Likewise, Kruger and Snyman (2005) suggested that KM principles should be predetermined for the successful institutionalization of KM practices in the organisation.

Nonaka (1991) first proposed the SECI model in 1991 which was further refined and expanded for a broader audience in 1995 (Nonaka and Takeuchi 1995). In 2000, Nonaka, Toyama and Konno (2000) further developed the model of knowledge creation to consist of three elements: (i) the SECI process, the process of knowledge creation through conversion between tacit and explicit knowledge; (ii) *ba*, the shared context for knowledge creation; and (iii) knowledge assets - the inputs, outputs, and moderator of the knowledge-creating process. The three elements of knowledge creation interact with each other to form the knowledge spiral that creates knowledge as shown in Figure 3.1.

The SECI model assumes that knowledge is created in a four-way taxonomy and it is transferred and converted based on socialisation (from tacit-to-tacit knowledge through shared experiences), externalisation (from tacit-to-explicit knowledge with the help of metaphors, models and analogies, for example printed materials, rock paintings), combination (from explicit-to-explicit

knowledge through ICTs) and internalisation (from explicit-to-tacit knowledge through learning by doing or translating theory into practice). It also assumes that the knowledge creation process in turn, depends on three different kinds of learning relationships that are set up between the individual (I), group (G) and organisation (O) (as depicted in Figure 3.1).
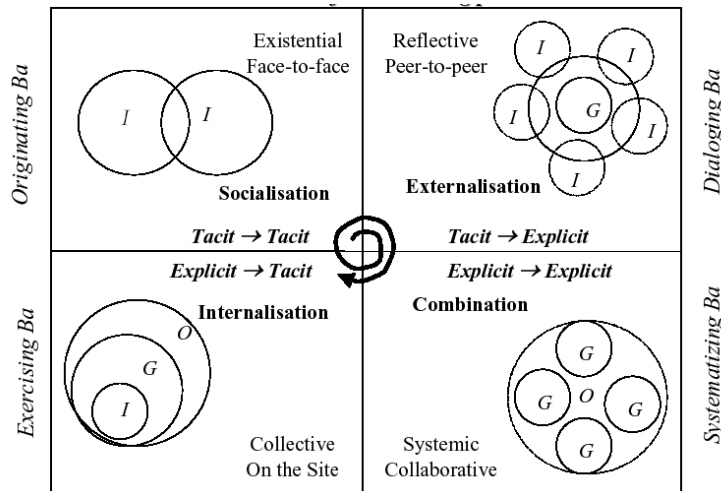
Figure 3.1: SECI as a self transcending process
(Adapted from Nonaka, Reinmoeller and Senoo 2001 cited in Rice and Rice 2005)

Ba is defined as a shared context in motion, in which knowledge is shared, created and utilised (Nonaka and Toyama 2003). It is a concept that unifies physical space such as an office space, virtual space such as e-mail, and mental space such as shared ideals, or good social relationships (Ichijo 2007). *Ba* provides the energy, quality and place to perform the individual conversations and to move along the knowledge spiral (Nonaka and Konno 1998). Four different notions of *ba* are defined correspondingly with SECI (Nonaka, Toyama and Konno 2000):

- The Originating *Ba*: defined by individual and face-to-face interactions (individuals feelings, emotions, experiences and mental models are shared). Although ICTs can be used, physical contact is important in this *ba* to facilitate knowledge creation through socialization (Nonaka and Konno 1998);

- The Dialoguing *Ba*: defined by collective and face-to-face interactions (individuals' mental models and skills are shared, converted into common terms, and articulated as concepts);

- The Systematizing *Ba*: defined by collective and virtual interactions (virtual space facilitates the recombination of existing explicit knowledge to form new explicit knowledge); and

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- The Exercising *Ba*: defined by individual and virtual interactions. It is a space where explicit knowledge is converted into tacit knowledge.

Knowledge assets (KA) are the inputs, outputs and moderating factors of the knowledge creating process (Nonaka, Toyama and Konno 2000). Knowledge assets are key elements that facilitate knowledge creation processes. Those assets include: (i) experiential, which is shared tacit knowledge that is built through shared hands-on experience; (ii) conceptual, consists of explicit knowledge articulated through images, symbols and language; (iii) systemic, consists of systematised and packaged explicit knowledge; and (iv) routine, consists of tacit knowledge that is reutilised and embedded in the actions and practices of the organisation. In their knowledge creation model, Nonaka, Toyama and Konno (2000) further emphasized that a company has to `map' its stocks of knowledge assets in order to manage knowledge creation processes effectively. The organisation leaders should also provide the knowledge vision, develop and promote sharing of knowledge assets, create and energise *ba*, and enable and promote the continuous spiral of knowledge creation.

Boisot's (1987) knowledge category model supported Nonaka (1991) model as shown in Figure 3.2 by classifying knowledge based on the ease of transmission and the readiness to share. Boisot (1987) regarded organisational knowledge as either codified or uncodified, and as diffused or undiffused. The term codified means that knowledge can be captured and transmitted (example, proprietary knowledge), the term un-codified refers to knowledge that cannot readily be transmitted (example, experience). The term diffused denotes knowledge that can be easily shared, and undiffused refers to knowledge that is difficult to share.

Codified	Proprietary Knowledge	Public Knowledge
Uncodified	Personal Knowledge	Common Sense
	Undiffused	Diffused

Figure 3.2: Boisot's knowledge category model (Adapted from Boisot 1987)

Nonaka's (1991) categorisation of explicit and tacit knowledge has at least some degree of correspondence with Boisot's (1987) reference to codified and uncodified knowledge. In both models, the horizontal dimension relates to the spread or diffusion of knowledge across the organisation (McAdam and McCreedy 2000).

On the other hand, McAdam and McCreedy (1999; 2000) emphasized the construction of knowledge within the social and scientific paradigms. The constructed knowledge is then embodied within the organisation, both through explicit programmes and social interchange processes. Following the embodiment process, there is a process of dissemination of the espoused knowledge throughout the organisation and its environment. Eventually, knowledge is seen as being of economic use with regards to the business benefits and employee emancipation in order to have the support and commitment of all stakeholders in the organisation.

Similarly to McAdam and McCreedy's (1999; 2000) KM model, Rowley's (2001) Learning with Knowledge Cycle (LK Cycle) model extended the Demerest's (1997) KM model. The LK Cycle embraces both the social construction of knowledge and the systems view, and emphasizes the relationship between knowledge and learning. The LK Cycle includes the following KM processes: (1) knowledge acquisition, creation and construction, which focus on acquiring knowledge from within or outside the organisation; (2) knowledge articulation and sharing, which involve the conversion of tacit knowledge to explicit knowledge; (3) knowledge repositories' updating, which involves collection and organisation of knowledge in both systems (machines and people's understanding, practices and awareness); (4) knowledge diffusion, access and dissemination, where knowledge may be accessed through searching a system, or by contacting others, or through training courses; (5) knowledge use, where knowledge may be used to develop new knowledge through integration, creation, innovation and extension of existing knowledge; and lastly, (6) knowledge revision, which takes place as a result of knowledge use and of reflection on the experience of actions and decisions. Such reflection drives individual learning that can form the basis for the creation of new knowledge, which may supplement or substitute the existing knowledge. Further, this stage is crucial for individual development and learning.

Rowley (2001) further emphasized that KM needs appropriate systems to store and disseminate explicit knowledge. It also needs a culture which not only ensures that knowledge is valued as a resource, and is recognised as a resource to be shared, but emphasizes the role of knowledge in supporting individual and organisational learning.

Bouthillier and Shearer's (2002) KM model is also parallel to McAdam and McCreedy (1999) and Rowley (2001) KM models. Bouthillier and Shearer (2002) KM model has three major steps. First, the "gathering" step which includes discovery, acquisition, and creation of knowledge processes. Discovery involves locating internal knowledge within the organisation. Acquisition involves bringing knowledge into an organisation from the external sources. Creation of new knowledge may be accomplished in several ways: internal knowledge may be combined with other internal knowledge to create new knowledge, or information may be analyzed to create new knowledge. Secondly, knowledge sharing involves the transfer of knowledge from one (or more) person to another one (or more). Lastly, the model is completed by the knowledge storage, and knowledge use and application steps.

Probst, Raub, and Romhardt's (2000: 30) KM building blocks as shown in Figure 3.3 is almost similar to Bouthillier and Shearer's (2002), McAdam and McCreedy's (1999) and Rowley's (2001) KM models. Probst, Raub, and Romhardt (2000: 30) core processes of KM include:

- Knowledge identification: analyzes and describes the company's knowledge from both internal and external environment;
- Knowledge acquisition: imports a substantial part of knowledge from outside sources;
- Knowledge development: focuses on generating new skills, new products, better ideas and more efficient processes;
- Knowledge sharing and distribution: gets knowledge to the right place;
- Knowledge utilisation: ensures that the present knowledge is applied productively for the benefit of that organisation; and
- Knowledge retention: selects, stores and regularly updates knowledge for potential future value.

Probst, Raub, and Romhardt (2000:33) further added two building blocks, namely, knowledge goals and knowledge assessment. The knowledge goals clarify the strategic direction of KM and the concrete objectives of specific interventions, while knowledge assessment provides a method for measuring normative, strategic and operational knowledge.
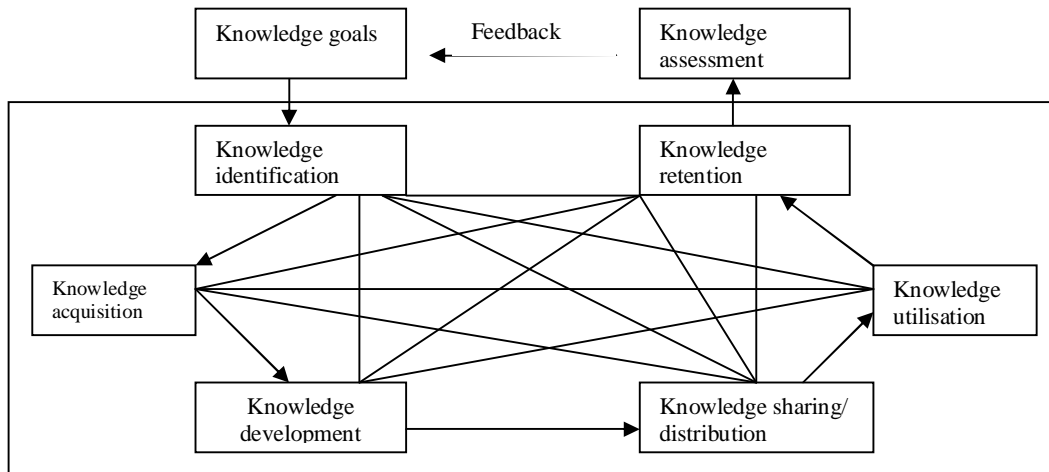
Figure 3.3: Building blocks of knowledge management
(Adapted from Probst, Raub, and Romhardt 2000)

In contrast, Small and Tattalias's (2000) KM model at Mitre as shown in Figure 3.4 views KM from a two-dimensional perspective. The first dimension (bottom in Figure 3.4) consists of activities that are critical to knowledge creation and innovation which are knowledge exchange, knowledge capture, knowledge reuse, and knowledge internalization. The second dimension (top in Figure 3.4) consists of elements that enable or influence knowledge creation activities. According to Small and Tattalias (2000), these elements include:

- *Strategy*: the alignment of corporate and KM strategies;
- *Measurement*: the measures or metrics captured to determine if KM improvement is occurring or if a benefit is being derived;
- *Policy*: the written policy or guidance that is provided by the organisation;
- *Content*: the subset of the corporate knowledge base that is captured electronically;
- *Process*: the processes for achieving organisation mission and goals;
- *Technology*: the information technology that facilitates the identification, creation, and diffusion of knowledge within and across enterprises; and

- *Culture*: the environment and context in which KM processes must occur.
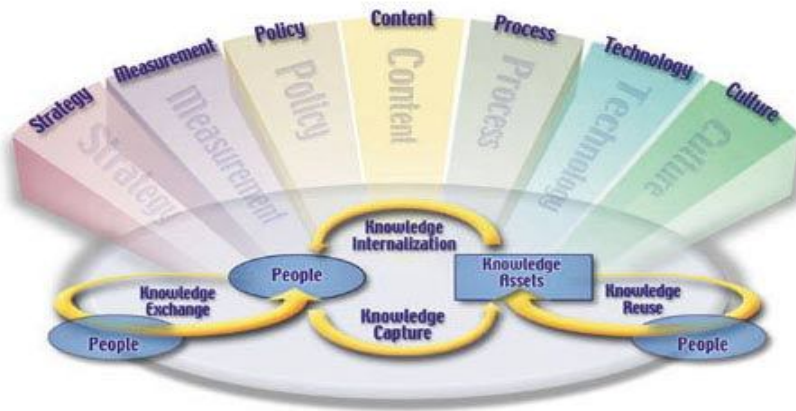
Figure 3.4: KM model at Mitre
(Adapted from Small and Tattalias 2000)

Davenport's (1998) ten principles supported the second dimension of Small and Tattalias (2000) and two building blocks (knowledge goals and assessment) of Probst, Raub, and Romhardt (2000). Davenport (1998) asserted that these ten principles can be used to govern or guide KM processes in organisations. When an organisation decides what principles (issues) it agrees upon with regard to KM, it can then create detailed approaches and plans based upon these principles. The principles are as follows:

- *Knowledge management is expensive.* Knowledge is an asset, but its effective management requires investment of other assets;

- *Effective management of knowledge requires hybrid solutions of people and technology* in complementary ways;

- *Knowledge management is highly political.* This principle requires the identification of influential knowledge champions, people who know the organisation's politics;

- *Knowledge management requires knowledge managers;*

- *Knowledge management benefits more from maps than models, more from markets than from hierarchies.* Hence, only knowledge with a strategic value should be mapped;

- *Sharing and using knowledge are often unnatural acts.* Thus, people should be judged according to their ability to share and use knowledge;

- *Knowledge management means improving knowledge work processes.* The organisation must identify and improve key business processes that are important in knowledge work process for effective KM activities:
- *Knowledge access is only the beginning.* Although access to knowledge is important, it becomes useful when it is shared and applied to specific situations;
- *Knowledge management never ends.* The categories of the required knowledge are always changing due to the continuous advancement of technologies, management approaches, regulatory issues, and customer concerns; and
- *Knowledge management requires a knowledge contract* which should be between the company and the employees.

Earl (2001) also proposed a model that ought to help corporate executives to understand the sorts of KM initiatives or investments that make sense in their context. Earl's (2001) schools of KM include technocratic, economic and behavioural. Technocratic consist of the first three schools which are largely based on ICTs, and large emphasis is being put on validating, mapping, capturing, codifying, controlling and updating the specialists' knowledge in knowledge bases. Similarly to Davenport (1998), Nonaka, Toyama and Konno (2000) and Probst, Raub, and Romhardt (2000:30), Earl (2001:221) also emphasized the need to map knowledge as a success factor for this school.

The economic school is rather more singular, being the most commercial in orientation, explicitly creating revenue streams from the exploitation of knowledge and intellectual capital. In agreement with Davenport (1998) and Nonaka, Toyama and Konno (2000), Earl (2001:223) noted that this school can be successful is there is a development of a specialist team or function to aggressively manage knowledge property. Another success factor is the development or acquisition of techniques and procedures to manage intellectual assets as routine processes. The behavioural school includes the last three schools, where the greater focus is on stimulating the managers and managements to be more proactive in creating, sharing and using knowledge as a resource. However, Earl (2001) cautioned that no school outperforms others since each school represents a particular orientation, a different sort of organisational intervention. Like Davenport

(1998) and Small and Tattalias (2000), Earl (2001) also proposed that the potential contribution of ICT is manifold once knowledge strategy drives KM initiatives.

Kruger and Snyman (2005) also agreed with Davenport's (1998), Earl's (2001) and Small and Tattalias's (2000) KM models. Kruger and Snyman (2005) proposed that not only should knowledge be governed by a strategy before detailed KM plans can be made, but more importantly that sound KM practice should be based on predetermined principles and strategies. In order to ensure uniformity in the purpose of institutionalizing these principles, Kruger and Snyman (2005) suggested that not only should principles be encapsulated within a policy, but also that a strategic management process (strategic requirements for knowledge leading to a knowledge strategy) be used to determine the priority of principles, that is strategy acting as a filter in deciding on the allocation of resources to successfully institutionalize principles.

3.3.2.1 Lessons learned from the reviewed KM models

This section presents KM principles that were distilled from the nine KM models which were used to guide the study. From the discussion of the nine KM models, it can be argued that all of these models focus on the business or organisational settings. However, this study sought to assess the application of KM models and ICT in managing IK in the local communities. The study therefore adapted ideas from all these nine models in order to provide theoretical guidance for the application of KM model and ICTs in managing IK in the local community setting.

On one hand, it is evident that these models emphasize the implementation of KM processes for the effective management of knowledge in organisations (Bouthillier and Shearer 2002; Probst, Raub, and Romhardt 1999: 33; McAdam and McCreedy 1999; Small and Tatalias 2000; Earl 2001; Rowley 2001). These KM models used different labels to show their KM processes, but they all emphasized the following processes: knowledge identification, acquisition, development, sharing, preservation and application. Implementation of these KM processes would enable the communities to identify, create, share, preserve and use the available knowledge in order to improve their farming activities.

Similarly, Nonaka, Toyama and Konno (2000) also proposed that knowledge can be managed through the knowledge creation process, whereby, the three elements of the knowledge creation process (that is SECI, *ba*, and knowledge assets) interact with each other to form a knowledge spiral that creates knowledge. Boisot's (1987) knowledge category model is similar to Nonaka's model where the horizontal dimension of both models relates to the spread or diffusion of knowledge across the organization. It can be concluded that all these models emphasized the use of KM processes for effective KM activities in the organisations.

On the other hand, the reviewed KM models also emphasized the identification of KM principles that could be used to guide or influence the implementation of KM processes in organizations (Davenport 1998; Earl 2001; Kruger and Snyman 2005; Nonaka, Toyama and Konno 2000; Probst, Raub, and Romhardt 1999: 33; Small and Tatalias 2000). The designers of these models argued that KM principles need to be pre-determined for effective implementation of KM processes in the organization setting.

Among others, these principles included the development of a policy (Davenport 1998; Earl 2001; Probst, Raub, and Romhardt 1999: 33; Small and Tatalias 2000). However, this principle has been the subject of different views. Nonaka, Toyama and Konno (2000) identified that a knowledge vision should be put in place to develop and promote sharing of knowledge assets, create and energise *ba*, and enable and promote the continuous spiral of knowledge creation processes (SECI). In relating the knowledge vision to knowledge principles, Snyman and Kruger (2004), argued that certain principles not only form the basis for developing an organisational knowledge vision, but in order to encapsulate these principles (to institutionalise a knowledge culture), organisations should embark on the formulation of a knowledge policy. Kruger and Snyman (2005:79) further clarified that a knowledge vision and a knowledge policy should be derived from knowledge principles for the effective management of knowledge.

Other principles identified in KM models included the development of a strategy, leadership, and legal frameworks (Davenport 1998; Earl 2001; Probst, Raub, and Romhardt 1999: 33; Small and Tatalias 2000). In the local community context, strategy involves the alignment of national and

institutional strategies and KM strategies. Leadership involves the existence of a leader to facilitate the creation of a strategy to build, maintain and utilize the local community's knowledge assets. The presence of legal frameworks, rules and regulations concerning IK help to ensure that IK is shared and protected from misappropriation.

The use of mapping is another principle that can enable the communities to identify where and how particular IK is stored within and outside the community (Davenport 1998; Earl 2001:221; Nonaka, Toyama and Konno 2000; Probst, Raub, and Romhardt 1999). The identification of knowledge from both the internal and external environment can enable the integration of the relevant exogenous knowledge into the IKS in the local communities.

Further, according to Small and Tatalias (2000), other principles include: measurement, content, culture, process and technology. Measurement determines if KM processes are improved and if a benefit is being derived from the communities' knowledge assets. Content ensures that the relevant content is created in the local language and it is retained both physically and electronically. Culture guarantees the creation of an environment and context in which KM processes occur (such as values, norms, and practices) in order to facilitate KM activities. Processes involve the identification of activities that farmers carry out to achieve their developmental goals for the successful KM processes. Lastly, technology may facilitate local communities to create, share, preserve and utilize their knowledge from within and outside their communities. Thus, the integration of indigenous and exogenous knowledge would be feasible.

In this context, this study adopted the KM processes as deduced from the reviewed nine KM models to allow the local communities to manage their knowledge based on pre-determined principles. Thus, the focus of the study was particularly on the following KM processes: knowledge identification, acquisition, development, sharing, preservation and application. The study also adopted KM principles which were used to guide or influence the implementation of KM processes in the local communities, which included the following: recognizing the importance of the policy, culture, a legal framework, information communication technologies (ICTs), and context and space.

The study is guided by ideas distilled from all the KM models discussed. The study proposed a KM model based on lessons learned from all these nine models and the empirical findings of the study (see section 7.7 of Chapter Seven).

3.4 Review of related studies

This section provides an overview of the agricultural sector and the management of the agricultural IK in developing countries. Other issues include KM practices, knowledge needs and identification, information seeking behaviour, access to exogenous knowledge in the local communities and the role of ICT in the management of IK and providing access to exogenous knowledge in the local communities. The review that follows highlights each of these aspects.

3.5 The agricultural sector: an overview of the developing countries and African countries

Agriculture is an important instrument for development and a source of livelihood in developing countries. Agriculture provides employment opportunities to 1.3 billion people worldwide, with 97 percent of them in developing countries (FAO 2007b). In Sub-Saharan Africa (SSA), agriculture contributes to 29 percent of the gross domestic product (GDP), employs 65 percent of the labor force and generates between 42 and 75 percent of rural income (World Bank 2007:107). Despite its importance for development, agricultural yields in developing countries continue to decline, which contributes to food shortages. According to 2006 estimates, the number of countries facing serious food shortages throughout the world stood at 39, where 24 were in Africa (FAO 2006b).

Subsistence farming is identified as one of the major causes of low agricultural production. About 85 percent of farmers farm on less than two hectares in developing countries (World Bank 2007:124). Other factors that contribute to low agricultural performance in developing countries include; unsustainable land management practices; land scarcity; increased population pressure; poor infrastructure; lack of markets and credits; inadequate policies; civil strife; adverse weather; the HIV/AIDS pandemic; lack of access to knowledge and information; and inadequate and inequality of labor supply where women do most of agricultural activities (Aina 2007; Ehui and Pender 2003; FAO 1998:2; 2006b; World Bank 2007:9). It is estimated that women produce more than half the food worldwide, and in some regions such as sub-Saharan Africa, they

produce 60 to 80 percent of the food crops (FAO 1998:5). Given the fact that much of Africa's food is wasted due to lack of access to information and knowledge, one of the important inputs could be the development and dissemination of relevant information and knowledge in the local communities for sustainable agricultural growth.

3.6 Indigenous knowledge: an overview

Indigenous knowledge is socio-economically affordable, sustainable, involves minimum risk to rural farmers and producers, and it is better for conserving natural resources (Charyulu 1999; Makhura 2004:40). IK is mainly used as the basis for local-level decision-making in agriculture, health care, education, natural-resource management and a host of other activities. For example, the world market for herbal medicines has reached US$43 billion, with annual growth rates of between 5 and 15 percent (Correa 2001), which highlights the importance of IK for socio-economic development.

Despite its importance to sustainable and equitable development, IK has largely been marginalized, neglected and suppressed due to ignorance and arrogance, politics, and dominant ideology of a particular historical period (Dondolo 2005:120; Grenier 1998; Ocholla and Onyancha 2005:248). Nevertheless, there is a renewed interest on IKS due to its important role for sustainable development and rational resource use (Brokensha, Warren and Werner 1980; Tella 2007; Warren 1991; Warren, Slikkerveer and Brokensha 1995). The indigenous-rights movements have also increased the recognition of IK (Grenier 1998). Consequently, there has been an explosive growth of literature on the relevance of IK. An informetric analysis of eight indigenous knowledge databases hosted by EBSCOHost and SABINET revealed a significant growth of IK documents from 1997 to 2002 (Ocholla and Onyancha 2005). Findings from the three largest search engines (Google, AltaVista and Yahoo) also indicated a growing presence of IK and IK-related information on the web (Le Roux 2003). The IK notes database of the World Bank which covers 93 documents from 1998 to 1998, also shows the significance of IK for socio-economic development in developing countries (World Bank 2009b).

In spite of these positive developments, IKSs are threatened by socialization, education systems, the influence of western technology and the unavailability of certain crops that limit local people's especially youth's use of IK (Dube and Musi 2002). It is estimated that each year two percent of the languages (and the cultures and knowledge expressed by them) of the world disappear and in one century 99 percent will have disappeared (Muñoz 2004). Very little IK has actually been documented, limiting access and reach to an immensely valuable database (Chisenga 2002; Magara 2002; Rao 2006; Sithole 2007). There is thus an urgent need to manage IK to enhance its availability for development activities before much of it is completely lost.

3.6.1 The role of indigenous knowledge for sustainable agricultural practices

The potential role of IK in improving agricultural performance is widely recognised (Akiiki 2006:1; Akullo *et al.,* 2007; Hart 2007; Hart and Mouton 2005; Kudadjie 2006; Nathaniels and Mwijage 2000). Statistics show that at least 50 percent of the world's population depends on IK for crops and food supplies (CSOPP 2001; Hart and Vorster 2006). Various empirical studies have also shown that IK can play a great role in improving agricultural production in various developing countries, such as Burkina Faso, Benin, Côte d'Ivoire, Ghana, Mali, Niger, and Togo (Kaboré and Reij 2003), Samoa (Tikai and Kama 2004), and Uganda (Hart 2007; Hart and Mouton 2005).

Farmers possess an extensive base of IK that they use to solve various crop and livestock management problems. For instance, a study in Limpopo province, South Africa revealed that farmers had a broad range of criteria that they used for classifying soil, land, livestock, weather forecasting, production practices and post-harvest technologies, and that the values related to this system provided a relevant basis for explaining the decisions and actions taken by farmers (Magoro and Masoga 2005). Related observations were made by various studies in Bangladesh (Miah *et al.,* 2005), Burkina Faso (Gray and Morant 2003), Cameroon (Lambi 2004), Nepal (Walker *et al.,* 1999), Nigeria (Ajibade and Shokemi 2003; Akpabio and Akankpo 2003; Gana 2003; Ogen 2006; Osbahra and Allan 2003), Laos (Saito *et al.,* 2006), Peru (Rhoades 1989), South Africa (Luseba and Van Der Merwe 2006), Tanzania (Hill 2003; Kamwenda 2002; Minja 2001; Mollel 1991; Mshana 1992), Uganda (Hart and Mouton 2005), and Zambia (Sikana 1994).

Various studies have shown that IK is developed to fit a particular biophysical and socio-economic setting and usually cannot be transferred "as is" to other settings (Waters-Bayer and van Veldhuizen 2005). However, other scholars have argued that local knowledge can effectively be applied outside the spatial locales in which it was developed (Briggs 2005; Briggs and Sharpe 2004; Warren 1991:2). In fact, IK can effectively improve farming practices if applied in the localities with similar conditions. For example, in Burkina Faso, the use of traditional planting pits techniques for an improved traditional soil and water conservation practice was replicated in Benin, Côte d'Ivoire, Ghana, Mali, Niger, and Togo. There were year to year variations but it was revealed that the yields from areas with planting pits were invariably positive compared to yields on similar land without pits (Kaboré and Reij 2003). It is thus important to assess the extent to which farmers possess IK, and to examine the role of IK in farming activities, since it can be adapted to stimulate innovation and improve productivity outside the spatial locales in which it was developed.

Many developing countries are now promoting the use of low-external inputs in farming due to the effectiveness, simplicity, reliability, safety and affordability of the indigenous technologies (Adedipe, Okuneye and Ayinde 2004; Akullo *et al.,* 2007:10; Charyulu 1999; Gana 2003; Nwonwu 2008). The failure of the application of conventional agricultural techniques in different types of agro-ecological zones has also resulted in greater attention being paid to IK in developing countries (Hart and Mouton 2005:249; Ogen 2006; Onyango 2002:251). Other factors that contribute to the high use of agricultural IK in developing countries include: creation of social harmony and cohesion; preparations are demand driven; expired products are no longer a problem; application of IK does not always demand specialist attention (Akullo *et al.,* 2007:10); and lack of finance and quality education to enhance the appropriate use of exogenous technologies (Ehui and Pender 2003; Hart 2007; Kolawole 2005; Reddy 2007). It is clear that agricultural development interventions will continue to fail unless they take IKS into consideration.

3.7 Knowledge management

Knowledge management (KM) is increasingly being adopted by many organisations to build their competitive strength and achieve a sustainable growth pattern (Ichijo and Nonaka 2007; Kalseth and Cummings 2001). The need to manage knowledge is mainly brought by problems faced by many organisations in locating, preserving and using knowledge both within and outside their organisations (Alavi and Leidner 2001:113). KM ensures that knowledge is created, built, deployed and exploited to serve the objectives and needs of the people, the enterprise and its stakeholders (Wiig 2004:246). The effectiveness of a KM intervention in a particular organisation is determined by the selection of appropriate tools, approaches and practices (Wiig 2004:246).

KM processes of explicit knowledge are well defined and well documented. Tacit KM processes however, are not explicitly defined and are performed by individuals in the organisation (Mostert and Snyman 2007). Certain tacit knowledge can be harvested from its owner and codified to make it more readily sharable. However, much of tacit knowledge cannot be externalized in organisations (Buchel 2007; Frappaolo 2006). Tacit knowledge cannot be externalized mainly due to the personal implicit attributes which can never be diffused, and when they are transferred, they are valueless (Sigala and Chalkiti 2007). Other difficulties are linked to perception, language, time, value, and distance (Haldin-Herrgard 2000). Lack of trust and other political and cultural influences such as shared beliefs and values may inhibit people from sharing their knowledge in organisations (Leonard and Sensiper 2005; Raza, Kausar and Paul 2007). Hence organisations need to provide a conducive environment for individuals to share and use their tacit knowledge and expertise to increase organisational performances.

Social networks such as communities of practices (CoPs) can improve knowledge creation and sharing processes in organisations (Steyn and Kahn 2008; Miller 2005; Von Krogh, Ichijo and Nonaka 2000). CoPs are groups of people who share a concern for something they do and interact regularly to learn how to do it better (Wenger 2005). Organisational design is also regarded as another key enabler to effective KM processes. Drawing on Stiglitz's writing, Mchombu (2005:3) asserted that organisations need to shift their organisational structures from

top-down hierarchical systems to horizontal structures such as networks and semiautonomous teams, and other forms of matrix organisations to create the right context for KM processes. Further, the organisations need to create a culture that values the creation, sharing and use of knowledge by its employees (Alavi and Leidner 2001:126; Ardichvill, Page and Wentling 2003:69; Kalseth and Cummings 2001). Leadership as another KM enabler identifies knowledge gaps and finds ways to close them to enable KM processes. It also champions innovation, creates the right context to foster dialogue and communication, and develops a reward system to promote knowledge sharing (Miller 2005; Sallis and Jones 2002:30). By drawing on various ICT tools and capabilities, ICTs can also play a variety of roles in support of organisational KM practices (Alavi and Leidner 2001). It is thus important for organisational management to support the KM effort, and create the right context for the KM processes to occur.

While the potential role of KM practices in organisations is widely acknowledged (Von Krogh, Ichijo and Nonaka 2000:3), its centrality in the developing countries is more of a recent phenomenon. Thus, the following section reviews various KM concepts such as knowledge needs and identification, and shows how KM practices can be applied to manage IK in the developing countries.

3.7.1 Knowledge needs and identification

Identification involves locating knowledge from within and outside the organisation (Kraaijenbrink and Wijnhoven 2006; Probst, Raub and Romhardt 2000:69). Identification is a condition where the interests of an individual merge with the interests of the organisation, resulting in the creation of an identity based on those interests (Johnson, Johnson and Haimberg 1999 cited in Kankanhalli, Tan and Wei 2006). In KM perspective, identification involves locating the resources from which the knowledge is to be captured, and it involves functionalities such as locating, accessing, valuing, and/or filtering (Holsapple and Joshi 1999). Kraaijenbrink and Wijnhoven (2006) was also of the opinion that knowledge identification involves need identification, gap analysis, searching, viewing, and finding. Despite the fact that there are theories to better understand knowledge identification processes in the organisational context (Holsapple and Joshi 1999; Kraaijenbrink and Wijnhoven 2006; Probst, Raub and Romhardt

2000:72), the information needs and information seeking behaviour is the relevant theory for this process.

3.7.2 Information needs and information seeking behaviour

This section provides the definition for the terms information need, information seeking and information seeking behaviour, and its role in the local communities.

3.7.2.1 Information needs

A need is a subjective experience which occurs only in the mind of the person in need and, consequently, is not directly accessible to an observer (Wilson 1981). Information need is described as a gap in individual's knowledge in sense-making situations (Dervin, Foreman-Wernet and Lauterbach 2003), or an anomalous state of knowledge (ASK) (Belkin 1980). Case (2002:5) viewed information need as a recognition that personal knowledge is inadequate to satisfy a goal that needs to be achieved. However, the level of similar information need may differ between persons or groups of persons depending on a variety of factors, such as demographic factors of education, age, social and economic background, or those that are resource based, namely, availability, awareness of availability, acquaintance with, and ease of use of resources (Kaniki 2001). These information needs can be recognised by the information seeker him/herself or by the information expert on behalf of the information seeker. Both information seeker and expert may need to work together towards "disentangling" and establishing the actual information needs (Kaniki 2001). As part of the search for the satisfaction of these needs, an individual may engage in information-seeking behaviour (Wilson 1981). Information needs are thus a requirement that may drive farmers into an information seeking process to fulfill their information and knowledge gaps.

3.7.2.2 Information seeking

Information seeking is described as a conscious effort to acquire information in response to a need or gap in one's knowledge (Case 2002). It is a process with which humans engage to purposefully change their state of knowledge. An information seeker directs attention on adapt to stimuli, reflect on progress, and evaluate the efficacy of knowledge base of the information

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seeker (Marchionini and Komlodi 1998:97). Wilson (1999) defined information seeking as, "the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking and information use. Thus, it includes face-to-face communication with others, as well as the passive reception of information as in, for example, watching television advertisements without any intention to act on the information given". Thus, information seeking encompasses both purposive and passive activities. Information seeking is therefore a human process that requires adaptive and reflective control over the afferent and efferent actions of the information seeker (Ikoja-Odongo and Mostert 2006; Oladele 2002; Singh and Satija 2006).

3.7.2.3 Information seeking behaviour

Information seeking behaviour (ISB) results from the recognition of some needs, perceived by the user, who as a consequence makes demands upon the formal system such as libraries and information centres, or some other person in order to satisfy the perceived information need (Singh and Satija 2006). According to Pettigrew (1996), information seeking behaviour involves personal reasons for seeking information, the kinds of information which are being sought, and the ways and sources from which the needed information is being sought. Wilson (2000) described information-seeking behaviour as purposive in nature and is a consequence of a need to satisfy some goal. In the course of seeking, the individual may interact with people, manual information systems, or with computer-oriented information systems. Thus, the individual recognises an inadequacy in his/her knowledge that needs to be resolved in order to deal with a problem. The efforts to satisfy the perceived need result in information seeking behaviour (Ikoja-Odongo and Mostert 2006).

3.7.2.4 Information seeking behaviour in the local communities

Knowledge about the information needs and information seeking behaviour of small-scale farmers is crucial to effectively satisfy the felt information needs and develop demand-led extension and advisory services (Rees *et al.,* 2000; Garforth 2001). With relevant agricultural knowledge and information, farmers could improve their work in order to sustain agriculture and also benefit economically (Lesaoana-Tshabalala 2003). In the context of the local communities, Aina's (2004) information seeking model shows that a user may have a need for information, either for problem solving or for awareness. The need for information for problem solving is

purposive, immediate and time framed, while that need for awareness is passive. When the information need is for problem solving, the user approaches interpersonal informal channels such as colleagues, friends, and neighbours and so on. Sometimes, the information channel used may not be able to provide the information needed and then the user may be directed to a formal agency such as a government department or a non-governmental organisation (Aina 2004). However, when the information needed is for awareness, both informal and formal information channels are utilised (Aina 2004).

Dutta (2009) found that primary information needs of the rural poor are related to occupation as well as for basic survival in developing countries. For instance, Kalusopa (2005) found that farmers' information needs were mainly categorised into three areas: farm management, dairy management, and poultry equipment and technology in Zambia. Similar observations were made in Nigeria (Sabo 2007). Lesaoana-Tshabalala (2003) also found that farmers' information needs are specific, and they varied from farmer to farmer, and from location to location in Lesotho. Similar results were observed in rural Manipur (Meitei and Devi 2009). There is thus a need for regular need assessments to cope with the changing and dynamic needs and satisfy the felt needs of farmers (Chilimo 2008; Kaniki 1989:73). By assessing those needs, the service providers are able to understand and design more effective information systems (Wilson 1981).

Studies on knowledge and information sources used by most information seekers, especially in the rural areas of developing countries, have shown that local people mainly seek knowledge and information from informal sources as compared to formal sources which supports Aina's (2004) information-seeking model. In Ghana, Chisenga, Entsua-Mensa and Sam (2007) found that poultry farmers mainly sought their knowledge and information from farmer associations, followed by fellow farmers, radio and television. Apart from NGOs, most farmers relied on personal experience, and informal networks (family, friends, and colleagues) to meet their needs in Zambia (Kalusopa 2005). Conversations with friends, relatives, and neighbours were also major sources of knowledge and information in other farmers' information behaviour studies in Zambia (Kaniki 1994), rural dwellers in India (Chakrabarti 2001), and Tanzania (Chilimo 2008), fishermen in Uganda (Ikoja-Odongo and Ocholla 2003) and Nigeria (Njoku 2004). Mass media

such as radio, television and newspapers were a major source of knowledge and information for the majority of rural poor in Manipur (Meitei and Devi 2009) and Nigeria (Momodu 2002). Generally, these studies indicate that farmers rely on the informal networks and to a lesser extent, mass media to meet their information needs. In the analysis of twelve articles on information behaviour of urban and rural dwellers in developing countries, Dutta (2009) also concluded that people mainly rely upon informal social networks to meet their information needs.

Certain factors may interfere positively or negatively in the process of information seeking, and thus they may create barriers. Various scholars have illustrated these issues. Wilson (1996) described these factors as personal, emotional, educational, demographic, social/interpersonal, environmental, economic, and source characteristics. Other barriers may include high cost, illiteracy, and lack of ICT infrastructure (Aina 2004) which may fall within Wilson's (1996) intervening variables. Other barriers include culture (Hepworth 2007; Meyer 2009), social, psychological and behavioural needs (Hepworth 2007). Many empirical findings have illustrated these barriers in developing countries. For instance, internal (personal) and external or environmental factors were perceived as major barriers that hindered information seeking processes of informal entrepreneurs (Ikoja-Odongo and Mostert 2006) and fishermen in Uganda (Ikoja-Odongo and Ocholla 2003). Dutta (2009) also revealed that illiteracy, unknowledgeable extension workers, and the digital divide were the major obstacles for meeting information needs of rural dwellers in eight developing countries. It is thus important to conduct a study on information needs, and information seeking behaviour of the rural farmers for improved agricultural information and knowledge provision strategies in the rural areas.

3.7.3 Application of knowledge management practices in managing agricultural indigenous knowledge: an overview in developing countries

KM has been successfully applied to improve business performances of many organisations in the developed countries (Ichijo and Nonaka 2007; Von Krogh, Ichijo and Nonaka 2000:3). Many scholars have argued that KM practices in closed systems or formal organisations are likely to be more successful than in the informal systems or open systems because they have formal

structures and rules to which members of organisations adhere (Mosia and Ngulube 2005; Noeth 2006). As a result, most organisations in developed countries end up with better customer service, improved products, business processes and innovative new ideas for commercialization (Ikoja-Odongo 2006).

However, KM should also be applied in the rural areas of developing countries for equitable and sustainable development since knowledge is a key resource for socio-economic growth (Hamel 2005; Kalseth and Cummings 2001; Mosia and Ngulube 2005; Noeth 2006; Rao 2006; World Bank 1998b). Rural communities in the developing countries have an extensive base of widely available knowledge which is IK. While the organisational knowledge is used as a source for competitive advantage (Alavi and Leidner 2001:108; Leonard and Sensiper 2005), the aim to which IK is utilised is for social advantage (Ikoja-Odongo 2006). KM can be used to integrate and share the diversity of IK in a community that desires to achieve developmental goals (Mosia and Ngulube 2005:175).

IK is a systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, intimate understanding of the environment in a given culture, as well as through contact with other local and international knowledge systems (Flavier, de Jesus and Navarro 1995; Letty and van Veldhuizen 2006; Rajasekaran 1993; Warren 1991). In their study of potato production by Andean farmers, Rhoades and Bebbington (1988) identified three kinds of local people's experiments, which were curiosity, problem solving and adaptation to experiments. Similar observations were made in Ethiopia (Dixon 2002), Tanzania (kajembe and Kessy 1999), and Zimbabwe (Mudege 2005). Thus, IK is socially and culturally constructed in the local communities.

Despite the extensive base of agricultural IK, much of this knowledge is preserved in people's memories, practices and expressions of the practising communities (Dondolo 2005; Rao 2006). The human memory however has a limited capacity and stored information may be eroded by failing memories (Meyer 2002). Much of this knowledge is possessed by elderly people who are also aging and dying without a demonstrable plan to preserve their knowledge and transfer it to

future generations (Nwonwu 2008). Thus, most of IK is rapidly disappearing in developing countries.

IK is shared and communicated orally, by specific example and through culture. It is expressed in the form of stories, folklore activities, cultural values, beliefs, community laws, local languages, agricultural practices, equipment, materials, plant and animal breeds, and apprenticeships (Akullo *et al.,* 2007; Ikoja-Odongo 2006; Owuor 2007; Rao 2006; Sen and Khashmelmous 2006). This knowledge is usually shared and exchanged within social networks, with individuals making use of their primary networks (family, friends, neighbours, members of the community) and secondary networks (other contacts and relations outside their primary networks or closer circles such as organisations, work or business contacts, and other intermediated contacts), not only to obtain their information and gain access to new knowledge, but also to share it (Arévalo 2007:23). In these primary networks, the oral tradition and empirical learning are the principal ways of transmitting knowledge. The codification of the tacit and explicit knowledge which exists in the local communities is complemented by the secondary network; where ICTs (such as the radio and Internet) and print formats are produced in the local communities (Arévalo 2007:23). Thus, IK is commonly created and shared in the primary social networks, while explicit sources of knowledge such as ICTs and print format play a supplemental role.

However, IK is not equally shared and distributed in the communities. Social dimensions (age, gender, status, wealth, political influence and so on) affect perceptions, actions and access to knowledge resources in the communities (Fairhead and Leach 1994). Resistance to change and social relevance as a control mechanism to transmit what is perceived as significant and omit the rest over a period of time have largely limited the sharing of IK (Meyer 2003; Tella 2007). IK sharing is also inhibited by attitudes, perceptions, norms, values and belief systems inherent to indigenous people (Meyer 2009). Another factor is related to the security mechanism of the local people to protect their own intellectual property (Nwonwu 2008). Thus, issues related to literacy, ownership, culture and social status need to be considered for effective KM practices in the local communities.

Formal education has also excluded IKSs and African systems of knowledge creation as not essential to education (Raseroka 2002:9). Only a few countries such as South Africa (universities) have initiated an investigation on how to include IK into curricula (Raseroka 2002:9). Further, as major information providers, libraries have also neglected the importance of managing IK as a necessary input for socio-economic development (Mchombu 2005:9; Raseroka 2002:9; Sithole 2007). Some of the reasons for this negligence include financial constraints and lack of formal IK programs in the African librarianships schools (Raseroka 2002:7). In addition, different players like libraries, information centres, and NGOs also undertake various activities of documenting IK in an uncoordinated way (Tella 2007). There is thus a need for developing countries to recognise the importance of managing IK. Much of the knowledge required for agricultural development already exists with farmers and traditional practitioners. Hence, the need to preserve and share IK cannot be over-emphasized.

KM approaches can be used to enable the diffusion of tacit knowledge to cope with the dynamic world in the developing countries (Dlamini 2005; Ikoja-Odongo 2006; Kaniki and Mphahlele 2002; Kok 2005; Ngulube 2003; Noeth 2006). KM balances out interest and power differences and encourages knowledge exchange and learning (Bode 2007). However, it is argued that the externalization and diffusion of tacit IK may separate such knowledge from its human agents and from the context, in which it is generated, transformed and re-generated (Davenport and Prusak 1998:68; Ellen and Harris 2000; Leonard and Sensiper 2005; Mohamed and Stankosky 2006; Ngulube 2003; Raseroka 2008). Further, IK may change as it undergoes the documentation processes due to the translations, strategies and objectives of those using it (Ellen and Harris 2000; Raseroka 2008). There is thus a need to strike a balance between the desire to preserve IKS in *exsitu* databases and the importance of facilitating the continued performance of IK in its original context (Ngulube 2003; Nzewi 2005).

Certain factors are needed to enable the developing countries to manage IK through KM practices as it is done in the developed world. Some of those factors include having an educated population to absorb and apply new knowledge (Abu-Rashed, Bertaux and Okuneye 2005; Ikoja-Odongo 2006; Mchombu 2007). Supportive policies to create an enabling environment for sustainable social change are also important for the effective KM practices (Mchombu 2007).

Yet, very few countries in the developing world have formulated such policies. For instance in Africa, only two countries (Uganda and South Africa) have formulated national IK strategies and policies (Nyiira 2003; Sibisi 2004). Behavioural, cultural and structural changes, transparency, political will, coordination of public and private sectors, and improved ICT infrastructure are also needed for effective KM practices (Abu-Rashed, Bertaux and Okuneye 2005; Ikoja-Odongo 2006; Mchombu 2007). Africa's IKS can thus be used to improve agricultural activities if the KM approaches are put in place and are being prioritized. A case in Uttar Pradesh India is an example of the way local communities are involved in documenting and disseminating their bio-resources and conservation practices since 1995 (Sen 2005). Thus, the need for KM practices cannot be over-emphasized in developing countries.

3.7.4 Application of knowledge management practices in managing agricultural indigenous knowledge: review of empirical studies

There are a lot of theoretical studies that discuss the extent to which IK can effectively be managed by using KM principles (Dlamini 2005; Kaniki and Mphahlele 2002; Kok 2005; Ngulube 2003) (see Section 1.4). However, few studies have been conducted to assess the extent to which IK can be managed through KM approaches in the developing countries (Ha, Okigbo and Igboaka 2008; Mosia and Ngulube 2005; Noeth 2004; 2006). Other studies did not assess the application of KM approaches, but they investigated the management of IK in the local communities, and thus they were found relevant to the current study (Mudege 2005; Wall 2006).

Ha, Okigbo and Igboaka (2008) conducted an experimental study to examine the effects of using broadband internet technology for managing agricultural knowledge in Nigeria. Pre and post-test interviews of a panel of female farmers were conducted before and after the establishment of a free broadband internet access service centre and experimental web site. A survey of another 97 farmers in the village was conducted to examine awareness and perception of the knowledge centre. The study found that the experimental web site provided relevant knowledge, and the centre was a great place for socializing with and learning from other fellow farmers. The study found that Nonaka's (1994) knowledge creation model was partially fulfilled. Ha, Okigbo and

Igboaka (2008) suggested that the collaborative model of knowledge dissemination can partially be effective among farmers in knowledge creation activities.

A study to assess the management of knowledge for the utilisation of estuaries in the local communities of Eastern Cape in South Africa was conducted by Mosia and Ngulube (2005). The study used questionnaires, semi-structured interviews, and focus groups to determine how knowledge was shared and distributed in an "open" system. The study revealed that the knowledge sharing activities of the communities were fragmented. The communities mainly shared their knowledge through person to person communication, such as community meetings, general meetings, and workshops. Local communities had limited access to explicit knowledge on the management of estuaries contained in documents and databases. This study suggested that communities of practice and storytelling could be effective ways to facilitate knowledge sharing.

A study to investigate the application of the KM approaches for service delivery in three rural communities in South Africa was conducted by Noeth (2004; 2006). The study found that there was limited amount of information and knowledge, and the available information and knowledge was neither shared nor preserved which had a negative impact on the delivery of services in the surveyed communities. Therefore, the study proposed that a generic KM model could be used to eliminate many of the problems encountered in these communities and subsequently improve the range, as well as the quality of services available to community members. This model comprises the KM enablers (that is, organisational culture, leadership, preservation, and organisational structure) which can either support or hinder KM processes in the local communities, which include knowledge identification, mobilization, generation and elaboration, application and evaluation.

Mudege (2005) conducted an ethnographic study to investigate the knowledge production and dissemination in a resettlement area in Zimbabwe. The study established that agricultural knowledge was primarily social and its production was a social process, and thus gender dynamics, politics, power, conflicts, resistance, religious beliefs and government policies determined the production and socialization of this knowledge. For developmental activities, the

study suggested that local knowledge can make use of conventional knowledge systems based on the state organised interventions.

A study to investigate the way agricultural knowledge is managed in the rural Khorezm region of Uzbekistan was conducted by Wall (2006). An anthropological/sociological approach was used, where unstructured and semi structured interviews, direct observation, documents and sociological survey were triangulated. The study revealed that farmers had an extensive base of IK on farming practices. However, their knowledge was limited by knowledge loss. Modes of knowledge reproduction within Khorezm were confined at family level although there were examples of external forms of knowledge being accessed and then reproduced within the knowledge system. The study indicated that power and culture determined creation, sharing and use of agricultural knowledge in the rural Uzbekistan. The study suggested that there should be constant use and sharing of knowledge to prevent knowledge loss.

It is clear from the aforesaid that Ha, Okigbo and Igboaka's (2008) study was also relevant to the current study. Issues related to KM models and ICTs were further investigated in the present study. Noeth's (2004; 2006) research findings were used to inform the theoretical framework, research methods and the interpretation of the results of the current study. Wall's (2006) and Mudege's (2005) research methods were also used to inform the research design of the current study where mixed methods were used. More pertinent to this study were issues related to gender, power, culture, and government policies as they affect knowledge creation and sharing in the local communities which were further investigated in the present study. Mosia and Ngulube's (2005) study was also relevant to this study since they assessed the knowledge sharing activities in the local communities. Some of the KM approaches (that is, communities of practice and storytelling) were important to inform the theoretical framework of the present study.

3.8 Protection of agricultural indigenous knowledge in developing countries
Despite the fact that KM practices can be used to manage IK, issues related to ownership and access to IK are still questionable. A balance must be drawn between open access to knowledge and the local community's right to control delivery of content. For instance, within local

communities, access to knowledge is determined by various factors and it varies from one community to the other. Knowledge may be shared during certain seasons (for example, during winter), or to a particular gender, or level of expertise, or training (Roy 2003). Intellectual Property Rights (IPR) are a significant legal instrument by which IK can be protected from misappropriation in developing countries.

Two main intellectual property regimes could protect agricultural IK in terms of the biological resources of plants or animals and its associated knowledge. However, they are rather limited in protecting these resources. These regimes include patents and plant breeder's rights. For instance, the conditions required by the patents are often hard to meet in developing countries. Most of the biological resources are not contemporary and have been used for long periods, and thus the requirement of novelty, distinctness, uniformity, and stability may be difficult to meet in developing countries (Correa 2001; Van Overwalle 2005). Similarly, the plant breeders' rights protect the biological resources if the standard conditions of distinctness, uniformity, stability and novelty (commercial) are met and although this threshold is significantly lower than the patent one, conditions have to be fulfilled (UPOV 1991). If they were effective, patents and plant breeders' rights could allow communities and IK custodians to enforce control measures over the use of their knowledge and apply varied licensing agreements (Kargbo 2006:75).

Further, copyrights can be used to protect the artistic work of the local communities. For instance, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the World Intellectual Property Organisation (WIPO) Model Provisions for National Laws for the Protection of Expressions of Folklore against Illicit Exploitation and other Prejudicial Actions 58 of 1985 outline how this component of IK can be protected. The WIPO model provides a framework not only to protect individuals, but also communities, and allow the protection of ongoing or evolutionary creations (Correa 2001). Few countries (Bolivia and Morocco) have implemented rules based on the framework of the Model Provisions. In addition, very few national laws and constitutions (Costa Rica, Brazil, Panama, Thailand, and Philippines) have enacted the intellectual rights of the communities (Correa 2001). If enacted, copyrights of this nature can help to protect the cultural expressions of the local communities in the developing countries.

Apart from the IPR instruments, there are a number of international conventions and treaties which deal with the protection of agricultural IK (that is, plant genetic resources and knowledge). However, the treatment of IK within these international instruments is still inadequate. For instance, the 1992 Convention on Biological Diversity (CBD) which was negotiated under the auspices of the United Nations Environment Programme (UNEP) also recognises the value of IK on biological diversity (UNEP 1992). However, CBD inadequately protects agricultural IK, by asserting the national sovereignty and control over genetic resources, without recognising the rights of indigenous communities to genetic resources. It also addresses IK separately from genetic resources, traditional territories and customary laws. Further, IK issues are addressed within a paradigm of 'property', and the Working Group on Article 8(j) lacks government commitment (Swiderska and Argumedo 2006:2).

Another international initiative includes the Food and Agriculture Organisation (FAO) Treaty on Plant Genetic Resources (ITPGR) for Food and Agriculture, which was enforced in 2004 (FAO 2004). The treaty aims at ensuring food security through conservation, exchange and sustainable use of world's plant genetic resources, as well as fair use and equitable benefit sharing, in harmony with CBD (FAO 2004). The ITPGR prohibits intellectual property rights over material obtained through the multilateral exchange, although it does not necessarily prohibit intellectual property protection over derivatives thereof (Collier 2006).

Other international instruments, such as the 1994 United Nations (UN) Declaration on the rights of indigenous people also recognises the rights and aspirations of the IK. However, it is a soft law instrument with limited scope for ensuring implementation and compliance. It also does not elaborate comprehensive provisions to protect IK (Swiderska and Argumedo 2006:9). The Convention for the Safeguarding of Intangible Cultural Heritage which came into force in 2006 is another framework that recognises IK (UNESCO 2003). However, it lacks attention to indigenous participation, resource control and self-determination (Swiderska and Argumedo 2006:7). Other frameworks, such as the World Trade Organisation's (WTO) Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs) makes no explicit mention of the protection of IK and also makes no mention of the CBD (Daya and Vink 2006:325; Rao 2006).

Similarly, the International Labour Organisation Convention 169 ('ILO 169') which came into force in 1991 does not specifically protect IK and it is not widely ratified and implemented (Swiderska and Argumedo 2006:9). Such rights are inappropriate to Africa's rural communities who have collective ownership over their knowledge and genetic resources.

Despite the fact that there are valuable international conventions and treaties dealing with agricultural IK, these frameworks inadequately protect this knowledge. To address the problem of collective ownership of IK, Swiderska and Argumedo (2006) proposed the concept of collective bio-cultural heritage which can address the biodiversity and culture together, rather than separating them. If implemented, it can also recognise collective as opposed to individual rights, and places them in the framework of 'heritage' as opposed to 'property'.

A *sui generis* is another tool that was developed by the Third World Network (Community Intellectual Rights Act) in 1994 in order to give communities property-like rights over their collective knowledge (Lewis Clark College 2007). The *sui generis* system is stipulated within Article 27.3 of the TRIPs that requires the protection of plant varieties either through patents or a *sui generis* system or through a combination of the two (WTO 2008). However, some authorities were of the opinion that the article 27.3 of TRIPs Agreement had failed to recognise other traditional forms of innovation and the relationship between TRIPs and the CBD is still not clear (European Commission 2000). Further, few efforts have been made at implementing this kind of framework in developing countries (Correa 2001).

The Organisation of African Unity (OAU), now known as African Union (AU) also developed a model for IK law in 1998 which recognises the community's rights over their knowledge (AU 2000). The model law aims at conserving and sustaining use of, and sharing the benefits accruing from biological resources and community knowledge and technologies in order to sustain all life support systems (Egziabher 2002). However, the development of national laws based on this model has been slow in Africa due to the inadequate expertise in legal drafting and awareness of its implication for national development and international cooperation (Ekpere 2002:3).

It can be argued that the inadequacies of many IPRs (for example, patents and plant breeders' rights), and international conventions and treaties, to appreciate the collective nature of IK, and their focus on the economic value of information, have failed to protect IK (Tella 2007). As a result, pharmaceutical companies have misappropriated genetic resources and/or IK through the patent system. For instance, McGown (2006) reported 36 brief case studies of medicines, cosmetics and agricultural products that originate from biodiversity in African countries including Tanzania and that have been patented by multinational companies without evidence of benefits accrued by the countries of origin. However, there are a number of tools such as the *sui generis,* and the OAU model which if implemented, can effectively protect IK because its collective nature is recognised.

3.9 Exogenous knowledge and information: an overview

Although, IK is significant for sustainable agricultural practices, knowledge from outside sources can also bring fresh ideas, opportunities that are needed for constant changes for socio-economic development (Garforth, Khatiwada and Campbell 2003; Rosenberg 2001). Various studies emphasize that a lack of knowledge and information can negatively affect the development process (Sturges and Neill 1998; Meyer 2002). Although exogenous knowledge is a key resource for the socio-economic development, the linkages between information investments and the achievement of specific development goals are extremely weak (Mchombu 1992; Katundu 2000). This situation is mainly caused by the policymakers who are not aware of the potential of knowledge for development (Mchombu 1995b). As a result, the knowledge base of the developing countries especially those in Africa, is outdated, creating a need to have access to the updated knowledge similar to the developed countries (Mchombu 2005; World Bank 1998b). It is thus important to assess the accessibility of exogenous knowledge in the local communities in order to establish their impact for socio-economic development. Mchombu (2001) asserted that if such impact can be demonstrated to decision makers, resource allocators and politicians, it would increase the support of information and exogenous knowledge as vital resources in development and wealth creation.

3.9.1 The role of exogenous knowledge and information for sustainable agricultural practices

Exogenous knowledge plays a critical role in facilitating agricultural and rural development and bringing about social and economic change (Asaba *et al.,* 2006; Demiryurek 2008; Lesaoana-Tshabalala 2003). The importance of knowledge for agricultural development is closely linked to the innovation and knowledge production initiatives (Pardey *et al.,* 2007). However, most of the developing countries incur very little of their GDP on agricultural innovation and knowledge production. Both public and private sources in developing countries invest only a ninth of what industrial countries put into agricultural research as a share of agricultural GDP (World Bank 2007:18). In Tanzania for example, about 0.5 percent of the agricultural GDP is allocated to research activities (MAFS 2001). Further, many public research organisations also face serious leadership and management problems as well as those of retrenchment that need to be tackled (Jones 2006:12; World Bank 2007:19). As a result, some regions such as Sub-Saharan Africa have had low or incomplete adoption of agricultural conventional technologies, where many countries have almost no area under improved crop varieties (World Bank 2007:223-224). Thus, much effort is needed to improve the research activities for the development of the agricultural sector in the developing countries.

3.9.2 Access to agricultural exogenous knowledge: an overview

Various studies have revealed that there is a positive relationship between the increased flow of exogenous knowledge and agricultural development (Akullo *et al.,* 2007; Cash 2001; Fawole 2008; Kalusopa 2005; Raju 2000). In Tanzania, rural information provision was demonstrated to have a positive impact on agricultural practices (Mchombu 2001; 2003). Similar observations were also made in Malawi (Muyepa 2002), Burkina Faso and Nigeria (FAO 1998:4). However, despite its potential for agricultural development, most African countries have not devoted their efforts to disseminating knowledge and information, especially in rural areas, where 70 to 80 percent of the African population lives (Adomi, Ogbomo and Inoni 2003; Meyer 2003). Only a small amount of information on various innovations is known to the majority of smallholder farmers (Laizer 1999; Ochieng 2004), despite the large extent of knowledge that exists in research institutions, universities, public offices and libraries. Libraries which are the major sources of knowledge are rarely being used to deliver such knowledge to farmers mainly due to lack of funds (Iwe 2003:169; Lwoga and Chilimo 2003).

Currently, extension services are the major providers of improved technologies to promote agricultural development in the rural areas (Malhan and Rao 2007:3; Sharma 2003). The failure of the Training and Visit (T&V) extension approach (which focuses on transfer of technologies) in Asia and Africa in the late eighties and early nineties activated the extension reforms and new extension models such as agricultural knowledge and information system (AKIS) (Eicher 2007). However, the potential of the AKIS approach to improve agricultural productivity has been debated because it does not prioritize farmers' needs in the research and development agenda of the government and universities (Eicher 2007; Garforth, Khatiwada and Campbell 2003). Leeuwis (2004) also noted that AKIS looks at knowledge generation and use without considering the influence of political and other forces in the system and therefore cannot yield a complete and realistic analysis. Thus, there has been a shift from the AKIS paradigm to an agricultural innovation system.

Agricultural innovation systems are characterised by participatory approaches such as farmer field schools (FFS). For instance, FFS have already been introduced in some 80 developing countries (van den Berg and Jiggins 2007). Currently, extension reforms are underway in many countries in Asia and Latin America and to a lesser extent in Africa (Eicher 2007). However, recent research indicated problems in operationalizing the agricultural innovation paradigm in developing countries. Studies have shown that the extension agents, in an effort to identify and prioritize farmers' knowledge and needs in developing countries, do not interact well with farmers (Apantaku, Oloruntoba and Fakoya 2003; Van der Stichele 2000). Many extension services are still used to the Transfer of Technology (TOT) model (Castella *et al.,* 2006:110; Chambers 1994a; Heemskerk and Wennink 2004:36; Warburton and Martin 1999:1). The failure to adopt participatory approaches is also caused by the inadequate number of extension workers, lack of resources to mobilize communities, lack of infrastructure, and weak linkages among different actors (such as, research, education and extension institutions) which limit their effectiveness to contribute to development (Castella *et al.,* 2006:110; Kiplang'at 2003; Rees *et al.,* 2000; Tire 2006). Thus, most extension services have been disseminating knowledge which is not relevant to farmers' needs.

Although they produce 80 percent of the food, women receive seven percent of the assistance from agricultural extension services, and they access less than ten percent of available credit in the agricultural sector in Africa (Holmes 2000). However, this situation does not undermine the fact that women possess a wealth of agricultural IK which could be improved with the access to appropriate and timely agricultural technologies. Research findings from Burkina Faso revealed that agricultural yields could increase by six percent if some labor and manure were reallocated to women, since they receive inadequate support from the extension and loan services (Basu 2006). It is thus important to develop gender-sensitive and culture-specific strategies in the demand for labor and access to assets and knowledge to enhance agricultural performances in developing countries (Sokoya, Collings and Muthukrishna 2005; World Bank 2007:221).

3.9.3 Access to agricultural exogenous knowledge: empirical studies

Research studies were reviewed on access to agricultural exogenous knowledge which were carried out in other parts of the globe especially developing countries and Africa. These studies were from India (Conroy *et al.,* 2004), Myanmar (Cho 2004), Vietnam (Castella *et al.,* 2006) and other parts of Africa (Adomi, Ogbomo and Inoni 2003; Bagnall-Oakeley *et al.,* 2004; Garforth 2001; Kalusopa 2005; Leach 2001; Matovelo, Msuya and de Smet 2006; Rees *et al.,* 2000; Stefano *et al.,* 2005).

Adomi, Ogbomo and Inoni (2003) investigated the extent to which crop farmers' had access to agricultural information in rural areas of Delta State, Nigeria. Data was gathered by questionnaires from ten villages. The findings revealed that farmers rely heavily on personal experience, neighbours and friends as sources of information for their farm work. Similar observations were made in Eritrea (Garforth 2001), Kenya (Rees *et al.,* 2000), Myanmar (Cho 2004) and Tanzania (Matovelo, Msuya, and de Smet 2006). Written sources and libraries were also important. Lack of visitation by agricultural extension officers, lack of a nearby library and illiteracy were identified as obstacles to information use. The Adomi, Ogbomo and Inonis' (2003) study recommended the following: employ more agricultural extension officers, establish a community library in every village, and encourage adult literacy education.

A study to examine the indigenous agricultural knowledge and information systems in Uganda was conducted by Bagnall-Oakeley *et al.,* (2004). This study used PRA tools, which were wealth ranking, information network diagrams, linkage analysis matrix, and cataloguing and assessing information. The study revealed that access to information was confined to wealth. The richer and progressive farmers had information networks which went beyond the community boundaries (example, radio, extension workers, agri-business enterprises and newspapers). On the other hand, poor farmers' information networks were limited to relatives, friends, and radios and to a lesser extent, extension workers. For both groups, delivery of information on technical farming details and marketing was the main problem.

In Vietnam, Castella *et al.,* (2006) examined how better interactions of rural information providers may help marginal farmers to improve their living conditions. Interviews and questionnaires were used in the study. The findings revealed that formal sources of information within the village (village meetings, training courses and technical brochures) were the major sources of information to farmers. Neighbours and other farmers (56 percent) and on-farm demonstrations (50 percent) were important sources of information. Farmers were well aware of the involvement of the extension service in their community. However, only eight percent of the farmers had been visited by the extension agent, suggesting the limited interaction between these two actors, as it was also found in Kenya (Rees *et al.,* 2000), Myanmar (Cho 2004), and Nigeria (Adomi, Ogbomo and Inoni 2003). This study suggested that participatory approaches should be used to develop and disseminate agricultural technologies to promote technology adoption by farmers.

A study to assess the implications for technology dissemination and development to smallholder farmers in Myanmar was conducted by Cho (2004). The study findings revealed that the major sources of knowledge for small-scale farmers were friends, relatives, neighbours and markets. This finding was also found to be a similar case in Eritrea (Garforth 2001), Kenya (Rees *et al.,* 2000), Nigeria (Adomi, Ogbomo and Inoni 2003) and Tanzania (Matovelo, Msuya and de Smet 2006). Non Governmental Organisations (NGOs) and United Nations Development Programme (UNDP) were also important sources of information in those areas where they were active. On

the other hand, public extension services were not effective although they were the major source of information. Neither the communities nor the extension personnel themselves were satisfied with the quality or frequency of interaction. Lack of access to information on technical details of farming was the major knowledge gap.

A study was conducted by Conroy *et al.,* (2004), to establish the poultry keepers' agricultural knowledge and information systems in India. Group interviews, structured individual interviews, information mapping and linkage diagrams, agricultural timelines and feedback meetings were used. The study findings showed significant variations in information sources and media preferences, both between various locations and between gender categories within them. Similar observations were made in Kenya (Rees *et al.,* 2000), Eritrea (Garforth 2001) and Uganda (Bagnall-Oakeley *et al.,* 2004). The results also indicated that the vast majority of farmers, women in particular, do not regard government extension workers as their main source of agricultural information. The most frequently cited main sources were radio, family members, other farmers and the private sector (input suppliers, traders); and, in the two Udaipur villages, BAIF NGO was the main source for most people, particularly women. Further, written media was not regarded as useful, with exception to posters due to low literacy rates especially among women. Training of various kinds, and meetings were also seen as important sources of information, with exceptions to self-help groups, which were cited more often by women than men.

Garforth (2001) analyzed agricultural knowledge and information system in Hagaz, Eritrea. The study used both quantitative (questionnaires) and qualitative methods (semi-structured interviews, agricultural timelines, transect walk, problem tree and information mapping). Two villages, Ashera and Hagaz were used as case studies. As other studies, such as Conroy's *et al.,* (2004), Rees's *et al.,* (2000) and Bagnall-Oakeley's *et al.,* (2004), Garforth (2001) also found that there were distinct variations with regards to farmers' knowledge needs and access to information and knowledge in different locations, and between gender and socio-economic categories within them. Data revealed that more than half of the farmers accessed agricultural information from traders although they felt that it was not trustworthy. Information from the

Ministry of Agriculture was thought to be very reliable although frequency of contact and ease of access were not high, as it was also found to be the case in Myanmar (Cho 2004) and Kenya (Rees *et al.,* 2000). Informal sources within the village were also not reliable although the frequency of contact and ease to access was high. In response to these findings, this study recommended the following: training to meet specific needs of different categories of farmers; local, adaptive research to solve specific local problems; and improved flow of appropriate information to farmers from both informal and formal networks.

Leach (2001) used focus groups to examine the information provision in a rural area of Kwa-Zulu Natal, South Africa. An oral or verbal format was the most preferable means for the group to share information in a particular situation although other formats were seen in positive terms by the rural adults groups. Other formats (print, pictures/posters, television, radio and theater) were essentially seen as one-way communication channels requiring some form of verbal intervention or follow up.

In Tanzania, Matovelo, Msuya, and de Smet (2006) investigated how smallholder farmers' acquisition of agricultural information can be enhanced for poverty reduction. A total of 600 men and women smallholder farmers were randomly selected for a face-to-face questionnaire survey. Farmers mainly depended on informal networks of relatives, friends, and neighbours (80 percent) to access information, as it was found to be a similar case in Eritrea (Garforth 2001), Kenya (Rees *et al.,* 2000), Nigeria (Adomi, Ogbomo and Inoni 2003) and Myanmar (Cho 2004). Extension workers (72 percent), radio (64 percent), and printed materials (24 percent) were also important information sources. Most respondents (92 percent) were eager to access and use printed agricultural information. Similar observations were made in South Africa (Stefano *et al.,* 2005), and Uganda and Ghana (Carter 1999).

A study to investigate the significance of different actors and organisations as potential dissemination pathways for agricultural technologies in Kenya was conducted by Rees *et al.,* (2000). The study was implemented in four districts of Kenya by using the following methods: rapid appraisal of agricultural knowledge systems (RAAKS), participatory rural appraisal (PRA), and strengths, weaknesses, opportunities and threats analysis (SWOT). Similar to other studies

(Conroy *et al.,* 2004; Bagnall-Oakeley *et al.,* 2004; Garforth 2001), Rees *et al.,* (2000) also found that the agricultural knowledge and information system was complex, and there were distinct differences with regard to agricultural enterprise, agro-ecology, and location. The study revealed that local actors (neighbours, family, markets and community based organisations) were the major sources of information. Similar observations were made in Eritrea (Garforth 2001), Myanmar (Cho 2004), Nigeria (Adomi, Ogbomo and Inoni 2003) and Tanzania (Matovelo, Msuya, and de Smet 2006). Public extension services were an important source of information, though both farmers and extension personnel were dissatisfied with the quality and frequency of their interactions. Similar observations were made in Myanmar (Cho 2004), and Vietnam (Castella *et al.,* 2006). NGOs, Churches, chief's *barazas* (community meetings) and agricultural companies were significant information sources in some locations. Horizontal linkages between the external organisations were generally poor. This study advocated the use of participatory learning approaches as ways to integrate IK and exogenous knowledge to enhance agricultural productivity.

A study to assess the printed information needs of small-scale organic farmers in KwaZulu-Natal, South Africa, was conducted by Stefano *et al.,* (2005). Participatory rural appraisal methods (focus groups, semi-structured questions, information tabulation, voting, ranking, sorting and observation) were used. The study showed that intermediaries such as NGO, church-based development facilitators, researchers and extension officers were the main sources of agricultural information to farmers. Despite having limited access to printed materials, the findings showed that farmers valued printed materials as a source of information. Similar observations were made in Tanzania (Matovelo, Msuya, and de Smet 2006), Uganda and Ghana (Carter 1999). The study concluded that printed materials were not sufficient to meet farmers' information needs, and recommended a collaborative, action research approach to ensure that farmers are involved in developing their agricultural knowledge and information systems.

A study by Adomi, Ogbomo and Inoni (2003), Bagnall-Oakeley *et al.,* (2004), Castella *et al.,* (2006) and Cho (2004) were important to the current study. Some of the issues which were addressed in these studies were also handled in the current study which included farmers'

knowledge needs, and knowledge sources. Bagnall-Oakeley *et al.,* (2004) PRA methods' were used to inform the methodology of the current study. Leach's (2001) and Stefano's *et al.,* (2005) studies showed that rural people preferred oral medium to access knowledge which was important aspect to inform the theoretical framework of the current study. The use of focus group discussions were also used to inform the methodology of this study. Conroy's *et al.,* (2004), Garforth's (2001) and Rees's *et al.,* (2000) studies were also significant to the current study. The variations (such as locations, farming systems, and gender categories) in people's access to information were also addressed in the data collection method of this study. The qualitative methods (semi-structured interviews, problem tree, and information mapping) were also used to inform the methodology of this study. Some of the issues investigated by Matovelo, Msuya, and de Smet (2006) were also addressed in the present study, which include farmers' information and knowledge needs, information sources and delivery mechanisms for agricultural information.

3.10 The need to integrate the exogenous and indigenous knowledge for agricultural development: an overview

IK can continuously innovate from within and also adapt external knowledge to suit local situation and improve agricultural productivity (Abu 2005; Ajibade and Shokemi 2003; Hart and Mouton 2005; Letty and van Veldhuizen 2006; Lwoga and Ngulube 2008; Maponya and Ngulube 2007; Reij and Waters-Bayer 2001; Waters-Bayer and van Veldhuizen 2005). In fact, this integration might be usefully seen as adding value to local knowledge, innovations and practices rather than replacing them (Adedipe, Okuneye and Ayinde 2004; Dove 2000; Hill 2003; Mundy 1993:5; Pottier 2003:5; Vivekanandan *et al.,* 2004:3; Walker *et al.,* 1999). The integration of exogenous and indigenous knowledge systems enables farmers to compete and respond to global opportunities and challenges. It also enhances adoption of agricultural technologies generated by the research organisation that has been relatively low (Akullo *et al.,* 2007:11; Wall 2006).

However, indigenous knowledge systems are poorly understood, and their integration into agricultural research is almost non-existent, with the result that farmers' knowledge has been undermined and eroded (Bagnall-Oakeley *et al.,* 2004; Magoro and Masoga 2005; Odame

2004:20). Instead, the main concern of conventional agricultural research is completely on the technical aspects, ignoring the social, environmental and other dimensions that significantly influence the technical aspects (Grenier 1998; Hart and Mouton 2005; Scoones and Thompson 1994b). Most of the extension services in developing countries are still used to the transfer of technology (TOT) model (Castella *et al.,* 2006:110; Chambers 1994a; Heemskerk and Wennink 2004:36; Warburton and Martin 1999:1). The transfer of technology approach on rural people makes farmers less knowledgeable, which is a form of dis-empowerment to the communities (Chambers 1994a; Mariam and Galaty 1993:26; Mchombu 1995a; Warburton and Martin 1999). The challenge is thus to move beyond the existing innovations that farmers have developed, using their IK and creativity, and to develop these ideas further in joint experimentation, integrating relevant information and ideas from elsewhere (Friis-Hansen and Egelyng 2007; Waters-Bayer and van Veldhuizen 2005).

3.10.1 The current approaches that are used to integrate indigenous and exogenous knowledge for sustainable agricultural practices

In KM literature, knowledge integration refers to a process in which different pockets of knowledge that are valuable for a particular organisational process and held by different organisation members, are applied to that organisational process (Berends, van der Bij and Weggeman 2006). Despite the fact that most KM initiatives focus on managing knowledge that exists within the corporate environment (Maznevski and Athanassiou 2007), the term knowledge integration has recently gained in popularity and has been used for the integration of knowledge from individuals or departments within and outside an organisation (Berends, van der Bij and Weggeman 2006; Becerra-Fernandez and Sabherwal 2001; Grant 1996; Kraaijenbrink and Wijnhoven 2006; Munkovold 2006:763; Okhuysen and Eisenhardt 2002).

However, most KM studies have focused on the corporate environment where knowledge integration is relatively easier since it is within the same knowledge system. On the other hand, transfers from a formal knowledge system to a local one or vice versa is difficult because the transferred messages do not make much sense within the other knowledge system (Hess 2006). Very often the contexts from which the information and knowledge products or services are originated are different from the cultural context of the local farmers (Meyer 2009). In literate

cultures, information is stored as records, while in oral cultures it is primarily captured and stored in the collective memory of communities in oral cultures (Meyer 2009). The challenge is therefore to facilitate the communication and sharing of knowledge between agricultural professionals and farmers who have distinct knowledge systems which originate from different cultural contexts. Recognition and understanding of farmers' knowledge helps in understanding how information gaps can be filled, and linkages can be made or strengthened (Waters-Bayer *et al.,* 2006:6). Recognising the innovativeness of farmers, creates a fertile ground for their collaboration with other actors (Waters-Bayer *et al.,* 2006:5) and for linking indigenous and exogenous knowledge systems for effective KM practices in the local communities.

Participatory approaches have been the practical way of bringing together farmers' knowledge systems with agricultural science knowledge (Dondeyne, Emanuel and Deckers 2003:45; Hess 2006; Jesajas and Packham 2003; Reij and Waters-Bayer 2001; Waters-Bayer *et al.,* 2006; Waters-Bayer and Bayer 2009). These approaches focus on local people's own knowledge and practices and they take place within the community (Warburton and Martin 1999). Participatory approaches are important for the development of technologies which are usually appropriate to farmers' technical level and culture. Such technologies are also relevant to farmers' needs, easily and readily adopted by participating farmers and their colleagues, thus increasing their productivity and ensuring sustainability (Apantaku 2006; Duveskog, Mburu and Critchley 2002). These efforts can thus make a positive contribution to the KM practices in the agriculture sector.

Apart from participatory approaches, some authors have emphasized the significance of developing models of community knowledge management when linking exogenous and indigenous knowledge systems (von Liebenstein 2000). Shiruma (2004) suggested that interdisciplinary knowledge sharing can be applied as another approach to streamline and integrate exogenous and indigenous knowledge systems and address some information gaps. Among other means, traditional folk media can also be used to integrate and share local agricultural knowledge with new knowledge from outside sources (FAO 1998). Dixon (2002) also emphasized that the knowledge intermediaries should focus more on local level participation and facilitating the exchange of information and technologies through indigenous channels rather

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than through traditional extension methods for improved KM activities. Onyango (2002:250) also suggested that indigenous and exogenous knowledge can be brought together through publications and farmer-to-farmer networks. There is thus a need to consider all these approaches when integrating IK into exogenous knowledge systems. It is also important to assess the extent to which KM approaches can be applied to integrate indigenous and exogenous knowledge systems in the local communities.

3.10.2 The integration of indigenous knowledge and exogenous knowledge systems for sustainable agricultural practices: review of empirical studies

Research studies on the integration of agricultural indigenous and exogenous knowledge systems in rural areas which were carried out in other parts of the globe, especially developing countries and Africa were reviewed. These studies were from Guatemala (Siebers 2003), India (Rajasekaran and Martin 1992; Rengalakshmi 2004), Jamaica (Protz 1998) and other parts of Africa (Bagnall-Oakeley *et al.,* 2004; Boateng 2006; Meyer and Boon 2003).

For example, Bagnall-Oakeley *et al.,* (2004) examined the indigenous agricultural knowledge and information systems in Uganda. Findings revealed that farmers' information networks are confined by wealth. This study also showed that formal knowledge and information systems can be linked with farmers' knowledge systems through public-private research and extension partnerships and farmer groups, community-based libraries, 'learning by doing' approach (such as study tours, practical demonstrations), media (such as radio, posters, flyers and so on), and on-farm trials.

A study was conducted by Boateng (2006) to investigate the application of KM models for effective agricultural extension practices in Ghana. The study interviewed 160 farmers, community leaders and government officers. The study revealed that the circular KM model which is an amalgamation of the Nonaka and Takeuchi's (1995) and the Hansen, Nohria and Tierney's (1999) KM models can be used by agricultural extension officers to inform farmers' decisions regarding improved technologies. The model can also be used to incorporate farmers' knowledge in the design and development of such technologies.

A study to assess the training programme on maize production in South Africa was conducted by Meyer and Boon (2003). This study showed that the utilisation of communication mechanisms inherent in the IK system becomes imperative for the provision of exogenous knowledge and information to the rural communities where the oral tradition still prevails. Meyer and Boon (2003) developed a merger model which demonstrates that information from both the modern information systems and IKS can be harnessed for improved agricultural performances.

Protz (1998) investigated the way agricultural technologies can be transferred to the rural women in Jamaica. The study found that a participatory communication and extension methodology that incorporates both indigenous and exogenous knowledge and which uses a variety of traditional and modern communication methods according to the needs of farmers can be effective in delivering agricultural technologies in the rural communities. Actually, this research emphasized that the more culturally appropriate agricultural materials and their delivery are, the more readily they will be received.

A study was conducted by Rengalakshmi (2004) to analyze how traditional and conventional knowledge systems can be linked to enhance climate prediction and utilisation in India. This study revealed that a multi-stakeholder participatory approach can be used to integrate exogenous and local knowledge on climate to develop localized climate and weather systems at the village level in India. The findings indicated that access, availability of infrastructure, skill and expertise are crucial to develop reliable region-specific scientific forecasts to serve the farming communities.

In their study to assess agricultural extension perceptions regarding IK systems in India, Rajasekaran and Martin (1992) developed a model to integrate indigenous knowledge systems into agricultural and extension education. The model starts with the need to establish a national resource centre to collect, document and disseminate IK. Once trained on the methodologies for recording IK, extension workers should also train other extension workers on how to record IK at the field level by considering various agro-ecological conditions. The IKS thus collected should be fed back to the extension-research system via bi-weekly training programs and zonal

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workshops. On-station and on-farm research project should be conducted by the discipline's scientists based on the classified IKS to integrate both indigenous and conventional knowledge systems.

An ethnographic study to analyze the management of knowledge and social transformation in Guatemala was conducted by Siebers (2003). The study found that culture and power determined the knowledge sharing processes and the integration of the exogenous knowledge, called "Q'eqchi" into the local knowledge system, called "na'leb". There was a significant pattern of social interaction between local Q'eqchi communities and the representatives of farmers. Farmers' representatives perceived themselves as superior to local farmers which inhibited knowledge integration processes. Further, farmers were not afraid to apply exogenous knowledge (such as mineral fertilizers), but they were reluctant to apply these inputs into their traditional land use patterns due to lack of trust and fear of over reliance upon urban sources for their indigenous economic activities.

It can be asserted that all these studies are important to the current study. These studies have shown that farmers possess relevant and wide stocks of IK which can effectively be linked to the exogenous knowledge system. Various aspects from Boateng's (2006) KM model, Merger model (Meyer and Boon 2003), strategies proposed by Bagnall-Oakeley *et al.,* (2004), Rajasekaran and Martin's (1992) model, and participatory approaches (Rengalakshmi 2004; Protz 1998) were used to inform the theoretical framework and methodology of the study. Major emphasis was put on understanding whether or not the use of communication mechanisms that are familiar to farmers used to oral traditions may influence the fusion of indigenous and exogenous knowledge systems (Meyer and Boon 2003:174; Protz 1998). Issues raised by Siebers (2003) related to culture and power relationships were used to inform the theoretical framework and the methodology of the study.

3.11 Information and communication technologies: an overview of developing countries

Information and communication technologies (ICTs) can positively improve access to knowledge to enhance human capabilities and contribute to economic growth (Emmanuel and

Lwoga 2007; Von Krogh, Ichijo and Nonaka. 2000:3; Sife, Lwoga and Chilimo 2004; UNDP 2001). There has been a growing use of ICTs in developing countries mainly due to both demand-side factors, such as the increasing popularity of mobile phones and the Internet, and by supply-side factors, such as regulatory reforms, falling costs and prices, and technological innovation (Cecchini and Scott 2003; FAO 1998:12; Gray and Magpantay 2005:9).

For instance, in countries that reformed their telecommunications sector, teledensity and user intensity increased at a higher rate between 1996 and 2000 than in countries where reform had not taken place (Beardsley et al., 2002). The Internet has also spread at a great speed. In Africa, although the level of internet usage is less (6.8 percent) than the rest of the world (28.9 percent), the number of internet users in the continent is growing at a fast rate by 1,392.4 percent than other regions of the world which is 367.5 percent (Internet World Stats 2009). Telecentres, community radio and television also continue to have a wide penetration and reach, particularly in Africa, South America and parts of Asia (Munyua 2000; Padania and Silvani 2005), which have increased access to knowledge in the rural areas.

Despite the rapid growth of ICT access and use, the digital divide has been slightly reduced. Uneven growth rates of ICT access exist between the developed and developing countries. A person in a high-income country is over 22 times more likely to be an Internet user than someone in a low-income country (UN 2006). The digital divide is even deeper within the African region. For example, three quarters of all Africa's fixed lines are found in just six countries of the continent's 55 countries (WSIS 2005). There are also similar divisions within individual countries, where rural areas tend to be marginalized in terms of access and use of ICTs. In addition, there are related divides within the communities due to different levels of education, social equity including gender equity, and the appropriateness of ICTs and knowledge to its socio-economic context (Harris 2004:11). Particularly, compared to men, women in the developing world are less likely to access and use ICTs due to their low level of education, economic and political power (Huyer et al., 2005:145; Odame 2004:2). For instance, research of 35 ICT projects in nine countries in Africa and Latin America revealed that 30 percent of the users were female while 70 percent were male (IICD 2006). More efforts are thus needed to

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bridge the digital divide at various levels for improved access to knowledge to enhance sustainable agricultural and rural development.

Major factors that limit ICT investments in developing countries especially rural areas is the cost of deployment, particularly in the building of technology infrastructure, which is high relative to revenue (Dossani, Jhaveri and Misra 2005; Emmanuel and Lwoga 2007; Lwoga *et al.,* 2006; Sife, Lwoga and Chilimo 2004). Other reasons that may limit ICT investments in the rural areas are related to infrastructural, technical, regulatory, distributional, social, cultural, and economic issues (Zeleza 2005:283). As a result, ICT services, especially those related to computers, internet and information services, tend to be poorly utilised, whilst some others, including radio, and telephone have a moderate to high level of demand (Cecchini 2002; Parkinson 2005).

3.11.1 The role of ICTs in managing agricultural indigenous knowledge

The need to preserve and share indigenous knowledge through ICTs is well documented despite the issues of inequitable access (Chisenga 2002; IICD 2006:32; Lwoga and Ngulube 2008; Mutula 2002; Shibanda 2001). In fact, the local communities have a considerable interest in using ICTs for preserving and strengthening their cultural heritage (Harris 2004:31). For instance, telecentres have enabled some local communities to capture and share IK through ICTs in developing countries, such as India (Arunachalam 2005), and Tanzania (Lwoga and Ngulube 2008). Further, a combination of telecentres and radio has been effective in collecting and sharing IK in some countries, such as Bolivia (IICD 2006:35). Rural farmers are also equipped with the effective agricultural indigenous production methods through the internet. In India for example, the Honey Bee Network uses ICTs to collect and disseminate agricultural IK in local language through the internet, which helps owners to obtain incomes from local patents and the commercialization of inventions (Cecchini and Shah 2002; Harris 2004:18; May, Karugia and Ndokweni 2007:15). Similarly, other countries and international agencies such as the Indian Traditional Knowledge Digital Libraries project, CAB International, Centre for International Research and Advisory Networks (CIRAN), FAO LinKS project, World Bank, Canadian International Development Agency, and the International Development Research Centre have established research centres and websites to document and share IK (CIDA 2002; FAO 2007a; World Bank 2009b).

Multimedia technologies are also used to manage indigenous farming production techniques in developing countries. The Agrecol Andes NGO has strengthened the documentation and exchange of indigenous production techniques among Bolivian farmers through digital pictures and multimedia presentations (IICD 2006:32). A similar project in Ecuador uses multimedia to document and share effective production methods for coastal areas (IICD 2006:33). In Africa, the Kyanika Adult Women's Group (KAWG) in Kenya also preserves the diversity of bottle gourds, locally called "Kitete" through ICTs (audio tapes, photographs and video) (Morimoto and Maundu 2002). These facts indicate that ICTs can play a great role in managing IK in the local communities.

Although there is an awareness of the impact of ICTs in knowledge acquisition, factors such as a lack of ICT policies, financial resources, language, infrastructure, and content limit the adaptation of ICTs in the rural areas (Lwoga and Ngulube 2008). Further, little has been done to accommodate cultural differences of the local communities and knowledge providers when designing knowledge products and services (Hepworth 2007; Meyer 2009). Individual needs and those that stem from the wider cultural and the local social context are, therefore, only partially catered for (Hepworth 2007). It is therefore important to consider all these factors for effective management of IK through ICTs in the rural areas.

3.11.2 The role of ICTs in disseminating exogenous knowledge and information in developing countries

ICTs can improve access to exogenous knowledge and information that may meet the location specific information needs of the farmers (FAO 1998; Sharma 2003). The fundamental idea behind ICTs is to improve access to prices, markets and agricultural production information and knowledge (IICD 2006:29). ICTs such as community radio have been effective in reaching illiterate farmers and providing them with agricultural information in a language they understand (Chapman *et al.,* 2003). Rural radios have increasingly been established in many developing countries, such as Cameroon, Mali, Ghana, Uganda (Kiplang'at 2003; Odame and Atibila 2003) and Bolivia (IICD 2006:35). The combined use of ICTs has also increased access of agricultural knowledge in the developing countries. For example, Kothmale community radio station in Sri Lanka is an example of the combined radio and Internet access project. This radio station

browses the Internet in search of answers to listeners' queries which are made by phone or post during the daily "radio browsing programmes" (Girard 2003:13; Pringle and David 2003). The use of mixed modes of ICTs to disseminate market price has also been implemented in various countries such as Bolivia and Ghana (IICD 2006:26-28), Chile and Mexico (FAO 2001), and Zambia (Zulu 2002).

Telecentres or village information shops (kiosks) have also been experimented with in many developing countries' rural areas to enable access to knowledge, such as India (Arunachalam 2005; Harris 2004:32; Nath 2000; Sasidhar and Sharma 2006), Bolivia, Ecuador, Jamaica, Uganda, Zambia (IICD 2006:67), South Africa (Caspary 2002), and Benin and Senegal (Ryan 2003). Cell phones have also been effective in providing access to agricultural information and knowledge to farmers in developing countries, such Senegal and Uganda (Ryan 2003), Bangladesh through the Grameen Bank cell-phone program (Bayes, von Braun and Akhter 1999), Kenya (Mukhebi 2007), and Malawi (Williamson 2007). Thus, ICTs can instantly transform an isolated, knowledge-starved village into one which has a greater control over its agricultural development through access to relevant knowledge.

3.11.3 The role of ICTs in managing indigenous knowledge and disseminating exogenous knowledge and information: review of empirical studies

Very little substantial or detailed research has analyzed the role of ICTs in managing agricultural IK in the local communities. Most of the reviewed studies have uncovered how local communities use a range of ICTs to access exogenous knowledge for improved farming productivity in their communities. These studies include those ones from Africa (Campbell and Garforth 2001; Chilimo 2008; Kalusopa 2005; Pott 2003; Souter *et al.,* 2005) and outside Africa, such as India and Nepal (Pigato 2001).

Campbell and Garforth (2001) investigated the communication strategy for the Plan of Modernization of Agriculture (PMA) in eight districts of Uganda. The study used a survey method to interview 1256 subsistence farmers including 63 commercial farmers. The study found that radio was the major source of information and knowledge for farmers. Similar observations were made in other studies in Uganda (Bagnall-Oakeley *et al.,* 2004) and India

(Conroy *et al.,* 2004). On the other hand, newspapers were also important sources of knowledge to commercial farmers. Other ICTs were less preferred by all categories of farmers, including: posters, television, telephones, video and cinemas. NGOs, extension officers and farmer associations were more likely to be reported as sources of knowledge by commercial than subsistence farmers. Subsistence and semi-commercial farmers were more likely to report informal social networks of friends, relatives and neighbours, and formal gatherings such as agricultural shows. The study suggested that radio broadcasts and printed materials should be used to disseminate agricultural information to farmers.

A study to examine the relationship between ICTs and sustainable livelihoods in selected rural areas of Tanzania was conducted by Chilimo (2008). The structured interview protocols were administered to 203 users and non-users of ICTs in the rural areas of Tanzania. The major information needs of the local communities were business and agricultural issues. The communities mainly depended on the informal networks of friends, relatives and knowledgeable farmers to access information, followed by radio and internet services provided by the telecentres. However, the use of ICTs such as internet or mobile phones for knowledge acquisition was not very common. The study recommended the need to strengthen the following: regular information needs assessments; universal access policies; capacity building; and collaboration among information intermediaries.

A study was conducted by Kalusopa (2005) to assess the challenges that small-scale farmers face in the use of ICTs in two selected provinces in Zambia. Findings indicated that the information centres (65.5 percent) and NGOs (63.9 percent) were the most useful sources of information to small-scale farmers. Only 36.7 percent felt that the government extension service provided them with the relevant information for their farming activities. Most farmers relied on personal experience (46.8 percent) and local groups (36.7 percent). In terms of ICTs, only radio and television (34 percent) were seen as good mediums for accessing information by farmers. Computers and cell phones were still undeveloped due to poor ICT infrastructure, high tariffs and slow pace of private investment in this area. This study recommended the need to strengthen the following: human capital, collaboration between the information intermediaries and farmers,

ICT application for effective KM practices at the government, institutions and rural level, and the establishment of national information policy.

A study to analyze information needs and access to ICTs by poor urban and rural households in Nepal and India was conducted by Pigato (2001). Interviews were conducted in 300 rural households and 400 urban households in Nepal and India. Findings indicated that the poor rely mostly on informal networks of trusted family, friends, and village and local leaders for their information needs. In contrast, formal sources such as NGOs, newspapers, and school teachers, were rated low and in both countries, politicians were the least trusted. Poor people had no access to digital information and the new forms of ICTs (internet, fax and computers) were accessible to some degree by only two percent of low income households, mainly in urban areas in both countries. By contrast, the poor had access to radio, and increasingly, to television in urban areas. This study recommended the following: balanced policy goals, maximized benefits-minimized risks, user-centred strategies, increased ICT capabilities, supported community-based intermediaries, and encouraged local capacity through education and training.

Pott (2003) examined the role of ICTs in the flow of information in Uganda. Interviews were used to collect data from Luwero District, Uganda. Findings revealed that the information was closely associated with the people's livelihoods. Mobile phones and CD-ROM were used to provide up-to-date information on market and agricultural production to farmers. The study concluded that for ICT to play a positive role, access to relevant, adaptable and augmentable information was required.

A study was conducted by Souter *et al.,* (2005) to assess the impact of the telephone on the lives of the rural poor in three developing countries, which were the state of Gujarat in India, Mozambique and Tanzania. Questionnaires were used to solicit data from 250 people in thirty villages of each country. The findings from all three countries revealed that face-to-face communication was the main source of information on issues such as farming, business and education in all three countries. Other findings revealed that telephone and broadcasting were less used for knowledge acquisition. Internet services had low use (less than two percent) in all

three countries. This study suggested the following: use of information intermediaries in applying ICTs to development, mitigation issues to prevent inequality in gender and socio-economic categories, focus on the established and trusted communications patterns within communities and build upon them, and enforce universal access strategies and funds.

Similar to Campbell and Garforth's (2001), Kalusopa's (2003), and Souter's *et al.,* (2005) studies, the present research investigated issues concerning the role of ICTs in disseminating exogenous knowledge in the local communities. In contrast to these studies which used a survey method, the present study used mixed method approaches to collect data. Chilimo's (2008) and Meera, Jhamtani and Rao's (2004:6) studies were also relevant to the current study by providing a wider picture of the farmers' information needs, frequency of use and gender equity when accessing knowledge through ICTs. However, these studies were only limited to the analysis of services provided by telecentres, while this study also investigated the role of various types of ICTs in managing knowledge in the local communities. Pigato's (2001) study was also significant for the present study. Issues pertinent to the present study included the information needs, information sources, and the role of ICTs in delivering information and knowledge to the rural poor. In contrast to Pigato's (2001) study which used a survey method, the present study used mixed method approaches. Further, this study only surveyed the rural communities, where as Pigato (2001) surveyed both urban and rural communities. Further, some of the issues that were investigated in Pott's (2003) study were also examined in the present thesis, which include: information needs, barriers, and the role of ICTs in knowledge management practices in the rural areas. Pott's (2003) study also used a qualitative method which was also used to inform the methodology of the current study.

3.12 The implications of the reviewed literature and a critique of the reviewed studies

The reviewed literature showed that despite the importance of the agricultural sector for socio-economic development, there has been low agricultural productivity in most developing countries including Tanzania. Studies indicated that IK is an important resource for improving agricultural production and ensuring food security. Although IK is site specific, research has shown that IK can effectively be applied outside the spatial locales in which it was developed (Briggs 2005; Briggs and Sharpe 2004; Warren 1991:2). It was thus imperative to establish the

extent to which farmers possess IK, and to assess its value in farming activities, since it can be adapted to stimulate innovation and improve productivity outside the spatial locales in which it was generated.

Although, IK is significant for sustainable agricultural practices, studies have shown that exogenous knowledge can also bring fresh ideas, and opportunities that are needed for sustainable agricultural development. However, the literature showed that farmers do not only lack opportunities to share their own IK, but they are also deprived from accessing exogenous knowledge. Studies highlighted various constraints that limit farmers from managing their agricultural IK and accessing relevant exogenous knowledge. It was thus important to assess the extent to which IK is managed and how exogenous knowledge is integrated in the local communities' knowledge system for improved farming activities.

Various scholars were on the opinion that KM approaches can be used to manage knowledge in the local communities as they have been successfully applied to improve business performances of many organisations in the developed countries (Hamel 2005; Kalseth and Cummings 2001; Mosia and Ngulube 2005; Noeth 2006; Rao 2006; World Bank 1998b). Difficulties in managing and externalizing tacit knowledge were identified, and ways of deploying KM approaches for managing IK were suggested by various KM scholars. This issue was pertinent to the study since most IK is tacit in nature, and thus it was important to assess the extent to which KM approaches can be used to manage IK in the local communities. Within this context, the KM enablers as suggested by various KM scholars (see Section 3.7) were similar to the KM principles as distilled from the theoretical framework (See Section 3.3.2.1), which included culture, leadership, ICTs, organizational structure, and community of practices. It was thus important for this study to assess the applicability of these KM enablers (such as, culture, leadership, ICTs, and community of practices) in managing IK and introducing relevant exogenous knowledge in the local communities for effective farming activities.

The empirical findings regarding the application of KM approaches in the local communities showed that there were a lot of theoretical studies. However, there were few studies that had

assessed the application of KM approaches in managing IK in the developing countries (Ha, Okigbo and Igboaka 2008; Mosia and Ngulube 2005; Noeth 2004; 2006). Other studies did not assess the application of KM approaches, but they investigated the management of IK in the local communities, and thus they were found relevant to the current study (Mudege 2005; Wall 2006). Most of these studies have focused on the social construction of knowledge, and its embedded nature in socio-cultural and power relationships (Mudege 2005; Siebers 2003; Wall 2006). Few studies (Boateng 2006; Ha, Okigbo and Igboaka 2008; Mosia and Ngulube 2005; Noeth 2004; 2006) have attempted to analyze the role of KM approaches in managing farmers' knowledge with little attempt to examine the integration of indigenous and exogenous knowledge, and role of ICTs in managing IK and providing access to exogenous knowledge in the local communities. It was also evident that the issues of ownership and knowledge policies were inadequately addressed in the reviewed studies. In this regard, it was important to assess the applicability of KM approaches and ICTs in managing IK, and introducing relevant exogenous knowledge in the local communities for improved agricultural activities in Tanzania.

In the context of knowledge identification, the information needs and information seeking behaviour were the relevant theory for this process. Studies on information needs showed that farmer's information needs were location specific. Research also showed that local people mainly seek knowledge and information from informal sources as compared to formal sources in the rural areas of developing countries. Various barriers that may interfere the information seeking process were also highlighted in the literature. It was thus important to conduct a study on information needs and information seeking behaviour of the rural farmers for improved agricultural information and knowledge provision strategies in the rural areas.

The empirical findings regarding the accessibility of exogenous knowledge in the local communities showed that there were distinct variations in knowledge sources and media preferences, both between various locations and between gender and socio-economic categories within them (Conroy's *et al.,* 2004; Rees's *et al.,* 2000; Bagnall-Oakeley's *et al.,* 2004; Garforth 2001). It was also evident from the literature that there were various obstacles that inhibited farmers from accessing exogenous knowledge in their communities. It was also clear that most

studies have assessed the extent to which farmers access exogenous knowledge (Adomi, Ogbomo and Inoni 2003; Bagnall-Oakeley *et al.,* 2004; Garforth 2001; Kalusopa 2005; Leach 2001; Matovelo, Msuya and de Smet 2006; Rees *et al.,* 2000; Stefano *et al.,* 2005), while there was very little substantial or detailed research that has analyzed the use of exogenous knowledge that was received from various sources in the local communities. It was thus imperative to assess the extent to which farmers access and use exogenous knowledge in the local communities. It was also important to assess the barriers that farmers face when accessing exogenous knowledge for improved farming activities in Tanzania.

The literature showed that although KM approaches can be used to manage IK, issues related to ownership still need to be assessed. Intellectual Property Rights (IPR) were indicated as a significant legal instrument by which IK can be protected from misappropriation in developing countries. However, most of the intellectual property rights, and international conventions and treaties are not effective in protecting agricultural IK in the developing countries. It was thus pertinent to assess the current state of policies and legal frameworks that were relevant for protecting agricultural IK in Tanzania, and how they can be strengthened for effective protection of IK in the country.

In the context of knowledge integration, various studies showed that farmers possess extensive base of IK which can effectively be linked to the exogenous knowledge system. However, most of the extension services in developing countries are still used to the transfer of technology (TOT) model which makes farmers less knowledgeable, which is a form of dis-empowerment to the communities. Nevertheless, literature showed that various approaches can be used to integrate agricultural indigenous and exogenous knowledge in the local communities, such as KM models (Boateng 2006), Merger model (Meyer and Boon 2003), Rajasekaran and Martin's (1992) model, participatory approaches (Rengalakshmi 2004; Protz 1998), and strategies proposed by Bagnall-Oakeley *et al.,* (2004), and Siebers (2003). There is thus a need to consider all these approaches when integrating IK into exogenous knowledge systems. It is also important to assess the extent to which KM approaches can be applied to integrate agricultural indigenous and exogenous knowledge systems in the local communities.

The empirical findings regarding the role of ICTs in managing IK were very little. Most of the reviewed studies had examined the extent to which the local communities use a range of ICTs to access exogenous knowledge for improved farming productivity in their communities. Most studies showed that radio was the major ICT used by farmers to access knowledge (Bagnall-Oakeley *et al.,* 2004; Campbell and Garforth 2001; Conroy *et al.,* 2004; Kalusopa 2005; Pigato 2001), while advanced ICTs (such as email and internet) had yet to register high use among farmers in developing countries (Campbell and Garforth 2001; Chilimo 2008; Pigato 2001; Souter *et al.,* 2005). Face-to-face communication seemed to be a major source of knowledge in the communities of developing countries (Campbell and Garforth 2001; Chilimo 2008; Kalusopa 2005; Pigato 2001; Souter *et al.,* 2005). Having highlighted that there was little empirical research on the role of ICTs in managing IK, and given the situation that there is low use of advanced ICTs for knowledge acquisition, it was imperative to assess the role of ICTs in managing IK, and providing access to relevant exogenous knowledge in the rural communities of Tanzania.

3.13 Summary

Chapter Three provided the theoretical framework of the current study and the review of literature. The literature review discussed the following issues: an overview of IK and the agriculture sector, the role of indigenous and exogenous knowledge for sustainable agriculture practices, the overview of KM practices, current state of managing and protecting agricultural IK, access to exogenous knowledge, the integration of indigenous and exogenous knowledge systems, and the role of ICT in managing agricultural IK and accessing exogenous knowledge in the developing countries, and Africa in particular.

Previous studies in relation to IK, exogenous knowledge, ICTs and knowledge management in developing countries including Tanzania were discussed and it was realized that very little substantial or detailed research has analyzed the application of KM approaches and ICTs in managing IK and introducing exogenous knowledge in the local communities. This study thus bridged the knowledge gap in the area by assessing the application of KM approaches (which have successfully been used to manage organizational knowledge) and ICTs in managing IK, and

introducing exogenous knowledge in the local communities. On the whole, the literature review narrowed the research problem, highlighted possible research methodologies, provided a broad picture on how data can be interpreted and established the extent to which the research findings related to previous studies of a similar nature.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

This chapter describes the research methodology that was used for this study. Specifically, the section outlines the research design, study population, sampling procedure, data collection procedure and instruments, data analysis, validity, reliability, research ethics and the evaluation of the research methods.

4.2 Research methodologies

Research method and methodology are distinctly different from one another. Research methods refer to a range of techniques used in research to gather data that are to be used as a basis for inferences and interpretation, for explanation and prediction (Cohen, Manion and Morrison 2007:47). Specifically, research methods involve techniques concerned with different purposes: methods for data collection; statistical techniques for establishing relationships between data and unknown; and methods for evaluating the accuracy of the results obtained (Blaxter, Hughes and Tight 2006:58; Kothari 2004:8). On the other hand, research methodology does not only consider research methods, but also encompasses the logic behind the methods to be used in the research study, and the purpose of using a particular method so that the research findings are capable of being evaluated either by the researcher or by others (Kothari 2004:8). It focuses on the research process and the kind of tools and procedures to be used (Babbie and Mouton 2001:75).

4.3 Research design

A research design describes a flexible set of guidelines that connect theoretical paradigms first to strategies of inquiry and second to methods for collecting empirical materials (Denzin and Lincoln 2003:36). It provides the plan of action that links the philosophical assumptions, strategies of inquiry, and specific methods (Creswell 2003; 2009). Thus, it represents a structure that guides the execution of a research method and the analysis of the subsequent data with the view to reaching conclusions about the research problem (Bryman 2004:27; Ndunguru 2007:66; Welman, Kruger and Mitchel 2005:52).

Most studies tend to use quantitative or qualitative approaches to explore the unexplained phenomena as well as those which were previously explained but misunderstood (Welman, Kruger and Mitchel 2005:6; Creswell 2003:4). However, it is argued that to use only a quantitative or a qualitative approach falls short of major approaches being used in the social and human sciences. It is suggested that mixed methods approach should also be considered when planning the research design (Creswell 2003:4). This study used mixed methods research design, with both quantitative and qualitative data collection methods.

4.3.1 A distinction between qualitative and quantitative approaches

A qualitative approach is the systematic analysis of socially meaningful action through the direct detailed observation of people in natural settings in order to arrive at understandings and interpretations of how people create and maintain their social worlds (Denzin and Lincoln 2003; 2005:3; Neuman 2006:88; Payne and Payne 2004:175). It is used to answer questions about the complex nature of phenomena, often with the purpose of describing and understanding the phenomena from the participants' point of view (Leedy and Ormrod 2005:94; Silverman 2006:43). A qualitative approach is also referred to as the interpretative, constructivist, postpositivist approach, or anti-postpositivist approach (Leedy and Ormrod 2005:94; Teddlie and Tashakkori 2009; Welman, Kruger and Mitchel 2005:6).

In contrast, the quantitative approach underlies the natural-scientific method in human behavioural research and holds that research must be limited to what can be observed and measured objectively (Welman, Kruger and Mitchel 2005:6). This method requires the use of standardized measures so that the varying perspectives and experiences of people can be fit into a limited number of predetermined response categories to which numbers are assigned (Denzin and Lincoln 2005:13; Leedy and Ormrod 2005:94; Patton 2002:14; Payne and Payne 2004:180; Silverman 2006:39). A quantitative approach is also referred to as the traditional, experimental or positivist, post-positivist approach (Creswell 2003:18; Leedy and Ormrod 2005:94).

A qualitative research is more holistic and emergent, with flexible guidelines that may change along the way. Categories (variable) emerge from data, leading to context bound information, patterns and theories that help to explain the phenomenon under study (Leedy and Ormrod

2005:95). On the other hand, the quantitative research represents a mainstream approach to research with structured guidelines that exist for conducting such studies. Concepts, variables, hypotheses and methods of measurement tend to be defined before the study begins and remain throughout the study (Leedy and Ormrod 2005:95). In qualitative study, because the intent is to learn from participants, the questions are open-ended questions, allowing participants to provide information from their perspectives. In quantitative approach, the intent and the literature point towards focused closed-ended that relate variables to each other (Creswell and Plano-Clark 2007:30).

A qualitative approach is useful in the description of groups, small communities, and organisations (Welman, Kruger and Mitchell 2005:188). This approach centres its research on experiencing the human behaviour, while the quantitative focuses on a study of observable human behaviour (Welman, Kruger and Mitchel 2005:7). Qualitative studies may lend themselves more aptly to studying cases that do not fit into particular theories, while quantitative methods may be more useful in hypothesis-testing research (Welman, Kruger and Mitchell 2005:188). Qualitative research is often exploratory in nature, and it may use its observations to build theory from the ground up (Leedy and Ormrod 2005:95). Theory can either be causal or noncausal and is often inductive (Neuman 2006:57). On the other hand, quantitative approach seeks to establish, confirm, or validate relationships and to develop generalizations that contribute to theory (Leedy and Ormrod 2005:95). Theory is largely causal and is often deductive (Neuman 2006:57).

The research procedures in qualitative studies are particular and replication is very rare, while, the procedures in quantitative studies are standard and replication is frequent (Neuman 2006:157). In data analysis, the qualitative approach proceeds by extracting themes or generalization from evidence and organising data to present a coherent and consistent picture. On the other hand, the analysis in quantitative study proceeds by using statistics, tables or charts and discussing how they relate to hypotheses (Neuman 2006:157). A quantitative study usually ends with the confirmation or disconfirmation of the hypotheses that was tested (Leedy and Ormrod 2005:94 - 95). On the other hand, qualitative study is more likely to end with tentative answers

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or hypotheses about what was observed. These tentative hypotheses may form the basis of the future studies (perhaps quantitative in nature) designed to test the proposed hypotheses (Leedy and Ormrod 2005:94 - 95).

On the whole, both qualitative and quantitative approaches try to understand the subject's point of view (Welman, Kruger and Mitchel 2005:9). However, both approaches differ in their strengths and weaknesses. They specify a different form and sequence of decisions, and different answers to when and how to focus the research (Neuman 2006:176). These differences can make techniques used by the other approach inappropriate or irrelevant. Researchers who judge the qualitative approach on the basis of assumptions and standards of the quantitative approach are often disappointed, and vice versa (Neuman 2006:151). It is better to understand and recognise the strengths and limitations that each approach offers on its own terms (Neuman 2006:151). Patton (2002:14) maintained that although they involve differing strengths and weaknesses, qualitative and quantitative methods constitute alternatives which are not mutually exclusive, strategies for research. Both qualitative and quantitative data can be collected in the same study. In fact, the combination of qualitative and quantitative approaches provides the most complete or insightful understanding (Powell and Connaway 2007).

In practice, researchers combine qualitative and quantitative methodologies, however some authorities have raised their concerns that whether this kind of action should be encouraged or not (Niglas 2000). This situation leads to what various authors referred to as multi-strategy research (Bryman 2004), or multimethod (Polit and Beck 2003:273), or mixed methods (Bergman 2008; Creswell 1994; 2003; Creswell and Plano-Clark 2007; De Vos, Strydom and Fouche 2005; Johnson and Onwuegbuzie 2004; Morgan 1998; Tashakkori and Teddlie 1998; 2006). Gaining an understanding of the strengths and weaknesses of quantitative and qualitative research puts a researcher in a position to mix or combine strategies (Johnson and Onwuegbuzie 2004). However, Bergman (2008:19) cautioned that mixed methods cannot claim to bridge the unbridgeable gap between positivism and constructivism. Instead, it is able to provide an alternative to mono-method designs for specific research questions, under certain circumstances, and given resources.

4.3.2 Mixed methods research

Mixed methods research involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in the research processes. It also involves the methods of inquiry which focus on collecting, analyzing and mixing both quantitative and qualitative data in a single study or a series of studies (Creswell and Plano-Clark 2007:5). De Vos, Strydom and Fouche (2005:357) and Tashakkori and Teddlie (2003) described mixed research as a type of research approach in which qualitative and quantitative approaches are used in types of questions, data collection and analysis procedures, and/or inferences. Johnson and Onwuegbuzie (2004) defined mixed methods research as the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study. Mixed research involves the mixing of quantitative and qualitative research methods, approaches, or other paradigm characteristics (Johnson and Christensen 2008:34). Mixed methods approach tends to base knowledge claims on pragmatic grounds (that is, consequence-oriented, problem centred and pluralistic) (Creswell 2003; 2009; Johnson and Onwuegbuzie 2004; Onwuegbuzie and Johnson 2006:54; Teddlie and Tashakkori 2009:4).

The primary focus of this approach is the use of multiple approaches in answering research questions, rather than restricting or constraining researchers' choices (Johnson and Onwuegbuzie 2004). Mixed research can simultaneously address both exploratory and confirmatory questions, thereby gathering information that can result in conclusions or explanation or meta-inferences about the phenomenon under the study that neither the quantitative nor qualitative could do alone (Tashakkori and Teddlie 2008:101; Teddlie and Tashakkori 2009:33). It thus provides a better understanding of research problems than either one approach alone (Brannen 2006; Creswell and Plano-Clark 2007; Johnson and Onwuegbuzie 2004). It also provides strength that offset the weaknesses of both quantitative and qualitative research (Bryman 2006a; Creswell and Plano-Clark 2007:9; Johnson and Christensen 2008:51). It can also provide better opportunities for testing alternative interpretations of the data, for examining the extent to which the context helped to shape the results, and for arriving at convergence in tapping a construct (Polit and Beck 2003:275). Thus, if the two approaches are combined, the potential and perhaps the likelihood of

unanticipated outcomes are multiplied leading, to a better understanding of research problems than either approach alone (Bryman 2006a:109; Creswell and Garrett 2008).

Despite their strengths, mixed methods have their weaknesses, which include the need for extensive data collection, and the requirement for the researchers to be familiar with both quantitative and qualitative forms of research (Creswell 2009:205; Johnson and Onwuegbuzie 2004). Other challenges as described by Johnson and Onwuegbuzie (2004) include: methodological purists belief that one should always work within either a qualitative or a quantitative paradigm; mixed methods are very expensive; and some of the details of mixed research remain to be worked out fully by research methodologists (for example, problems of paradigm mixing, how to qualitatively analyze quantitative data, how to interpret conflicting results). Other obstacles include epistemologic biases, inadequate researcher training, and publication biases (Polit and Beck 2003).

According to Greene, Caracelli and Graham (1989), there are five major purposes or rationales for conducting mixed methods research:

- Triangulation: seeks convergence and corroboration of results from different methods and designs studying the same phenomenon;
- Complementarity: seeks elaboration, enhancement, illustration, and clarification of the results from one method, with results from the other method;
- Initiation: involves discovering paradoxes and contradictions that lead to a re-framing of the research question;
- Development: using the findings from one method to help inform the other method; and
- Expansion: seeks to expand the breadth and range of research by using different methods for various inquiry components.

In addition to Greene, Caracelli and Graham (1989) rationale behind the use of mixed methods, Tashakkori and Teddlie (2008) added other reasons for utilising mixed research, which include the following: to compensate for weaknesses of one approach by utilising the other, and for diversity purposes, that is to obtain a divergent picture of the same phenomenon. Bryman

(2006a) also suggested a large number of reasons for conducting mixed research, which include the following: triangulation or greater validity, offset, completeness, process, to answer different research questions, one method is used to explain findings generated by the other, unexpected results, sampling, credibility, context, utility, confirm and discover, diversity of views, and enhancement. In general, the mixed methods often combine nomothetic and idiographic approaches in an attempt to serve the dual purposes of generalisation and in-depth understanding in order to gain an overview of social regularities (Bazeley 2004).

Various authors have made attempts to create taxonomies for combining qualitative and quantitative approaches in a single or multi-phased study. Most mixed methods have been classified by the level of prioritization of one form of data over the other, by the combination of data forms in the research process, and by the timing of data collection, such as whether the quantitative and qualitative phases take place concurrently (simultaneous/parallel) or sequentially (Blaxter, Hughes and Tight 2006; Creswell 1994; 2003:2009; Creswell and Plano-Clark 2007; Greene, Caracelli and Graham 1989; Johnson and Christensen 2008:51; Johnson and Onwuegbuzie 2004; Morse 1991; Niglas 2004; Polit and Beck 2003; Tashakkori and Teddlie 1998; 2003; 2008; Teddlie and Tashakkori 2009). In general, there is no exhaustive typology that has managed to capture all potential combinations (Bryman 2006a:99; Teddlie and Tashakkori 2009). The necessary issue is having a considered but open stance in deriving a design that captures the research question (Bryman 2006a:99; Fielding and Fielding 2008:558; Johnson and Onwuegbuzie 2004). Teddlie and Tashakkori (2009:163) proposed that it is important to look for the most appropriate or single best available research design, rather than the "perfect fit". One may have to combine existing designs, or create new designs for the study. In addition, the most appropriate mix for any particular study can also depend on the resources available, and the judgement on how one can get the most reliable and relevant data and reach the deepest and most convincing conclusions (Hulme 2007). Johnson and Christensen (2008:34) also added that the appropriate mix can depend on the research questions and situational and practical issues facing a researcher.

This study used mixed methods approach where the dominant-less-dominant model was used as proposed by various authors (Creswell 1994; Tashakkori and Teddlie 1998; Teddlie and Tashakkori 2009). In a dominant less-dominant model, the researcher conducts the study within a single dominant approach, with a small component of the overall study playing a secondary role (Creswell 1994; Teddlie and Tashakkori 2009). The dominant less-dominant model is similar to "embedded design" as referred by Creswell and Plano-Clark (2007) and Caracelli and Greene (1997), or "priority design" as expressed by various authors (Creswell 2003:212; Morgan 1998), or "concurrent embedded" (Creswell 2009). In this study, the qualitative paradigm was the dominant method.

4.3.2.1 Justification for a mixed methods approach

A mixed methods approach was deployed in this study for complementarity purposes, where quantitative data was used to locate results in a broader context in a qualitative study, as suggested by Silverman (2006:28). Quantitative data was also embedded in the qualitative design to enrich the description of the sample participants (Morse 1991), and to systematically measure certain factors considered important in the relevant research literature (Johnson and Onwuegbuzie 2004). This method was also used for purposes of comprehensiveness, where both qualitative and quantitative data were used to provide the complete analysis of the research problem in order to answer the research questions (Bryman 2006a:103; Kiptot 2007). A mixed methods approach was also deployed in this study for triangulation purposes as a means to seek convergence across qualitative and quantitative approaches (Greene, Caracelli and Graham 1989; Tashakkori and Teddlie 1998; 2006) (See Section 4.8.2 in Chapter Four). Mixed methods were also used because it is recommended by IK studies as an effective method to collect different types of data which can be used to confirm the validity and consistency of IK of a certain locality (Kiptot 2007).

This study also used mixed methods in order to offset the weaknesses of both qualitative and quantitative and to draw on the strengths of both (Bryman 2006a:103; Johnson and Christensen 2008:51; Morgan 1998; Onwuegbuzie and Johnson 2006; Polit and Beck 2003:273). A qualitative approach was used in this study in order to observe behaviour as it naturally occurred, and therefore increased realism. Thus, this study gained the following strengths by deploying the

qualitative approach: to obtain data that was based on the participants' own categories of meaning in order to examine behaviour as it occurs naturally and holistically; to describe complex phenomena, such as knowledge management, and ICTs; to provide understanding and description of people's personal experiences of phenomena under the study; and to describe, in rich detail, phenomena as they were situated and embedded in local contexts such as the role of IK in farming systems, and the way IK is managed in the local communities (Johnson and Onwuegbuzie 2004:20). On the other hand, a quantitative research was employed in the study in order to gain the following strengths: to obtain data that allowed the quantitative predictions to be made; to analyze data in a relatively less time; to study large numbers of people; to obtain data that may have higher credibility with many people in power, such as politicians; and to obtain research results that were relatively independent of the researcher (Johnson and Onwuegbuzie 2004:19). By deploying both qualitative and quantitative approaches, the objective truth existing in the world was measured and explained scientifically, and realism of the study findings was no longer a problem.

Despite the fact that the superiority of qualitative over quantitative research is less common (Flick 2006:35; Polit and Beck 2003:286), this approach was used in this study because qualitative method tends to apply a more holistic and natural approach to the resolution of a problem than does quantitative approach. It also tends to give more attention to the subjective aspects of human experience and behaviour (Powell and Connaway 2007). This approach is also recommended by various authors as an effective method for collecting data in IK studies than quantitative approach (Grenier 1998; IIRR 1996; Langill 1999; Sillitoe, Dixon and Barr 2005).

Various studies have also used mixed methods where qualitative method was the dominant approach to examine agricultural IK in the local communities of the developing countries (Den Biggelaar and Gold 1995; Munyua and Stilwell 2009; Rengalakshmi 2004; Sabetian 2002), and the developed world (Ingram 2008). For example, Den Biggelaar and Gold (1995) combined participatory (wealth ranking game) and formal surveys to understand endogenous agroforestry knowledge and the processes behind the generation of such knowledge in Rwanda. Munyua and Stilwell (2009) used a combination of qualitative (interviews, observation, participatory

approaches and focus group discussions) and quantitative techniques (that is, survey) to study the agricultural local and external knowledge and information system of small-scale farmers in Kenya. Rengalakshmi (2004) used multiple tools such as conventional survey method, anthropological tools such as non-participant observation, and participatory developmental tools such as focus group discussions to study the traditional knowledge on weather and climate prediction in India. Sabetian (2002) used ethnographic methods and semi-structured interviews to analyze the structure of a traditional Solomon Island village fishing system in order to demonstrate the value of ethnographic knowledge in fishery research design and management. In England, Ingram (2008) examined farmers' knowledge of soils through the analysis of data collected from semi-structured interviews with farmers and agricultural advisors and supplemented with data from an extensive postal questionnaire survey of advisors.

The dominant-less-dominant model (or embedded design) can be carried out sequentially or concurrently (Creswell 2009; Creswell and Plano-Clark 2007). In this study, the concurrent research design was used to combine or integrate both qualitative and quantitative data in a single phase of data collection. Quantitative data was then embedded within the dominant qualitative approach (Creswell 2003:218; Creswell and Plano-Clark 2007:118). Primarily, the qualitative data was collected through the following: semi-structured interview items, focus groups, non-participant observation, and participatory rural appraisal tools (information mapping and linkage diagrams, and problem trees). The secondary purpose was to gather quantitative data through closed questions which were embedded in the same semi-structured interviews. Various authors have also reported that data collection in mixed methods can include closed-ended items with numerical responses as well as open-ended items on the same survey (Brannen 2006; Driscoll *et al.,* 2007; Tashakkori and Teddlie 2006). Various IK studies in developing countries have also combined qualitative and quantitative responses in the same survey (Rengalakshmi 2004; Sabetian 2002). In this study, the same individuals provided both qualitative and quantitative data so that the data can be more easily compared as suggested by Driscoll *et al.,* (2007).

Both qualitative and quantitative data analyses were kept separate, and then they were combined or integrated into meta-inferences (Creswell and Plano-Clark 2007:118; Teddlie and Tashakkori

2009). Some of the qualitative themes were also transformed into counts, and these counts were compared with descriptive quantitative data (Creswell 2009:214). Thus, both data sets were used for descriptive and explanatory purposes. Both quantitative and qualitative questions addressed different, but associated questions so that the two types of data complemented one another.

4.4 Study population

A study population encompasses the total collection of all units of analysis about which the researcher wishes to make specific conclusions (Welman, Kruger and Mitchel 2005:52). To define a population, a researcher specifies the unit being sampled, the geographical location, and the temporal boundaries of the population (Neuman 2006:224). In this research, the study population included the following three categories of respondents, which were the local communities, knowledge intermediaries, and IK policy makers. Firstly, the local communities participated in the study because their livelihoods mainly depend on agriculture. Thus, they have an extensive base of agricultural IK that has accumulated over generations through local innovations and experimentations. By involving the local communities, the study gained a great understanding on the application of KM approaches and ICTs in managing IK and introducing exogenous knowledge in the rural areas of Tanzania. Thus, the local communities' category included the following: small-scale farmers and village leaders.

Secondly, knowledge intermediaries were selected to participate in the study because they are involved in the dissemination of exogenous knowledge and management of IK in the rural areas of Tanzania. By involving the knowledge intermediaries, the study gained a great understanding on the way farmers access exogenous knowledge, the integration of indigenous and exogenous knowledge, the management of IK, and the role of ICTs in knowledge management in the local communities of Tanzania. This category included the following: crop and livestock extension officers, agricultural researchers, Non-governmental organisation (NGO) officers, librarians, telecentre staff, and agricultural input suppliers. Lastly, IK policy makers were selected to participate in the study because they are involved in the development of key policies that deal with the protection of IK in Tanzania. Thus, they were considered as appropriate population for the study from which the conclusions regarding the policies and legal framework that are

relevant in protecting IK in Tanzania were made. This category included the following: officers from the Business Registration and Licensing Agency (BRELA), Copyrights Society of Tanzania (COSOTA), Tanzania Intellectual Property Advisory Service and Information Centre (TIPSAC), and the National Plant Breeder Registrar at the Ministry of Agriculture and Food Security in Tanzania. The following section describes the methods and procedures that were applied in the selection of the sample for the study.

4.5 Sampling procedures

A sample is a segment of the population that is selected for investigation (Bryman 2004:87). A sampling procedure is the process of selecting a sub-set, of people or social phenomena to be studied, from the larger universe to which they belong, in one of several ways so as to be either non-representative or representative (Kothari 2004:55; Payne and Payne 2004:204). Both qualitative and quantitative approaches address sampling differently. In qualitative study, the primary goal of sampling is to collect specific cases, events or actions that can clarify and deepen understanding. The main focus is to find cases that will enhance what researchers learn about the processes of social life in a specific context (Neuman 2006:219). The quantitative studies on the other hand aim at getting a representative sample, or a small collection of units from a much larger collection or population, such that the researcher can study the smaller group and produce an accurate generalization about the larger group (Neuman 2006:219). Thus, the process of sampling is important for both quantitative and qualitative research.

Most quantitative-oriented studies primarily use probability (random) sampling, while qualitative studies tend to use non-probability (non-random) technique (Cohen, Manion and Morrison 2000; 2007; Creswell and Plano-Clark 2007; Onwuegbuzie and Leech 2005; Teddlie and Tashakkori 2009:170; Welman, Kruger and Mitchell 2005:56). Probability samples aim to achieve representativeness, which is the degree to which the sample accurately represents the entire population (Teddlie and Tashakkori 2009:170). Non-probability technique is used to provide insights about a phenomenon, not empirical generalizations from a sample to a population (Brannen 2006:209; Patton 2002:40). In probability technique, the chances of members of the wider population being selected for the sample are known. A non-probability technique on the

other hand, the chances of members of the wider population being selected for the sample are unknown (Cohen, Manion and Morrison 2007).

In mixed methods, sampling involves combining well-established qualitative and quantitative techniques in creative ways to answer research questions posed by mixed methods research designs (Teddlie and Yu 2007). It involves the selection of units or cases of a research study using both probability (primarily quantitative) and purposive (primarily qualitative) procedures (Teddlie and Tashakkori 2009:171). Various authors have presented several sampling techniques for mixed methods (Johnson and Christensen 2008:247; Onwuegbuzie and Collins 2007; Teddlie and Yu 2007; Teddlie and Tashakkori 2009). Onwuegbuzie and Collins (2007) proposed that the decision regarding the sampling scheme in mixed methods depends on two criteria, which are time orientation (that is, concurrent or sequential), and weight or priority given to qualitative or quantitative samples in a particular study. Teddlie and Tashakkori (2009:181) further noted that mixed methods sampling depends on the purpose of the sampling, generalizability issue, follow assumptions of probability and purposive sampling, rationale for selecting cases, multiple samples varying in size, depth and breadth of information per case, time of sample collection, selection method, informal and formal sampling frame, and form of data generated (that is, numeric and narrative data).

Since this study used concurrent mixed methods approach and it was mainly of a qualitative nature, mixed methods techniques and non-probability techniques were used to select samples in order to collect both quantitative and qualitative data within the same time frame. The stratified purposive sampling (mixed methods sampling technique) and typical case purposive sampling technique (non-probability technique) were used to select farmers in the local communities. The snowball or chain sampling and intensity sampling techniques were also used to select the study participants for the other categories, which were knowledge intermediaries and IK policy makers.

4.5.1. Sampling procedure for the districts involved in the study

Purposive sampling is a method that is confined to specific types of people who can provide the desired information, either because they are the ones who have it, or they conform to some

criteria set by the researcher (Sekaran 2003:277). Many qualitative studies have a preference for purposive sampling because it involves selection of individuals or objects that yield the most information about the topic under investigation (Cohen, Manion and Morrison 2007:115; Creswell and Plano-Clark 2007; Kothari 2004:67; Leedy and Ormrod 2005:145; Neuman 2006:222; Patton 2002:230; Powell and Connaway 2007). This study used the stratified purposive sampling (mixed methods sampling technique) and typical case purposive sampling technique (non-probability technique) to select farmers in the local communities to participate in the study.

The stratified purposive sampling technique involves dividing the purposefully selected target population into strata with a goal of discovering elements that are similar or different across the subgroups (Tashakkori and Teddlie 2003). Patton (2002:240) described this strategy as samples within samples. The stratified nature of this sampling technique is similar to probability sampling, and the small number of cases it generates is a characteristic of purposive sampling (Teddlie and Tashakkori 2009:186). Thus, the subgroups of the population of study are identified, and then the cases from each subgroup are purposively selected (Teddlie and Tashakkori 2009:186). The purpose of a stratified purposeful sample is to capture major variations rather than to identify a common, although the latter may also emerge in the analysis (Patton 2002:240).

In this study, six districts were purposefully selected from six agricultural research zones, out of seven zones in Tanzania (see Section 2.8.1 of Chapter Two). Certain criteria were used to select six districts in the country, which included: high agricultural production and possession of telecentres. High agricultural productive areas were identified based on their diversity in agro-ecology, ethnicity, population density and infrastructure which influence local agricultural knowledge and information systems (Röling 1989). The same criteria were also used by various IK studies to select their study areas in Africa (Adedipe, Okuneye and Ayinde 2004; Lemma and Hoffmann 2005). On the other hand, the following criteria were used to select telecentres:
- Telecentres should operate in rural areas in order to get IK knowledgeable people who access and use ICTs;

- Telecentres should offer a variety of services including internet and email services, printing and photocopying. Community radio and computer training will be an added advantage; and
- Telecentres should be those ones that have been in operation for more than 12 months.

The same criteria for selecting telecentres were also used by other studies in analyzing the impact of telecentres in the African local communities (Etta and Parvyn-Wamahiu 2003; Maepa and Mphahlele 2004). In this study, these criteria were used in order to establish the role of ICTs in managing agricultural IK in the rural areas of Tanzania. The southern zone was not included in the study because its telecentre was still at the planning stage and thus it was not yet operational. Thus, the districts involved in the study included the following: Moshi Rural District (Northern Zone), Karagwe District (Lake Zone), Kasulu District (Western Zone), Kilosa District (Eastern Zone), Mpwapwa District (Central Zone), and Songea Rural District (Southern Highlands Zone) (See Section 2.9 of Chapter Two).

The stratified purposive sampling technique was thus used to identify two strata in each district based on the high agricultural production and the presence of ICTs such as telecentres, telecommunication signals, and infrastructure. Thus, two different villages were selected from each district to reflect the management of IK, access to IK and use of ICT to manage agricultural knowledge. The first stratum comprised one village in each district which was around or close to the telecentre, and other basic ICT facilities such as telecommunication signals and a good road. The second stratum included one remote village in each district (approximately 10 to 20 km from the telecentres). A typical case sampling technique was also used to select the respondents from identified strata as explained in the following section.

4.5.2 Sampling procedure for the local communities
Most of the purposive sampling techniques aim at finding instances that are representative or typical of a particular type of case on a dimension of interest, and to achieve comparability across different types of cases on a dimension of interest (Teddlie and Tashakkori 2009:175). There are various types of purposive sampling techniques (Patton 2002; Powell and Connaway 2007; Teddlie and Tashakkori 2009). This study adopted the typical case sampling technique, which involves selecting those cases that are the most typical, normal, or representative of the

group of cases under consideration (Teddlie and Tashakkori 2009:176). Despite the fact that representativeness is most often associated with probability sampling, the study used this technique so that the study findings can be transferred or generalized to other similar cases (Tashakkori and Teddlie 1998:66). A typical case sampling technique was thus used to select local communities from the stratified samples in the districts, as well as to sample other categories of respondents, which were knowledge intermediaries and IK policy makers as explained fully in section 4.5.3.

In mixed methods, different sample sizes are common because qualitative and quantitative data are usually collected for different purposes (Creswell, Plano-Clark and Garrett 2008:74). Typically, qualitative samples are smaller than quantitative samples because of the time demands of qualitative data collection and analysis processes (Creswell and Plano-Clark 2007; Creswell, Plano-Clark and Garrett 2008:74). Qualitative sampling designs specify minimum samples because the idea behind qualitative study is to purposefully select participants or sites that will best help the researcher to understand the phenomenon in depth (Creswell 2003; 2007; Creswell and Plano-Clark 2007; Neuman 2006:379; Patton 2002:46; Polit and Beck 2003; Powell and Connaway 2007). On the other hand, sample size in mixed research depends on the following factors: the priority of the research design (either the dominance of qualitative or quantitative); breadth and depth of the required information; external validity and transferability requirements; and what is practical. The simple rule is to achieve the "representative/saturation" requirement (Teddlie and Tashakkori 2009).

In concurrent design mixed research methods, data can be collected from the same individuals in both qualitative (smaller size, purposefully selected) and quantitative (larger size, random selected) samples, or data can be collected from the large qualitative sample for comparisons with the large quantitative sample (Creswell and Plano-Clark 2007; Creswell, Plano-Clark and Garrett 2008:74). It is also preferred to have the same individuals participate in both samples in order to make the data and results more comparable (Creswell and Plano-Clark 2007).

Since IK is unevenly distributed in the local communities (Grenier 1998; IIRR 1996:25), a typical case sampling technique was used to select respondents from the identified strata in the selected districts so as to tap the right sources for the study. When using typical case sampling technique, Patton (2002:236) pointed out that it is important to get broad consensus about which cases are typical, and what criteria are being used to define typicality. In this study, the strata in the surveyed district were characterised by people engaged in various agricultural activities, which included crop farming, livestock keeping, pastoralism and mixed farming. The identification of the study participants was based upon discussions with community leaders and local extension officers in each stratum in order to cover a broad spectrum of farming systems, ethnic-religious groups, gender and age groups. These characteristics were used because variations in knowledge can be observed by the diversity in agro-ecology, ethnicity, population density and infrastructure (Röling 1989). Hence, the sample of the study was a representative of these farming systems, ethnic-religious groups, gender and age groups in the identified strata.

This study concurrently collected and compared both quantitative and qualitative data through semi-structured interviews from the same sample. A total of 181 respondents were purposively interviewed from the identified strata in the surveyed villages, with a sample of 27 to 37 per district due to the availability of more information. (See section 4.8.5 of Chapter Four). Further, a separate sample of 128 respondents was also selected from the identified strata to participate in the focus group discussions. The study participants for the focus group ranged from six and twelve respondents per session depending on their availability (see section 4.8.5 of Chapter Four).

There are also similar illustrations of the use of the same individuals or sites to collect both quantitative and qualitative data in a concurrent design mixed methods. Wilson *et al.,* (1991) combined survey and ethnographic research methods (semi-structured interviews) to collect both qualitative and quantitative data from a sample of 74 truckers to design an intervention for long-distance truckers in Zimbabwe. Idler, Hudson and Leventhal (1999) also gathered information from a single sample (N=159) for both their quantitative (medical history survey) and qualitative data (ethnographic interviews) for their study of participants' self-ratings of health. Other studies

(Phinney and Devich-Navarro 1997; Way and Pahl 2001) also collected both in-depth qualitative interviews and survey measures from the large samples of participants.

4.5.2.1 Sampling of the respondents at Karagwe district

Administratively, the Karagwe district consists of four divisions, 28 Wards, and 117 registered villages (Karagwe District Council 2009; URT 2008e). The FADECO telecentre and community radio is located in the Bugene/Nyaishozi division. The study was based in one division, which is called Mabira division, due to the high agricultural production and further, the internet services at the FADECO telecentre had been closed in order to transform it into a radio station by the time of the survey. The respondents were selected from Iteera Village and Katwe Village in Mabira division. A total of 30 respondents participated in the semi-structured interviews, and 23 respondents attended the two focus group discussions.

4.5.2.2 Sampling of the respondents at Kasulu district

Kasulu district is divided into seven divisions, 30 wards and 83 villages (URT 1998e). The study was based in one division, which is called Heluchini Division, where the Kasulu telecentre was located. The respondents were selected from Nyansha Village and Kidyama Village in Heluchini Division. A total of 27 respondents participated in the semi-structured interviews, while 23 respondents attended the two focus group discussions in the selected villages.

4.5.2.3 Sampling of the respondents at Kilosa district

Kilosa district is divided into nine divisions, 36 wards and 132 villages (URT 2008d). The Kilosa Rural Services and Electronic Communication (KIRSEC) telecentre, Ilonga Youth Training Centre telecentre and the community radio (Kilosa Jamii Radio) were located in Kilosa Town Division. The study was based in two divisions (Kilosa Town and Kimamba Divisions) because some telecentre users were located in Kimamba Division. Kimamba division was also selected in order to include pastoralists (Maasai ethnic group). A total of 37 respondents were interviewed, which were selected from Twatwatwa Village (Kimamba Division) and Kasiki Village (Kilosa Town Division). A total of 24 respondents from both villages participated in the focus group discussions.

4.5.2.4 Sampling of the respondents at Moshi Rural district

Administratively, the district is divided into four divisions, 27 wards and 150 villages (URT 1998c). The study was based in one division, which was called Vunjo East Division. Two telecentres were located in this division, which included Marangu Village Internet Service and Guerba computer centre. The respondents were selected from Lyasongoro and Mshiri villages in Vunjo East Division. A total of 28 respondents participated in the interviews, while 13 study participants attended the focus group discussions in both villages.

4.5.2.5 Sampling of the respondents at Mpwapwa district

The district is divided into six divisions, 26 wards and 128 villages (URT 1998f). The study was based in one division, which was called Mpwapwa Town Division. Mpwapwa Teachers College telecentre was located in Mpwapwa Town division. Thirty respondents participated in the interviews, and they were selected from Vinghawe and Mazae villages in Mpwapwa Town Division. A total of 24 participants attended the focus group discussions in both villages.

4.5.2.6 Sampling of the respondents at Songea Rural district

The district has been administratively divided into seven divisions, 22 wards and 116 villages (URT 1997g). The study was based in one division, which was called Madaba Division. The Wino Development Association (WIDA) was located in Madaba Division. The respondents were selected from Matetereka and Lilondo villages in Madaba Division. A total of 29 respondents were interviewed, while 21 respondents attended the focus group discussions.

4.5.3 Sampling procedure of other categories of respondents

The snowball or chain sampling, and intensity sampling techniques were used to select other categories of the study participants, which included the knowledge intermediaries and IK policy makers. Snowball sampling refers to a technique of locating cases of interest from sampling people who know which cases are information-rich (Patton 2002). Intensity sampling on the other hand, refers to information rich cases that manifest the phenomenon of intensity, but not extremely (Patton 2002). These techniques were used to select twenty five knowledge intermediaries in the surveyed districts. On the other hand, a total of four officers were selected

from the institutions that dealt with intellectual property and IK policy issues in Tanzania, where one officer was selected from each office.

4.6 Data collection procedure and instruments

Mixed methods data collection refers to the gathering of a mixture of qualitative and quantitative data in a single study (Teddlie and Tashakkori 2009). This study used concurrent strategy to collect both quantitative and qualitative data simultaneously (Creswell and Plano-Clark 2007:118). Quantitative data was then embedded within the dominant qualitative approach. Both qualitative and quantitative data were also mixed during the analysis phase of the study (Creswell 2003:218; Creswell and Plano-Clark 2007:118).

Gaining access to the study area is a key factor to be considered in any research because it is not only difficult but also the release of information might be problematic (Cohen, Manion and Morrison 2007:109; Creswell and Plano-Clark 2007). Access may be denied due to a number of reasons, including access to sensitive and unauthorized areas, and also to some people who have something to protect or have busy schedules (Cohen, Manion and Morrison 2007:109). Permission to collect data might be gained through individuals in authority (gatekeepers) to provide access to study participants at a research site (Blaxter, Hughes and Tight 2006; Cohen, Manion and Morrison 2007:109; Creswell 2003:184; Leedy and Ormrod 2005:137; Neuman 2006:387). A gatekeeper is someone with an official or unofficial authority to control access to a research site (Neuman 2006:387). Entering and gaining access to the research site also involves writing a letter to inform the participants about the extent of time, the potential impact, and the outcome of the research (Creswell 2003:65).

The familiarity of the researcher with the community leaders and extension officers in some of the local communities was used to gain access to the research area in this study. Further, the introduction letters obtained from the University of KwaZulu-Natal in South Africa and the researcher's employer (Sokoine University of Agriculture (SUA) in Tanzania) were also used to get permission to conduct research in the selected regions of Tanzania (see Appendix 7 to 13). An informed consent form was also used to explain to the participants about the nature of the

study to be conducted and to ask for their voluntary agreement to participate in the study (Leedy and Ormrod 2005:101; Neuman 2006:135) (see Appendix 14).

In mixed research, two basic data collection approaches exist, which include within-strategy, and between-strategies mixed methods data collection (Teddlie and Tashakkori 2009). Within-strategy mixed-method data collection involves the gathering of a mixture of qualitative and quantitative data using the same data collection technique. Between-strategies mixed methods data collection involves the gathering of both qualitative and quantitative data using more than one data collection technique (Teddlie and Tashakkori 2009). Both within-strategy and between-strategies mixed methods data collection techniques were used in this study.

In this study, the within-strategy mixed methods was used to collect both qualitative and quantitative data from the semi-structured interviews where closed-ended and open-ended questions were posed. The between-strategies mixed methods techniques were used to collect both qualitative and quantitative data from semi-structured interviews, and to gather qualitative data from non-participant observation, focus groups discussions, and Participatory Rural Appraisal (PRA). Focus group discussions were combined with the visualization and diagramming PRA tools in order to increase the opportunity for farmers to represent their own local perceptions and diversity of knowledge (Scoones and Thompson 1994a:22). For PRA data collection tools, the study used information mapping and linkage diagrams, and problem trees.

These instruments for collecting data were constructed according to the guidelines from various literatures (Cohen, Manion and Morrison 2007; Grenier 1998; Leedy and Ormrod 2005; IIRR 1996; Kumar 2002; Sillitoe, Dixon and Barr 2005). Additionally, these data collection tools were translated into Swahili language since most Tanzanians are more comfortable in speaking Swahili than the English language. The data collection techniques are briefly described below.

4.6.1 Non-participant observation

Observation involves recording of units of interaction occurring in a defined social situation based on visual assessment of that situation (Teddlie and Tashakkori 2009:219). This technique enables the researcher to observe participants in natural or structured environments (Johnson and

Turner 2003:312). It is a purposeful, systematic and selective way of watching behavioural patterns of people in certain situations to obtain information about a phenomenon of interest (Johnson and Christensen 2008:211). It is the best method to study the behavior than the perceptions of individuals, or when the subjects are so involved in the interaction that they are unable to provide objective information about it (Kumar 2005:120).

There are two types of observation, which include participant observation and non-participant observation (Flick 2006:216; Kumar 2005:120). In participant observation, a researcher participates in the activities of the group being observed in the same manner as its members, with or without their knowing that they are being observed. On the other hand, a researcher in non-participant observation does not get involved in the activities of the group but remains a passive observer, watching and listening to its activities and drawing conclusions from this (Kumar 2005:120).

The extent to which the researcher is involved in observation can be arranged on a continuum. At one end is the complete participant, moving to the participant-as-observer, observer-as-participant, and finally to the complete observer. The move is from involved insider to detached outsider (Cohen, Manion and Morrison 2007:396; Gray 2004; Johnson and Christensen 2008:211; Johnson and Turner 2003; Neuman 2006:387; Powell and Connaway 2007). A complete participant is a researcher who takes an insider's role in the group being studied, but taking on an invisible role. A participant-as-observer is a researcher who takes a part of the social life of participants and documents what is happening for the research purposes. The observer-as-participant is a researcher who is known to the group and may have limited contact with the group. With the complete observer, the researcher observes without participating (Cohen, Manion and Morrison 2007:396; Creswell 2003:186; Neuman 2006:387). The level of involvement depends on negotiations with members, specifics of the field setting, researcher's personal comfort, and the particular role adopted in the field (Neuman 2006:387).

Another dimension of observational research can either be structured, semi-structured or unstructured (Cohen, Manion and Morrison 2000:305). Structured observation has a

predetermined set of categories of activities or phenomena planned to be studied (Sekaran 2003:252-253). Semi-structured has an agenda of issues but gathers data to illuminate these issues in a far less pre-determined or systematic manner (Cohen, Manion and Morrison 2007:397). Unstructured observational study does not have a definite idea of particular aspects that need focus, thus events are observed and recorded as they take place (Sekaran 2003:253). Structured observation is considered appropriate in descriptive studies, whereas in an exploratory study, the observational procedure is most likely to be relatively unstructured (Kothari 2004:96). In mixed research, the researcher can mix the characteristics of qualitative (unstructured observation) and quantitative (structured observation) in order to capitalize the strengths of both qualitative and quantitative observation (Johnson and Turner 2003:313).

The advantages of observation are that the observer may gain insights about the culture that could not be obtained in any other way (Leedy and Ormrod 2005:137; Johnson and Turner 2003:315; Strydom *et al.,* 1998:291). It is easy to obtain firsthand experience with participants (Creswell 2003:186; Johnson and Turner 2003:315). The researcher may discover recurring patterns of behaviour and relationships (Marshall and Rossman: 1999:107), thus group behaviour can be studied over time. It is more reliable and free from the respondent bias since data are obtained through observation of events as they normally occur (Sekaran 2003:253). Further, a researcher can record information as it is revealed. Unusual aspects can also be noticed during the observation. Lastly, it can be used to explore topics that may be uncomfortable for participants to discuss (Creswell 2003:186).

Observation however has its drawbacks such as the researcher may become so emotionally involved as to lose the ability to assess the situation accurately (Leedy and Ormrod 2005:145). By the researcher's presence, one may alter what people say and do and how significant events unfold (Creswell 2003:186; Johnson and Turner 2003:315; Leedy and Ormrod 2005; Patton 2002:306). Although moods, feelings and attitudes can be guessed by observing facial expressions and other nonverbal behaviours, the cognitive thought processes of individuals cannot be captured. An observer also needs to be trained in what and how to observe, and ways to avoid observer bias (Creswell 2003:186; Sekaran 2003:254). In addition, observation is more

expensive than other methods such as questionnaire (Johnson and Turner 2003:315; Sekaran 2003:254; Strydom *et al.,* 1998:292).

This study used the non-participant observation where the role of observer-as-participant was adopted, and the semi-structured observational instrument was employed. Non-participant observation was conducted in the local communities to determine the following: different types of agricultural IK; the way farmers manage IK and access exogenous knowledge; the role of ICTs in managing IK and providing access to exogenous knowledge; and the barriers that hinder the effective management of agricultural IK in the local communities. In this study, non-participant observation was conducted by taking field notes in the local communities.

4.6.2 Semi-structured interviews

An interview is data collection in face-to-face settings, using an oral question-and-answer format which either employs the same questions in a systematic and structured way of all respondents, or allows respondents to talk about issues in less directed but discursive manner (Payne and Payne 2004:129). The interviews enable participants (be they interviewers or interviewees) to discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view (Cohen, Manion and Morrison 2007:349).

The interviews can be classified as unstructured, semi-structured or structured (Castro 2006). Unstructured interviews are based on a clear plan or a list of topics that the interviewer follows (IIRR 1996:44). Semi-structured interviews are based on written lists of questions or topics that need to be covered in a particular order although some questions may arise during the semi-structured interviews (IIRR 1996:44; Pretty and Vodouhe 1997). Structured interviews are based on a set of predetermined questions and of highly standardized techniques of recording (Kothari 2004:97). Structured interviews are more applicable in descriptive studies, while less structured interviews are suitable for exploratory or formulative research studies (Kothari 2004:98).

This study employed semi-structured interviews since they are often used in qualitative analysis (de Zeeuw and Wilbers 2004:8; Gray 2004:215). They can be useful to obtain information in general or about a specific topic, to analyze problems and opportunities or to discuss plans as

well as to elicit perceptions (de Zeeuw and Wilbers 2004:8). Further, they are flexible, and thus they are likely to yield information that the researcher had not planned to ask for (Bryman 2004:321; Fontana and Frey 2005:705; Gray 2004; Leedy and Ormrod 2005:137; Marshall and Rossman 1999:108). Study participants need no special skills, and a longer session with more complex questions is possible without misunderstandings, because the interviewer is physically present. This physical presence also permits recording of non-verbal signals and spontaneous reactions (Payne and Payne 2004:132) thus, conducting non-participant observation at the same time. The interviews can also be stimulating for respondents and so aid in recall (Fontana and Frey 2005:705). Since the interviews are sufficiently open-ended, the contents can be reordered, digressions and expansions made, new avenues included and further probing undertaken (Cohen, Manion and Morrison 2007:182).

However, semi-structured interviews also have disadvantages. For instance, the researcher gets different information from different people during interview sessions and may not be able to make comparisons among interviewees. Thus, the results cannot be generalized (Kemmis and McTaggart 2005; Leedy and Ormrod 2005:137). Interviews are also costly (in terms of money and time) and there is also a potential for interviewer bias (Creswell 2003:186; Patton 2002:306; Payne and Payne 2004:132). Despite the author being in control, fieldwork is hard to organize and both researchers and their readers cannot know everything that goes on (Payne and Payne 2004:132-133). Lack of skills or a language barrier may also inhibit the interviewer not to ask questions that evoke long narratives from participants (Marshall and Rossman 1999:110). The interview's data are also subject to recall error, reactivity of the interviewee to the interviewer, and self-serving responses (Patton 2002:306). Further, the interviews provide indirect information filtered through the views of interviewees. It also provides information in a designated place rather than the natural field setting. A researcher's presence may bias responses, and thus people may not be equally articulate and perceptive (Creswell 2003:186). Quantitative parts of the semi-structured interviews are easy to analyse, while the qualitative parts are usually difficult to analyze (Gray 2004).

In this study, both open ended questions and closed ended questions were used to gather quantitative and qualitative data in the semi-structured interviews. Since interviews cannot be recorded on a standard form as Payne and Payne (2004:132) suggested, this study took field notes and recorded audio tapes so that the flow of interviews was not disrupted. These interviews were conducted with all categories of the study participants, namely local communities, knowledge intermediaries and IK policy makers. Three different semi-structured interview guides were formulated for each of these categories of study participants.

In the local communities, individual interviews focused on eliciting communities' perceptions with regard to the following: agricultural knowledge and information needs, different types of agricultural IK, role of IK and exogenous knowledge in the farming systems, the way they manage agricultural IK and access exogenous knowledge, role of ICT in managing agricultural IK and disseminating exogenous knowledge, the integration of indigenous and exogenous knowledge systems, and the barriers that inhibit effective management of IK and access to exogenous knowledge in the local communities. The knowledge intermediaries were interviewed to solicit their perceptions with regard to management of agricultural IK, dissemination of agricultural exogenous knowledge, the role of ICT in managing agricultural IK and disseminating exogenous knowledge, various ways they use to integrate agricultural exogenous knowledge with IK, and the barriers that hinder the effective management of agricultural IK and access to exogenous knowledge in the local communities. Lastly, the IK policy makers were interviewed to solicit information regarding the policy and protection issues related to agricultural IK in Tanzania.

4.6.3 Focus groups

The focus group is a contrived setting, bringing together a specifically chosen sector of the population to discuss a particular given theme or topic, where the interaction within the group leads to data and outcomes (Cohen, Manion and Morrison 2007:376). The prime purpose of the focus groups is to generate rich data on a topic, and thus there is no need for participants to agree, disagree or reach any kind of consensus. Only later when the data from different focus group exercises are placed before decision-makers, may there be a need for other consensus-building techniques (Sillitoe, Dixon and Barr 2005:177).

One of the advantages of focus groups is that the accuracy of the information and the rate at which it is generated is higher in groups than in individual interviews (Babbie 2004; Grenier 1998; IIRR 1996:62; Leedy and Ormrod 2005:146; Marshall and Rossman 1999: 115; Smithson 2008). Other advantages are that participants may query one another's points and explain their answers to each others (Neuman 2006:412). Less knowledgeable participants may learn something new (Grenier 1998). Focus groups are cheap, relatively easy and can be conducted in a brief time (Langill 1999:26; Krueger 1988:47; Marshall and Rossman 1999:115; Strydom *et al.,* 1998:324). They are flexible and produce validated data and speedy results. They also capture real-life data in a social environment (Krueger 1988:47; Marshall and Rossman 1999: 115; Strydom *et al.,* 1998:324). In addition, focus groups can be conducted with non-literate individuals who are not able to complete self-responding questionnaire (Welman, Kruger and Mitchell 2005:203).

The disadvantages of focus groups are that the desired information may be withheld because people in positions of authority (for example, administrators, politicians) and men tend to dominate the discussion (Bryman 2004:360; Cohen, Manion and Morrison 2007:377; Grenier 1998: Krueger 1988:44-45; Welman, Kruger and Mitchell 2005:204). The researcher may also have difficulty in interpreting and analyzing the observed data, and may have less control over proceedings than the individual interview. Groups are also difficult to assemble (Bryman 2004:360; Cohen, Manion and Morrison 2007:377; Krueger 1988:44-45; Marshall and Rossman 1999:115; Strydom *et al.,* 1998:325). A polarization effect may exist (that is, attitudes become more extreme after group discussion). A moderator may unknowingly limit open, free expression of group members. Focus group participants may also hide important facts from the facilitator and thus they may produce fewer ideas than in individual interviews. Risk of response bias makes it hard to convince outsiders of the reliability of findings (Copestake, Johnson and Wright-Revolledo 2005:58; Neuman 2006:412).

There are a number of planning issues that need to be considered before this technique is used which include group size, number of groups, participant selection, level of moderator involvement, political and ethical constraints, and budgetary and time constraints (Sillitoe, Dixon

and Barr 2005:179). Group size is determined by whether the researcher's need is to hear an individual or collective perspective (Sillitoe, Dixon and Barr 2005:179). The focus group should neither be too small (for example, five people) nor too large (for example, 40 people) (Grenier 1998). There is a likelihood that some participants will remain silent or speak very little in a larger group, while smaller groups often provide an environment where all participants can play an active part in discussion (Smithson 2008:359). Various authors have suggested different sample sizes for focus groups, such as a sample size for the focus group session can either be six to twelve participants (Neuman 2006; Welman, Kruger and Mitchell 2005:202); six to ten participants (de Vos, Strydom and Fouche 2005:305; Morgan 1988; de Zeeuw and Wilbers 2004; Patton 2002:385); six to seven respondents (Gray 2004:230); six only (Willig 2001); six to eight interviewees (Creswell 2003:186; Teddlie and Tashakkori 2009); four to eight (Smithson 2008: 359); four to twelve (Sillitoe, Dixon and Barr 2005:180); and ten to twelve interviewees (Leedy and Ormrod 2005:146).

The number of groups that one should conduct depends on the research question and on the number of different subgroups required (Morgan 1988:42). Morgan and Krueger (1998) maintained that conducting too few focus group meetings may result in something being missed, or lead to premature conclusions, but doing too many is a waste of time and money. The greatest amount of new information usually comes in the first two group meetings, with considerable repetition after that (de Vos, Strydom and Fouche 2005:306). Sillitoe, Dixon and Barr (2005:179) suggested that the more homogenous groups are in background and role-based perspectives, the less groups are required, while the more distinct population sub-groups are, the more are needed. The major concern should be on the richness of data and detailed description rather than the total counts of focus group sessions (de Vos, Strydom and Fouche 2005:306; Sillitoe, Dixon and Barr 2005:180).

The focus group discussions were used in this thesis since IK studies use multiple methods (example, individual and group interviews) to obtain more complete and accurate information (Kiptot 2007). In this study, focus group discussions were conducted with the local communities. A set of focus groups were formed through observation and informal participatory discussions

with individuals and groups based on gender, age and agro-economic activities (crop production and livestock keeping). Magoro and Masoga (2005) also used the same process to select the focus groups' respondents when examining the extent to which the local farmers' knowledge can be protected.

Further, the study gave more consideration to the following factors as recommended by various authors (Grenier 1998; Neuman 2006; Sillitoe, Dixon and Barr 2005:179; Welman, Kruger and Mitchell 2005:202) in order to yield high quality and quantity of the information when conducting focus groups. The focus group discussions had small group size, which were between six to twelve people depending on their availability (See Section 4.8.3 of Chapter Four). Group composition (gender and age), social, economic and cultural aspects were also considered. Two focus groups were conducted in each district. The questions were formulated in an unstructured manner in order to explore the research topics in depth. The focus group discussions were conducted by taking field notes and recording conversations on the audiotapes. Further, PRA tools were also used during focus groups discussion, which included the information mapping and linkage diagram and problem tree.

4.6.4 Participatory Rural Appraisal

A number of participatory approaches with varying terminologies have since come into practice over a period of time. Rapid Rural Appraisal (RRA) was the first to appear (Chambers 2002:1). This approach later evolved into Participatory Rural Appraisal (PRA), which is used interchangeably with Participatory Learning and Action (PLA) (Chambers 2002:1; Kumar 2002:29). The common theme to all these approaches is the shared ownership of research projects, community-based analysis of social problems, and an orientation towards community action (Kemmis and McTaggart 2005:560).

Although PLA is a more accurate title for what many practitioners of PRA believe in and are doing, PRA remains the usual label (Chambers 2002:2; Kumar 2002:30). PRA is described as a growing family of approaches, methods, attitudes and behaviours to enable and empower people to share, analyze and enhance their knowledge of life and conditions, and to plan, act, monitor, evaluate and reflect (Chambers 2002:2). PRA relies on visual techniques and graphical outputs

which have the advantage of being accessible and easily understood by people from a range of skills and disciplinary backgrounds (Sillitoe, Dixon and Barr 2005:46). In this way, this approach encourages local people to analyse their own problems and facilitate the communication of their thoughts to others, in order to further understanding of the poor through involvement (de Zeeuw and Wilbers 2004; Sillitoe, Dixon and Barr 2005:10; Warburton and Martin 1999:2). Thus, research functions not only as a means of knowledge production, but also as a tool for the education and development of consciousness as well as mobilization for action (Gaventa 1991:121-122).

PRA was employed in this study because it yields many insights into IK since it puts great emphasis on local people's own knowledge and practices and it normally takes place within the community (Warburton and Martin 1999:2). PRA is also recommended by various IK studies as an appropriate method to study and analyze the way local communities manage their IK for sustainable agricultural development processes (Grenier 1998; IIRR 1996; Langill 1999; Sillitoe, Dixon and Barr 2005; Scoones and Thompson 1993:3; Warburton and Martin 1999). In developing countries, many studies have also used PRA to examine agricultural IK in the local communities (Bagnall-Oakeley *et al.,* 2004; Conroy *et al.,* 2004; Garforth 2001; Hart and Mouton 2005; Morales and Perfecto 2000). In Tanzania, various authors have also used PRA to examine the role of IK for agricultural development in the rural areas (FAO 2006a; Kilongozi, Kengera and Leshongo 2005; Kweka 2004).

In developing countries, Bagnall-Oakeley *et al.,* (2004) used PRA to map and understand farmers' indigenous agricultural knowledge and information systems and the implications for contracted research and extension in Uganda. Conroy *et al.,* (2004) used PRA to assess the livestock keepers' agricultural knowledge and information systems in two locations in rural India. Garforth (2001) used PRA to analyze the local agricultural knowledge and information systems in Hagaz, Eritrea. Hart and Mouton (2005) used participatory research methods to examine the usage of IK in cultivating traditional vegetables in a rural parish in Uganda. Morales and Perfecto (2000) utilised participatory research process to understand farmers' agricultural knowledge in pest management in the Guatemalan highlands. In Tanzania, FAO (2006a) used

PRA to examine the role of IK in range management and forage plants for improving livestock productivity and food security in the Maasai communities in Tanzania. Kilongozi, Kengera and Leshongo (2005) employed PRA to assess the utilisation of IK in range management and forage plants for improving livestock productivity and food security in the Maasai and Barbaig communities of Kibaha in Tanzania. Kweka (2004) used PRA to identify local knowledge and institutions and to investigate their role in the conservation of biodiversity in East Usambara forest in Tanzania.

PRA relies heavily on visual techniques, such as diagramming and matrix ranking, rather than verbal ones (Sillitoe, Dixon and Barr 2005:85). This study used information mapping and linkage diagrams, and problem trees to collect data in the local communities as described in the following sections.

4.6.4.1 Information mapping and linkage diagram

An information mapping and linkage diagram is also referred to as institutional mapping or a venn diagram. It is a participatory method that uses small circles of paper to identify and represent both formal and informal institutions within a community and its external environment and the nature of the relationships between these and informants' community (Garforth 2001; IIRR 1996:103; Kumar 2002:234; Sillitoe, Dixon and Barr 2005:131). The main purpose of this approach is to identify and visualise the relative importance of institutions both within and beyond a community which impact upon the livelihoods of target individuals and groups (Sillitoe, Dixon and Barr 2005:131). The completed diagram can serve the focus group discussions to analyze the strengths and weaknesses of the various institutions and their contributions (or constraints) to the development of the community (IIRR 1996:103; Kumar 2002:234).

However, if information mapping is not well facilitated, it can become a facilitator-driven exercise and thus some valuable information may be lost. Further, information mapping generally becomes difficult and complex when the number of items increases (Kumar 2002). Sometimes, sensitive issues may be raised in the presence of the individuals or representatives of institutions that are being rated in the information mapping and thus participants may play safe

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and withhold information. Hence the output in such cases may not reflect the realities (Kumar 2002).

In this study, information mapping and a linkage diagram was used during the focus group discussions. This tool was used to identify local, formal or informal institutions and ICTs in their locality and their importance in providing access to agricultural exogenous knowledge in the local communities. This method was also be used to determine the agricultural knowledge and information needs in the local communities. A number of studies have also used information mapping and linkage diagrams to assess the management of the agricultural knowledge systems in the local communities (Bagnall-Oakeley *et al.,* 2004; Conroy *et al.,* 2004; Garforth 2001; Rees *et al.,* 2000).

4.6.4.2 Problem tree

A problem tree is a tool that can be used visually to depict causes and effects of a problem by using the outline of a tree (Kumar 2002:197). Problem mapping can be used to get people's views on the main problems and to identify and discuss alternative potential solutions. The technique is especially effective in communities with low literacy levels (de Zeeuw and Wilbers 2004). This analysis then provides an opportunity to identify causes which might be tackled by farmers, or with outside support (Garforth 2001). The strength of this method lies in its visual representation which makes it easy to depict and explain a problem, its causes, its effects and the interrelations of various causes as well as effects of using the analogy of a tree (Kumar 2002:197).

Problem trees were used in this study to analyze the causes and effects of major problems that affect the management of agricultural IK, access to agricultural exogenous knowledge and the use of ICTs in managing agricultural IK and disseminating exogenous knowledge in the local communities. This tool was used during the focus group discussions. The same technique was used by Garforth (2001) to analyze the causes and effects of the main problems faced by farmers when studying the agricultural knowledge and information systems in Hagaz, Eritrea.

4.7 Data analysis

Data analysis aims at discovering the patterns among data that point to theoretical understandings of a social life (Babbie 2004:376). Data analysis in mixed methods research involves analysis of the quantitative data using quantitative methods and qualitative data using qualitative methods (Creswell and Plano-Clark 2007:128; Teddlie and Tashakkori 2009). Thus, knowing the steps in both forms of qualitative and quantitative analysis is necessary in mixed methods questions since both qualitative and quantitative approaches deal with data analysis differently (Creswell and Plano-Clark 2007: 128; Powell and Connaway 2007; Teddlie and Tashakkori 2009).

Quantitative data analysis relies more on deductive reasoning, beginning with certain premises (for example, hypotheses, and theories) and then drawing logical conclusions from them. It proceeds with predetermined statistical procedures and uses objective criteria to evaluate the outcomes of those procedures (Leedy and Ormrod 2005:96). Qualitative data analysis on the other hand, uses inductive reasoning by making many specific observations and then draws inferences about larger and more general phenomena. It searches for patterns in data, recurrent behaviours, objects, phrases, or ideas which are subjectively identified and they are interpreted in terms of social theory or the setting in which they occurred (Leedy and Ormrod 2005:96; Neuman 2006:467).

The data analysis in qualitative studies is simultaneous, whereas the processes of data collection, data analysis, and report writing are not distinct steps. Instead, they are interrelated and often go on simultaneously in a research project (Creswell 2007:150; Leedy and Ormrod 2005:138; Patton 2002:436). In general, qualitative data analysis involves preparing and organising the data for analysis, then reducing the data into themes through a process of coding and condensing the codes, and finally representing the data in figures, tables or discussion (Creswell 2007:148). Quantitative data analysis on the other hand, is the analysis of numeric data using a variety of statistical techniques (Teddlie and Tashakkori 2009). It proceeds by statistical analysis of scores collected on instruments, checklists or public documents to answer research questions or to test

hypotheses. The overall intent is to reject or fail to reject the hypotheses to establish the theory (Creswell and Plano-Clark 2007; Neuman 2006:177).

The mixed methods data analysis occurs both with quantitative (descriptive and inferential numeric analysis) and qualitative approach (description and thematic text or image analysis), plus other strategies unique to mixed methods (example, data conversion or transformation, and triangulation) (Creswell 2009; Teddlie and Tashakkori 2009:8). Data analysis in mixed methods research also relates to the type of research strategy chosen for the procedures (Creswell 2009; Creswell and Plano-Clark 2007:128). Various authors have proposed several means for analyzing data in mixed methods research (Bazeley 2006; Creswell 2003; Creswell and Plano-Clark 2007; Tashakkori and Teddlie 1998:19; Teddlie and Tashakkori 2009).

In this study, both qualitative and quantitative data were analyzed and interpreted by using a concurrent approach as suggested by Creswell and Plano-Clark (2007), which is also similar to the parallel approach as proposed by Teddlie and Tashakkori (2009). According to Creswell and Plano-Clark (2007), the concurrent approach involves conducting initial data analysis for each of the qualitative and quantitative databases. Secondly, it merges the two datasets so that, in the case of an embedded design (or dominant-less-dominant model), the supportive dataset can reinforce or refute the results of the primary set. In this study, both qualitative and quantitative data were analyzed separately, and then quantitative data was merged to the qualitative data set in order to provide support to the results of qualitative data set. Further, most of the qualitative data was transformed into quantitative data in order to compare the datasets (Creswell and Plano-Clark 2007).

4.7.1 Qualitative data analysis

Qualitative software programs facilitate data storage, coding, retrieval, comparing and linking, but human beings do the analysis. They speed up the process of locating coded themes, grouping data together in categories, and comparing passages in transcripts or incidents from field notes (Patton 2002:442). In this study, qualitative data was analyzed by using a computer database program called Nvivo. This software is suitable for qualitative research studies. It provides a ready means of storing, segmenting and organising lengthy field notes, and it is designed to help

the researcher find patterns in the notes (Leedy and Ormrod 2005:137). The import and export function at the NVIVO software encourages triangulation by offering a port to export data to SPSS (Fielding and Fielding 2008:567). Such tools facilitate a mixed methods study transcending the quantitative/qualitative distinction (Bazeley 1999).

The generic steps of analyzing data in qualitative studies as described by various authors was used (Bazeley 2006; Creswell 2003; Leedy and Ormrod 2005; Neuman 2006:460). Data analysis was organised and presented according to the research questions because it is a useful way of organising data, as it draws together all the relevant data for the exact issue of concern to the researcher, and preserves the coherence of the material (Cohen, Manion and Morrison 2007:468). In this approach, all the relevant data from various instruments (semi-structured interviews, observation, focus groups, information mapping and problem trees) was collated to provide a collective answer to a research question (Cohen, Manion and Morrison 2007:468). Qualitative analysis involved the process of categorisation of themes contained in data, followed by linking of themes and ideas and exploring new ideas (Pickard 2007:280). The presentation of qualitative data in this study involved the discussions of themes and categories as well as figures and tables which presented different themes.

Further, most of the qualitative data related to social processes and the respondent's definition was transformed into quantitative counts by using NVIVO and SPSS software in the present study. Qualitative data was converted into quantitative scales for purposes of statistical analysis in order to provide detailed assessment of patterns of responses and a deep understanding of survey responses (Creswell 2009:218; Flick 2006:39; LeCompte and Schensul 1999; Schensul, Schensul and LeCompte 1999; Patton 2002:253; Sandelowski 2001; Silverman 2006:55; Tashakkori and Teddlie 1998:125; Teddlie and Tashakkori 2009). Qualitative data was also quantified to generate meaning from data, confirm and validate the study's conclusions, and to re-present target events and experiences (Polit and Beck 2003:323; Sandelowski 2001). Further, data was quantified to establish the significance of a research problem, to document what is known about a problem, and to describe a sample (Sandelowski 2001:231). The qualitative data was quantified to allow the exploratory and explanatory depths of understanding that qualitative

research can elicit. It also allowed the reporting of summary results in numerical terms to be given with a specified degree of confidence (Abeyasekera 2005:98). The quantification of qualitative data also enabled a researcher to compare quantitative results with the qualitative data (Creswell 2009:218). It also enabled the researcher to test and revise the generalizations, removing doubts about the accuracy of the impression about the data (Silverman 2006:55).

In the present study, qualitative data was transformed into quantitative counts by determining the percentages of participants whose responses were included in each of the emerged theme. Thus, the qualitative data provided the meaning of the concepts and variables used, while the quantified data gave an understanding (in terms of patterns, trends and underlying dimensions) of data not readily evident in the detail of the qualitative analyses. In this study, qualitative data emanated from the set of open-ended questions in the semi-structured interviews with local communities. Graphs generated with the aid of NVIVO and SPSS software were used to vary data presentation. In a similar study, Sabetian (2002) collected much detailed qualitative information through open-ended semi-formal interview and presented some of the findings in a quantified form to demonstrate the value of ethnographic knowledge in fishery research design and management in a Solomon Island village.

In this study, most of the findings from qualitative and quantitative methods appeared consistent. According to Onwuegbuzie and Johnson (2006:58) and Tashakkori and Teddlie (2008:115), if the inferences stemming from the quantitative and qualitative phases were consistent, then the meta-inference quality likely would be higher. It is further argued that the study is enhanced if the divergent and convergent findings are identified through comparisons of results and inferences, and if the possibility of a higher order conceptual framework is deployed (Teddlie and Tashakkori 2009:286). In this study, there were inconsistent findings in some instances, which were solved according to the Tashakkori and Teddlie's (2008:116) integrative framework (see Section 4.8.6 of Chapter Four).

However, Silverman (2006:59) cautioned that a dependence on purely quantitative methods may neglect the social and cultural construction of the variable which qualitative research seeks to

correlate. Sandelowski (2001:236) also offered good advice on avoiding the misuse of numbers, such as over-counting, or counting that is misleading. Hence, while most of the qualitative data was quantitized in this study, some of it was qualitatively analyzed and presented separately with the quantitative data in order to compare the study findings.

4.7.2 Quantitative data analysis

The SPSS software program was used to analyze the quantitative data from the set of closed-ended questions in the semi-structured interviews with the local communities and knowledge intermediaries. SPPS offers a powerful and easy ways to extract meaningful information from data (Pickard 2007:278). SPSS enables the input of raw data, modification, and re-organisation of data to carry out a wide range of simple, statistical and multivariate analyses (Blaxter, Hughes and Tight 2006). It can reduce time required to analyze data, reduce errors involved in coding data, analyze data with in-depth statistics and charts, and present results clearly with flexible reports and charts (Pickard 2007:278). In this study, frequencies, percentages and forms of graphical presentation were used to analyze and present quantitative data from semi-structured interviews.

4.8 Validity and reliability

Validity and reliability are of primary concern for data quality control measures in research (Ndunguru 2007:89). Validity and reliability help to establish the truthfulness, credibility and believability of findings (Gray 2004:218; Neuman 2006:188). However, validity and reliability can never be erased completely, rather the effects of these threats can be reduced by attention to validity and reliability throughout the research (Cohen, Manion and Morrison 2007:133). The following sections explain how threats to validity and reliability were minimized in the present study.

4.8.1 Reliability in qualitative, quantitative and mixed methods research

Reliability refers to the extent to which a measure can give consistent and stable results in a measurement process (Ndunguru 2007:89; Sekaran 2003:203). In fact, the reliability of a measure indicates the extent to which it is without bias (error free) and hence ensures consistent measurement across time and across various items in the instrument (Sekaran 2003:203). It

emphasizes that similar results would be found if the same research was to be repeated or carried out on a similar group of respondents in a similar context or conditions (however defined) (Babbie and Mouton 2001:119; Cohen, Manion and Morrison 2000:117; Gray 2004:219; Neuman 2006:188; Powell 1985:37; Welman, Kruger and Mitchell 2005:145).

Both qualitative and quantitative approaches perceive reliability differently. In qualitative methodologies, reliability includes fidelity to real life, context-and-situation-specificity, authenticity, comprehensiveness, detail, honesty, depth of response and meaningfulness to the respondents (Cohen, Manion and Morrison 2007:149). Thus, generalizations to other individuals, setting, and times are not desired (Creswell 2003:195; Polit and Beck 2003:430; Silverman 2006:303; Tashakkori and Teddlie 1998:65). The concern is about the replication of the findings in other similar cases or sets of condition (Brannen 2006). Reliability in qualitative studies can be attained through a range of data sources and use of multiple measurement methods (Neuman 2006:196). Reliability can also be addressed in two ways, such as use of standardized methods to write field notes and prepare transcripts, and comparing the analysis of the same data by several researchers in the case of interviews and textual studies (Silverman 2006).

The reliability in quantitative research is a synonym for dependability, consistency and replicability over time, over instruments and over groups of respondents (Cohen, Manion and Morrison 2007:146; Leedy and Ormrod 2005: 31; Payne and Payne 2004). It refers to the extent to which an experiment, test, or measurement yields the same result or consistent measurement on repeated trials (Cohen, Manion and Morrison 2007:146; Silverman 2006:282; Welman, Kruger and Mitchell 2005:9; Willig 2001). Reliability of measures in quantitative research may be achieved in four ways: clearly conceptualize constructs; use of a precise level of measurement; use of multiple indicators; and use of pilot tests (Neuman 2006:190).

In mixed methods studies, the crisis of representation refers to the difficulty in capturing (that is, representing) the lived experience using text in general and words and numbers in particular (Onwuegbuzie and Collins 2007). Reliability is referred to as the inference transferability in mixed methods research which is the degree to which the research conclusions may be applied to

other specific settings, people, time periods, context and so forth (Tashakkori and Teddlie 2003; Teddlie and Tashakkori 2009:27). It refers to generalizability and external validity (quantitative) and transferability (qualitative) (Tashakkori and Teddlie 2003; Teddlie and Tashakkori 2009:27).

4.8.2 Validity in qualitative, quantitative and mixed methods research

Validity means truthfulness (Neuman 2006:196; Silverman 2006:47; Tashakkori and Teddlie 1998). Broadly, validity is the extent to which the research findings accurately represent what is really happening in the situation (Leedy and Ormrod 2005:92; Welman, Kruger and Mitchell 2005:142; Willig 2001). Validity tests how well an instrument that is developed measures the particular concept it is intended to measure (Gray 2004:219; Leedy and Ormrod 2005:28; Neuman 2006:188; Sekaran 2003:203).

Both qualitative and quantitative approaches view validity in a different way. Qualitative researchers tend to focus more on minimizing threats to validity because the objective of the study must be representative of what the researcher is investigating (Welman, Kruger and Mitchell 2005:9). In the qualitative research, a primary focus is for researchers to capture authentically the lived experiences of people (Creswell 2003:196; Neuman 2006:196; Onwuegbuzie and Johnson 2006:49; Patton 2002:14). Because of the association with the quantitative conceptualization of the research process, the term validity has generally been replaced by the term "trustworthiness" (Angen 2000; Onwuegbuzie and Johnson 2006:51) or "validation" within qualitative research (Creswell 2007:207).

To establish the trustworthiness of the qualitative findings, Lincoln and Guba (1985) used alternative terms such as credibility, transferability, dependability, and confirmability. Lincoln and Guba (1985) also suggested that trustworthiness in qualitative research can be achieved through prolonged engagement, persistent observation, triangulation, peer debriefing, negative case analysis, referential adequacy, and member checks. Creswell (2007:204) also added that thick description, clarifying researcher bias and external audit are necessary to make sure that the findings are transferrable between the researcher and those being studied. Various scholars have also proposed several ways for determining the trustworthiness of a qualitative research (Cohen, Manion and Morrison 2000: 105; Onwuegbuzie and Leech 2007; Silverman 2006:295).

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Validity in quantitative research is more concerned with the measurement validity. Measurement validity refers to how well an empirical indicator and the conceptual definition of the construct that the indicator is supposed to measure fit together (Neuman 2006:192). Validity in quantitative approach can be minimized through: careful sampling, appropriate instrumentation and appropriate statistical treatments of data (Cohen, Manion and Morrison 2007: 133). Several scholars have also proposed various ways to minimize validity in quantitative research (Onwuegbuzie 2003; Shadish, Cook and Campbell 2001). For instance, Onwuegbuzie (2003) proposed 50 different threats to internal and external validity that might occur at the research design/data collection, data analysis, and/or data interpretation stages of the quantitative research process. Shadish, Cook, and Campbell (2001) classified research validity into four major types: statistical conclusion validity, internal validity, construct validity, and external validity.

In mixed research, authors have began to develop a bilingual nomenclature, and have either used "legitimation" (Onwuegbuzie and Collins 2007; Onwuegbuzie and Johnson 2006), or "inference quality" to refer to validity and trustworthiness of the mixed research findings (Tashakkori and Teddlie 2003). Inference quality refers to the standard for evaluating the quality of conclusions that are made on the basis of the quantitative (internal validity) and qualitative findings (credibility and trustworthiness) (Tashakkori and Teddlie 2003; Teddlie and Tashakkori 2009:27). Two broad criteria have also been suggested to evaluate the quality of inferences, which include design quality and interpretive rigor. Design quality refers to the degree to which the investigators have utilised the most appropriate procedures for answering the research question. On the other hand, the interpretive rigor is the degree to which credible interpretations have been made on the basis of obtained results. Thus, a strong inference is only possible if there is a strong and appropriate design that is implemented with quality (Tashakkori and Teddlie 2003:112).

Attaining absolute validity and reliability in any study is an impossible goal for any research model. Nevertheless, investigators may approach these objectives by conscientious balancing the various factors enhancing credibility within the context of their particular research problems and goals (Cohen, Manion and Morrison 2007: 133). Various methods were used to ensure that

validity and reliability of the findings were achieved in this study, which include: pre-testing of the interview schedule and observation guide, triangulation, sampling adequacy and saturation, and integrative efficacy.

4.8.3 Semi-structured interview and observation guides pre-testing

Pre-testing gives the researcher an opportunity to identify questionnaire or interview items that tend to be misunderstood by the participants, which may inhibit one in obtaining the needed information (Powell 1985:103; Sekaran 2003:249). The purpose of the pre-testing is to increase the reliability, validity and practicability of the instrument (Cohen, Manion and Morrison 2000:260; Ngulube 2005:136; Powell and Connaway 2007). Pretesting involves a use of a smaller number of participants to examine the appropriateness of the questions and their comprehension (Sekaran 2003:249). Essentially, it is not necessary that the pre-test subjects comprise a representative sample, although the instrument used should at least be relevant to the respondents (Babbie and Mouton 2001:244). Ideally, the use of a convenience sample to pretest a questionnaire is the most utilised approach because of the members' proximity and willingness to participate (Powell 1985:101; Powell and Connaway 2007).

For this study, semi-structured observation guides and interview schedules were prepared according to various guidelines (Cohen, Manion and Morrison 2007; Bryman 2004; Leedy and Ormrod 2005; Neuman 2006; Patton 2002; Welman, Kruger and Mitchell 2005). The interview schedules and observation guides were pre-tested at the Bigwa Village, a local community surrounding the Morogoro town municipality in Morogoro region, Tanzania. The pre-testing of the instruments was conducted between February 2008 and March 2008. Eight smallholder farmers and two knowledge intermediaries were interviewed, and twelve farmers participated in the focus group discussion at the Bigwa Village. The pre-testing was also conducted by a panel of experts consisting of five library and information science professionals from the Sokoine University of Agriculture in Morogoro, Tanzania. All the participants were conveniently sampled.

4.8.4 Triangulation

Triangulation enables the collection of multiple data using different strategies, approaches, and methods in such a way that the resulting mixture or combination is likely to result in complementary strengths and non-overlapping weaknesses (Gray 2004; Johnson and Onwuegbuzie 2004; Neuman 2006:149; Patton 2002:247). Triangulation can allow researchers to be more confident of their results. It can also stimulate the creation of inventive methods, new ways of capturing a problem to balance with conventional data-collection methods, and it may help to uncover the deviant or off-quadrant dimension of a phenomenon (Jick 2006:225). Hence, many studies prefer methodological triangulation because it bridges issues of reliability and validity (Babbie and Mouton 2001:275; Leedy and Ormrod 2005:100; Payne and Payne 2004:230; Silverman 2006).

This study used triangulation design to bring together the strength of both data sets to compare, validate, confirm and corroborate quantitative results with qualitative findings (Creswell 2003:96). The study also triangulated various methods to ensure the validity and reliability of the findings. By triangulation, accuracy of data was sought in several ways: triangulation of data collection methods, triangulation of investigators, triangulation of theories, and triangulation of data sources (Denzin 2006; Holland and Campbell 2005; Neuman 2006:149; Patton 2002; Silverman 2006:291).

In the methodological triangulation, two forms can be noted, which include within-method and between-method triangulation (Denzin 2006). Within-method triangulation involves the use of one method (such as questionnaire) and employs multiple strategies within that method to examine data. Between-method triangulation combines dissimilar research strategies to measure the same empirical unit, such as questionnaires and interviews (Denzin 2006). In this study, qualitative research was the dominant method used to collect data. Both forms of methodological triangulation were used. Different instruments were used and their results were compared to ensure the credibility of the findings and to achieve the between-method triangulation. Data collection methods included the following: non-participant observation, semi-structured interviews, focus groups, information mapping and linkage diagrams, and problem trees. The

quantitative data was collected through closed questions which were embedded in the semi-structured interviews. Different subscales for measuring an item in the semi-structured interviews were used to achieve the within-method triangulation.

Data triangulation involves the use of multiple data sources for the purpose of validating conclusions (Denzin 2006:200; Polit and Beck 2003). Further, data triangulation has three subtypes, which include time, space and person, which means that phenomena should be studied at different dates and places, and from different persons (Denzin 2006:200). Data triangulation in this study was achieved by the inclusion of various stakeholders in the study (that is, 181 small-scale farmers, 25 knowledge intermediaries, and four officers who were involved with intellectual property rights and IK policy issues). These small-scale farmers and knowledge intermediaries were selected from six districts in six research zones of Tanzania. This type of triangulation enabled the study to corroborate the data sources in order to enhance the validity and reliability of the findings.

Theory triangulation means approaching data with multiple perspectives and hypotheses in mind. Data that would refute central hypotheses could be collected, and various theoretical points of view could be placed side by side, to assess their utility and power (Denzin 2006:203). The recommended procedure is to utilize all the propositions that currently exist in a given area to determine which of the pre-supposed empirical relationships actually exist (Denzin 2006:204). Theory triangulation can help researchers to rule out rival hypotheses and to prevent premature conceptualizations (Polit and Beck 2003:431). Triangulation of theories in this study involved the use of nine different KM models. These models were used to build the theoretical framework of the study and to interpret the collected data in the study (see Section 3.3.2 of Chapter Three).

Investigator triangulation means that different observers or interviewers are employed to detect or minimize biases resulting from the researcher as a person (Denzin 2006:200). There could be recording errors, memory lapses and errors in interpreting activities, behaviours, events and nonverbal cues (Sekaran 2003:249). Through collaboration, investigators can reduce the possibility of a biased interpretation of the data (Polit and Beck 2003:431). This type of

triangulation ensures a systematic comparison of different researchers' influences on the issue and the results of the research (Flick 2006:389). In this study, two investigators were used to collect data to establish the accuracy of the observation made (Willig 2001:147). Further, multiple investigators were used in the study to ensure consistency of the collected data and to avoid errors or bias so as to achieve the validity and reliability of the study.

4.8.5 Sampling adequacy and saturation

The validity, meaningfulness, and insights that generate from qualitative inquiry are based on the information richness of the cases selected and the observation/analytical capabilities of the researcher than with sample size (Patton 2002:245). Thus, the sample size should be determined based on informational needs, where data saturation should be the guiding principle (Polit and Beck 2003). Data saturation means that sampling continues to the point at which no new information is obtained and redundancy is achieved (Marshall 1996; Patton 2002:246; Polit and Beck 2003; Teddlie and Tashakkori 2009). This point of data saturation is compared to information redundancy, which means that the sampling procedure continues until the researcher recognises that no new data is forthcoming (Lincoln and Guba 1985; Patton 2002:246). Flick (2006:127) also referred to this point as theoretical saturation, which means that sampling is finished when nothing new emerges any more. When researchers have truly attained saturation, informational adequacy has been achieved and the resulting description or theory is richly textured and complete (Polit and Beck 2003:308).

An appropriate sample size for this study was one that adequately answered the research question (Marshall 1996). The interview data were studied and analyzed as they were collected, until it was clear that perspectives were being repeated and data saturation reached (Gray 2004:219). Thus, the point of saturation was reached when the researcher conducted between 27 and 37 individual interviews with the small-scale farmers at each research site. The saturated point was also reached after the individual interviews with the knowledge intermediaries, which included the telecentre managers, telecentre staff, extension officers, librarians, researchers, NGOs and agricultural input suppliers.

4.8.6 Integrative efficacy

Integrative efficacy addresses the degree to which a mixed methods researcher adequately integrates the findings, conclusions, and policy recommendations gleaned from qualitative and quantitative methods (Tashakkori and Teddlie 2008:115). It refers to making meaningful conclusions on the basis of divergent or convergent results (Tashakkori and Teddlie 2008:115). For mixed methods research, the consistency between two sets of inferences derived from qualitative and quantitative strands have been widely considered as an indicator of quality (Onwuegbuzie and Johnson 2006:58; Tashakkori and Teddlie 2008:115). Divergent findings may indicate flaws or inconsistencies in the mixed research design (Creswell, Plano-Clark and Garrett 2008:72). However, some authors have argued that one of the major values of mixed methods might lie in specific instances in which the two sets of inferences do not agree with each other (Tashakkori and Teddlie 2008:116).

To resolve contradictory findings, researchers can give priority to one form of data over the other, use it as a means to uncovering new theories or extending existing theories (Creswell, Plano-Clark and Garrett 2008:72). Taking this further, Sandelowski (2006:364) pointed out that if the results from two data collection techniques do not converge, these results are treated as interpretive opportunities, either to show that no true divergence exists or to suggest the phenomenon that accounts for apparent discrepancy. Various scholars also noted that it is also important to identify the conditions under which findings are invariant, explain failures of invariance and determine why given conditions apply (Bazeley 2004; Bryman 2006b:155; Fielding and Fielding 2008:557; Johnson and Onwuegbuzie 2004; Tashakkori and Teddlie 1998:71).

In this study, most of the findings from qualitative and quantitative methods appeared consistent. In some instances, there were inconsistencies from the focus groups and interview findings addressed the same questions which were resolved as according to Tashakkori and Teddlie's (2008:116) framework. Tashakkori and Teddlie (2008:116) proposed that inconsistent findings can be used as a diagnostic tool for detecting possible problems in data collection and analysis, or the inferences derived from the results of one data type or the other. If this re-examination

does not reveal any problem in the two sets of inferences, then the next step would be to evaluate the degree to which lack of consistency might indicate that the two sets reveal two different aspects of the same phenomenon (complementarity). Not reaching a plausible explanation for the inconsistency, the next step would be to explore the possibility that one set of inferences provides the conditions for the applicability of the other (elaboration, conditionality). If none of these steps provide a meaningful justification for the apparent inconsistency, the inconsistency might be an indicator of the fact that there are two plausible but different answers to the question (that is, two different but equally plausible realities) (Tashakkori and Teddlie 2008:116). Consequently, data from interviews with knowledge intermediaries and policy makers were also used to clarify the divergent findings provided by the local communities.

4.8.7 Other strategies adopted to ensure validity and reliability

Other strategies were also used to achieve the reliability of the findings in this study. To avoid the observer bias, the study took behaviour at its face value and did not attempt to interpret real meanings, at least not at the time the observations were made (Powell 1985:117). Bias was also minimized in this study by following Cohen, Manion and Morrison's (2000:122) suggestions that the interviews had carefully formulated questions so that the meaning was crystal clear; thorough training was conducted with two research assistants so that they were more aware of the possible problems; and interviewer characteristics were matched with those of the sample being interviewed. The same data collection instruments (interviews, observation, focus groups) were also applied to all study participants to minimize data collectors' bias (Gray 2004:220).

Reliability was also minimized in data analysis by checking for consistent patterns of theme development among two research assistants as suggested by Creswell (2003:195). The instruments were always administered in a consistent fashion. Further, to the extent that subjective judgments were required, specific criteria were established that dictated the kinds of judgments the researcher makes (Leedy and Ormrod 2005:95). In addition, thick descriptions of the qualitative study findings were provided to maximize the transferability of the study findings and inferences to other people and settings which are similar to the context of the present study.

The issue of validity was also addressed by ensuring that question content in the data collection instruments (interviews, observation, focus groups) directly concentrated on the research objectives (Gray 2004:219). The study addressed external validity through various means. A sample was selected which allowed for a subject to be viewed from all relevant perspectives (Arksey and Knight 1999). Further, this study was able to ensure the validity of the findings through a quantitative survey of the semi-structured interviews, where the categories counted were derived from the theoretically defined concepts. According to Silverman's (2006:301) simple counting techniques, theoretically derived and ideally based on participants' own categories can offer a means to survey the whole corpus of data, test and to revise their generalizations, and removing doubts about the accuracy of their impressions about data.

4.9 Ethical issues

Ethics refers to a code of conduct or expected societal norm of behaviour when conducting a research (Sekaran 2003:17). Ethics define what is or is not legitimate to do, or what "moral" research procedure involves (Neuman 2006:129). Ethical issues are of importance to all kinds of social and behavioural research and of particular importance when human subjects are involved (Powell 1985; Powell and Connaway 2007). Many ethical issues involve a balance between two values: the pursuit of scientific knowledge and the rights of those being studied or of others in the society (Neuman 2006:129). Thus, potential benefits such as advancing the understanding of social life, improving decision making or helping research participants, must be weighed against potential costs, such as a loss of dignity, self-esteem, privacy, or democratic freedoms (Neuman 2006:129).

Any research therefore needs to consider the following research ethics: protection from physical harm, psychological abuse and legal jeopardy, informed consent, privacy, anonymity and confidentiality of research data, honesty with professional colleague and accuracy (Babbie and Mouton 2001; Blaxter, Hughes and Tight 2006; Christians 2005:145; Cohen, Manion and Morrison 2007:174; Leedy and Ormrod 2005:101; Neuman 2006:129; Powell and Connaway 2007; Welman, Kruger and Mitchell 2005:201; Willig 2001). Another ethical issue involves the special population or group of research participants that are not capable of giving true voluntary informed consent. These populations may lack the necessary competency or may be indirectly

coerced (Neuman 2006:137). A related critical ethical issue here is the ownership of the data and the results, the control and the release of the data (and to whom, and when) and what right respondents have to veto the research results (Cohen, Manion and Morrison 2007:175).

Ethics pervades each stage of the research process (Blaxter, Hughes and Tight 2006; Creswell 2003:63; Ndunguru 2007:59; Sekaran 2003:18). As according to Sekaran (2003:18) and Welman, Kruger and Mitchell (2005:181), those research stages include data collection, data analysis, reporting and dissemination of research results. Creswell (2003:63) further described that ethical issues arise when specifying the research problem, purpose statement and research questions, and collecting, analyzing and writing up the results of data. These observations indicate that ethical issues need to be considered at every stage of research process.

This study adhered to the University of KwaZulu-Natal research ethics policy (UKZN 2009). The relevant ethical clearance form was completed and submitted. The research complied with the University's code of conduct throughout the study. The researcher ensured that relevant research permits were obtained before the commencement of data collection. Further, all sources used in the study were acknowledged so as to avoid plagiarism. An informed consent form was also used to facilitate voluntary participation in the study. Aliases or pseudonyms were used in data analysis to ensure confidentiality and privacy of the study participants. Electronic data were also protected by using password and be stored in a variety of electronic devices (external hard drive, flash disk, CDROM and computer). This type of storage was used in order to provide backups for the collected data. Hard copies of the data were also stored in a secured place.

4.10 Evaluation of the research methodology

Research methods should be evaluated in order to explain what information was needed, and how it was collected and analysed (Ngulube 2005:139). The evaluation of research methods ensures that the research methods are appropriate to the research questions and compatible with the kind of knowledge the study is aiming to produce (Willig 2001). Although the reliability and validity are also key ways of evaluating research, other criteria are useful as well (Creswell 2007; Silverman 2006:59). These criteria include unexpected changes to the research design,

limitations of the research design, the acknowledgement of shortcomings of the execution of the study, ethical issues (Ngulube 2005:139), substantive/theoretical, interpretive, and presentational/stylistic dimensions of the study (Polit and Beck 2003:656). Howe and Ensenhardt (1990) also suggested that five standards can be applied to all research, which include: the research questions should drive the data collection and analysis, researcher's assumptions should be explicit, the study should be robust, data collection and analysis techniques should be competently applied in a technical sense, respected theoretical explanations are used, and lastly the study should have value both in informing and improving practice, and in protecting the confidentiality, privacy and truth telling of participants.

In evaluating the research methodology, this study considered several issues including the appropriateness of the data collection methods, the successes and challenges faced during data collection, how the study overcame the challenges, and if the researcher would recommend this methodology to future research in the same field. Mixed methods approach was used in this study, where multiple research instruments were deployed in the study in order to cross-check and verify the reliability of a particular research tool and the validity of the data collected (McNeil and Chapman 2005). These research instruments included the non-participant observation, semi-structured interviews, focus groups, and PRA tools (information mapping and linkage diagrams, and problem trees). The use of interviews, focus groups and PRA tools seemed useful as they were conducted on non-literate individuals who were not able to complete self-responding questionnaire. The use of interviews and focus groups enabled researchers to probe, clarify and to create new questions based on what was already heard. Further, the use of focus groups and PRA tools enabled less knowledgeable participants to learn new indigenous skills and technologies. The use of PRA tools also enabled the active involvement of farmers in the data collection process, and encouraged farmers to determine their own needs, generate knowledge and suggest possible solutions.

Further, focus groups, observation and PRA tools were used to build consensus, clarify and validate information gathered by interviews. Most of the findings from qualitative and quantitative data collection methods appeared consistent. In some instances, there were

inconsistencies from the focus groups and interview findings addressed the same questions which were resolved as according to Tashakkori and Teddlie's (2008:116) framework (see Section 4.8.6 of Chapter Four). Consequently, data from interviews with knowledge intermediaries and policy makers were also used to clarify the divergent findings provided by the local communities.

In mixed research where qualitative is the dominant approach, the rich and inclusive understandings that one obtains from the qualitative strand may provide the details necessary for a comprehensive assessment of the conditions from which the inferences were made and to which the recommendations may be transferred (Teddlie and Tashakkori 2009:311). The generalizability or transferability of the results is often closely linked to the way sampling is done (Flick 2006:392). In a qualitative method where non-statistical samples are employed, sampling may be conducted on the basis of criteria to ensure the replicability or transferability of the findings beyond a given context (Brannen 2006). This study used the following sampling techniques: stratified purposive sampling technique, typical case purposive sampling technique, snowball or chain sampling and intensity sampling techniques. The stratified purposive sampling (mixed methods sampling technique) and typical case purposive sampling techniques (non-probability technique) were used to select farmers in the local communities. The snowball or chain sampling and intensity sampling techniques were used to select the study participant for the other categories, which were knowledge intermediaries and IK policy makers (see Section 4.5).

In this study, certain criteria were used to select research sites in order to ensure that the sample was a representative of farming systems and existing ICTs such as telecentres. Those criteria included high agricultural production and the possession of fully operational telecentres, and telecommunication network. Thus, the first stratum comprised one village in each district which was around or near to the telecentre, and other basic ICT facilities such as telecommunication signals. Good road were also a consideration. The second stratum included individuals from a remote village in each district (approximately 10 to 20 km from the telecentres). According to Bazeley (2004), stratified purposive sampling replaces purposive sampling in order to ensure

generalisation of results as understood in statistical terms, and the inappropriate use of rules of one method distorts, and potentially invalidates, the assumptions of another. In this study, typical case sampling technique was also used to select the respondents from each stratum in order to cover a broad spectrum of farming systems, ethnic-religious groups, gender and age groups. Thus, the respondents represented major characteristics of the population and their knowledge in the agriculture activities.

This study was conducted in six research sites in order to explore local communities' knowledge and experiences in the farming systems and the management of this knowledge and to ensure the transferability of the findings. According to Flick (2006:393), generalization in a qualitative research is the gradual transfer of findings from case studies and their context to more general and abstract relations. The expressiveness of such patterns can then be specified to how far different theoretical and methodological perspectives on the issue have been triangulated. In this study, an attempt was made to provide thick descriptions of the qualitative study findings in order to maximize the transferability of the study findings and inferences to other similar cases.

In some research sites, the researcher encountered some problems with the focus groups' discussions. In some districts (that is Moshi rural), the attendance of focus groups discussions was low because most farmers were busy with their farming activities. Further, some of the information was withheld due to the customs and traditions of a particular ethnic group such as the Maasai tribe at Twatwatwa Village in Kilosa District. Desired information was also withheld due to the presence of the village leaders and extension officers in some of the focus group discussions, for example in Kilosa District (Kasiki Village) and Karagwe District (Iteera Village). This data was thus supplemented by the non-participant observation and interviews which generated a lot of data.

Other problems that were faced by the researcher during data collection fieldwork were related to transportation problems, the definitions of various ICT-related terms and possible bias of the respondents. Two of the sites visited were located in very remote areas of Tanzania, which included Karagwe and Kasulu. For instance, Karagwe is 1,800 kilometres away from the capital

city, Dar es salaam, and Kasulu is approximately located 1,500 kilometres from Dar es salaam. The roads joining these two districts to the rest of the country were not all tarmacadamised, and thus they needed to be repaired regularly to make them passable throughout the year.

Despite the problems faced during data collection, this study recommends that semi-structured interviews which can collect both quantitative and qualitative data should be supplemented with focus groups, non-participant observation and PRA techniques when collecting data for IK studies. Although the use of interviews enabled the study to collect reliable and validated data, focus groups, observations and PRA tools verified, clarified and validated information lacking detail in the interviews. On the whole, the mixed methods approach enabled the study to bring together a more comprehensive account of the area of inquiry where both quantitative and qualitative research methods were used. This study thus recommends that future researchers use mixed research design when they are conducting studies investigating the management and integration of indigenous and exogenous knowledge in the local communities.

4.11 Summary

Chapter four provided the research design of the study. The chapter discussed various issues including the research design, study population, sampling procedure, data collection procedure and instruments, data analysis, validity, reliability, research ethics and evaluation of the research methodology. The main themes that emerged in the chapter were that it is important for IK studies to use mixed methods in order to enable the local people to express theirselves and generate a lot of data. The triangulation of the research methods enabled the study to gather both qualitative and quantitative data and to check the accuracy of the data gathered by each method. Issues of validity and reliability were important in ensuring the credibility and trustworthiness of the research findings. It was also important for the research to adhere to and address research ethical guidelines. The data that was collected in the study addressed the research objectives. The research findings are now presented in Chapter Five.

CHAPTER FIVE: DATA PRESENTATION

5.1 Introduction

The aim of the chapter was to report the outcome of the data analysis which transformed the raw data, obtained from the study, into meaningful facts. The data presented in this chapter was obtained from semi-structured interviews, non-participant observation, focus groups and participatory rural appraisal (PRA) tools which were information maps and linkage diagrams, and problem trees. Data addressing a particular research theme are presented together. The study results are presented as verbal descriptions and symbolic representations which included tables and graphs. A total of twelve villages in six districts of Tanzania were surveyed, with two villages studied in each district. These districts included Kilosa (Morogoro Region), Moshi Rural (Kilimanjaro Region), Kasulu (Kigoma Region), Karagwe (Kagera Region), Songea Rural (Ruvuma Region) and Mpwapwa (Dodoma Region). One hundred and eighty one respondents participated in the semi-structured interviews. The respondents ranged between 27 and 37 per district depending on their availability.

A total of twelve focus group sessions were held in 12 villages, where one focus group session was held per village. One hundred and twenty eight respondents participated in the focus groups' discussions. The study participants for focus groups ranged between six and twelve respondents per session depending on their availability. The observation checklist was applied in twelve villages. A total of twenty five officers who were engaged with the management of agricultural knowledge in the surveyed villages were interviewed. Four officers who dealt with IK policy and intellectual property rights issues were interviewed, which included Registration and Licensing Agency (BRELA), Copyrights Society of Tanzania (COSOTA), Tanzania Intellectual Property Service Advisory and Information Centre (TIPSAC), and the National Plant Breeder Registrar at the Ministry of Agriculture and Food Security in Tanzania. The results are organised and presented according to the research objectives that were raised in section 1.5 of Chapter One. The sequence of data presentation is as follows:

1. To identify various types of agricultural indigenous knowledge and to establish the role of indigenous and exogenous knowledge in the farming systems in the local communities;

2. To study the current status of managing agricultural IK in the local communities;

3. To identify the agricultural information and knowledge needs of farmers in the local communities;

4. To determine the role of ICTs in managing agricultural IK in the local communities;

5. To find out how farmers accessed the agricultural exogenous knowledge in the local communities;

6. To identify the role of ICTs in providing access to agricultural exogenous knowledge in the local communities;

7. To assess the approaches that were used to facilitate the integration of agricultural indigenous and exogenous knowledge in the local communities;

8. To investigate the policies and legal frameworks that were relevant for protecting agricultural IK in Tanzania;

9. To determine the barriers that hindered the effective management of agricultural IK and access to exogenous knowledge in the local communities; and

10. To propose a KM model that could be used to manage agricultural IK in the local communities.

5.2 Characteristics of respondents

Despite the fact that respondents' characteristics were not part of the study objectives, it was considered necessary to present these data because the background of the respondents could partly explain the KM related activities in the sample under study. Therefore, the study described the characteristics of the respondents who participated in the semi-structured interviews and focus group discussions in terms of gender, age, education level, ethnicity, occupation and ownership of ICTs in the surveyed districts of Tanzania. The present study sought to include respondents who were actively involved in farming activities. Thus, most of the respondents were relatively middle aged or elderly and had access to ICTs. Most of the characteristics of the respondents are not representative of local communities in Tanzania, and thus the study findings cannot be generalised to all rural communities in Tanzania. In this study, the respondents were categorised into four groups, namely smallholder farmers in individual semi-structured interviews, smallholder farmers in focus groups, knowledge intermediaries and policy makers.

5.2.1 Characteristics of respondents: semi-structured interviews

In the semi-structured interviews, 181 smallholder farmers participated in the study, where 112 were men and 69 were women. The mean age of the respondents was 48. The majority of the respondents were middle aged or elderly, where 38 (21%) were between 26 to 35 years, 38 (21%) were between 36 to 45 years, 31 (17.1%) were between 46 to 55 years, and 36 (19.9%) were between 56 to 65 years. Few respondents, 10 (5.5%) were below 25 years, and 28 (15.5%) respondents were above 66 years. One hundred and fifty two (84%) respondents had some level of formal schooling, where 95 (84.8%) were men and 57 (82.6%) were women. The majority of the respondents 163 (91.2%) could also read and understand simple instructions.

Among those with formal schooling, male respondents dominated the higher education category as compared to female farmers. Male respondents accounted for 75 (62.5%) of those with primary school education, 14 (9.2%) with secondary education, and 5 (3.4%) with higher education (that is, 4 college diplomas and 1 university bachelor degree) as shown in Table 5.1.

Table 5.1: Highest education level by gender for the semi-structured interviews

Formal education	Female		Male		Total	
	No	%	No	%	No	%
Primary education	54	35.5	75	49.3	129	84.9
Secondary education	3	2	14	9.2	17	11.2
Adult education	-	-	1	0.7	1	0.7
Post primary education	-	-	5	3.4	5	3.4

Six districts were selected for the study. Table 5.2 shows the gender, age and literacy levels of the respondents at six research sites. Most of the interviewed respondents were elderly as compared to the youth. The number of females was slightly lower for Songea Rural, Kilosa, Mpwapwa, and Karagwe. The literacy levels (ability to read and write) were quite high at 163 (91.2%) at all research sites.

Table 5.2: Gender, age and literacy levels of the respondents in the semi-structured interviews

Demographic data	Districts						
	Mpwapwa	**Karagwe**	**Kasulu**	**Moshi Rural**	**Kilosa**	**Songea Rural**	**Total**
Respondents interviewed	30 (16.6%)	30 (16.6%)	27 (14.9%)	28 (15.5%)	37 (20.4%)	29 (16%)	181
Mean age	50	41	44	53	52	49	48
Female: Male ratio	10 (5.5%): 20 (11%)	11 (6.1%): 19 (10.5%)	12 (6.6%): 15 (8.3%)	14 (7.7%): 14 (7.7%)	14 (7.7%): 23 (12.7%)	8 (10.5%): 21 (5.5%)	112 (55.8%): 69 (44.2%)
Literacy: illiteracy level	29 (16%): 1 (0.6%)	27 (14.9%): 3 (1.7%)	23 (12.7%): 4 (2.2%)	28 (15.5%)	28 (15.5%): 9 (5%)	28 (15.5%): 1 (0.6%)	163 (90.1%): 18 (9.9%)

Figure 5.1 shows the distribution of ethnic groups for each district. The findings show that Moshi Rural and Kasulu districts were dominated by the Wachagga, 28 (100%) and Wamuha, 27 (100%) tribes respectively. Almost all respondents in Songea Rural district belonged to the Wabena tribe 28 (96.6%), while Karagwe district was dominated by the Wanyambo tribe 23 (76.7%), and Mpwapwa by the Wagogo tribe 19 (63.3%). Multiple numbers of the various ethnic groups were mainly found in Kilosa, followed by Mpwapwa and Karagwe.
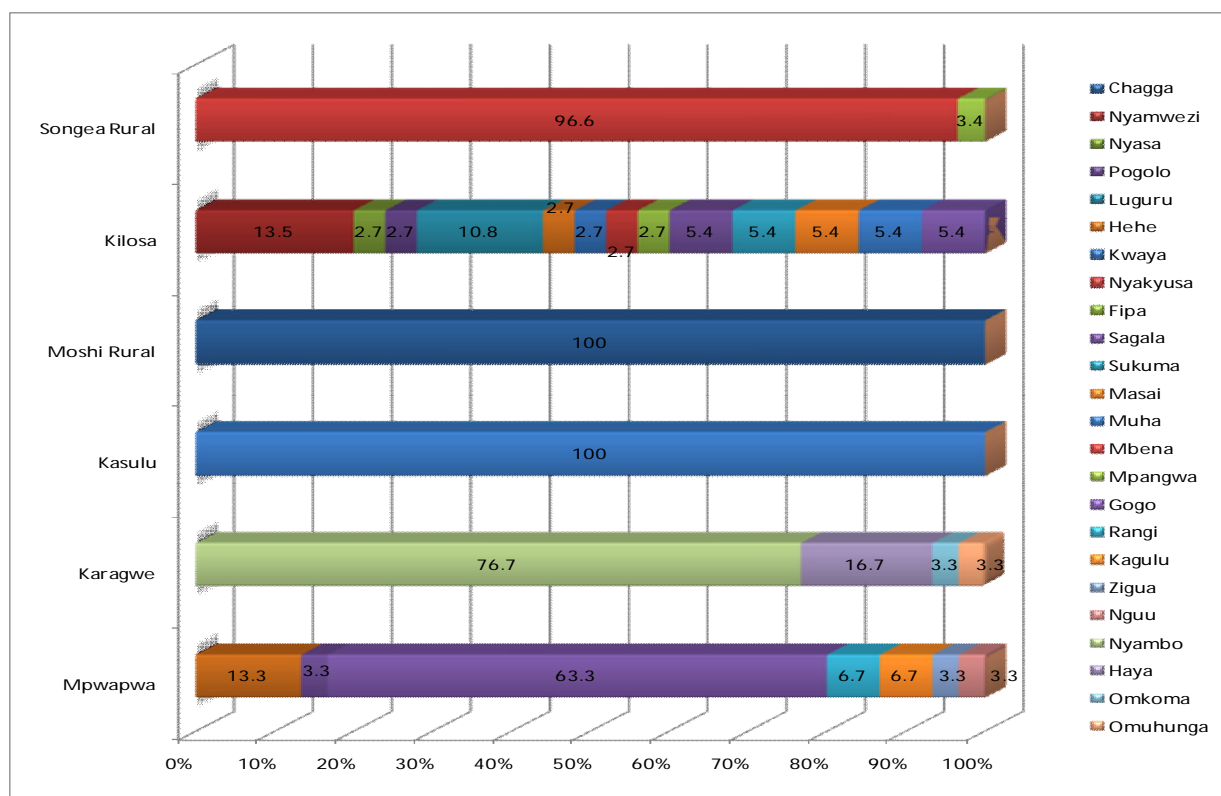
Figure 5.1: Ethnic groups for each district (N=181)

5.2.1.1 The occupation of the respondents

The majority of the respondents 168 (92.9%) were involved with crop farming, while 146 (80.2%) were engaged in livestock keeping. Among those crop farmers and livestock keepers, 133 (73.5%) respondents were engaged in mixed farming.

5.2.1.1.1 Crop production

The respondents who were involved in crop farming 168 (92.9% of total of 181 respondents) were asked to provide details of their farm sizes, agricultural tools, and purpose of conducting crop farming. The study findings indicated that small scale agriculture was predominant throughout the surveyed districts, where the average farm size was 4.9 acres. Of 168 crop farmers, sixty (35.7%) respondents had farm sizes below 2.9 acres, and 44 (26.2%) respondents had farm sizes between 3.0 and 4.9 acres. Fifty six (23.8%) respondents had farm sizes between 5.0 and 14.9 acres, followed by eight (4.8%) respondents, with farm sizes above 15.0 acres. Most of the respondents used more than one type of implements to cultivate their crops, where 156

(92.9%) used handheld implements, 14 (8.3%) used oxen-drawn plows and 8 (4.8%) used mechanical traction.

Those respondents 168 (92.9%) who were engaged in crop farming were asked to state their crop enterprises. Table 5.3 indicates the crops that were grown in the six districts.

Table 5.3: Crop production across the surveyed districts (N=168)

Crop enterprises	Districts												
	Mpwapwa		Karagwe		Kasulu		Moshi Rural		Kilosa		Songea Rural		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Maize	28	16.7	28	16.7	25	14.9	27	16.1	24	14.3	29	17.3	161	95.8
Rice	-	-	-	-	1	0.6	-	-	17	10.1	-	-	18	10.7
Cow pea	3	1.8	2	1.2	-	-	-	-	-	-	-	-	5	3
Beans	3	1.8	30	17.9	24	14.3	27	16.1	-	-	28	16.7	112	66.7
Sesame	2	1.2	-	-	-	-	1	0.6	6	3.6	-	-	9	5.4
Vegetables	4	2.4	1	0.6	10	6.0	27	16.1	3	1.8	1	0.6	46	27.4
Banana	1	0.6	24	14.3	13	7.7	28	16.7	5	3.0	8	4.8	79	47
Coffee	-	-	22	13.1	-	-	25	14.9	-	-	9	5.4	56	33.3
Yams	-	-	-	-	-	-	22	13.1	-	-	-	-	22	13.1
Irish potatoes	-	-	1	0.6	-	-	4	2.4	-	-	-	-	5	3
Sweet potatoes	7	4.2	-	-	3	1.8	2	1.2	2	1.2	-	-	14	8.3
Sugar cane	-	-	1	0.6	5	3.0	5	3.0	1	0.6	-	-	12	7.1
Peas	-	-	1	0.6	6	3.6	-	-	2	1.2	1	0.6	10	6
Groundnuts	24	14.3	5	3.0	7	4.2	-	-	5	3	9	5.4	50	29.8
Cassava	4	2.4	5	3.0	18	10.7	-	-	6	3.6			33	19.6
Sunflowers	20	11.9	-	-	-	-	-	-	-	-	1	0.6	21	12.5
Sorghum	25	14.9	2	1.2	-	-	-	-	-	-	-	-	27	16.1
Bambara[2]	2	1.2	-	-	-	-	-	-	-	-	-	-	2	1.2
Pearl millet	5	3.0	-	-	-	-	-	-	-	-	-	-	5	3

When asked to mention the purpose of practicing crop production, food security with 167 (99.4%) respondents, was the most important criterion for practicing crop production, followed by income generation 138 (82.1%). Other purposes of practicing crop farming were to improve soil fertility through the use of manure 130 (77.4%), to conserve soil moisture 52 (31%), to

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[2] Groundnut indigenous varieties

provide livestock feeds 29 (17.3%), human medicine 18 (10.7%), animal medicine 16 (9.5%), fuel 8 (4.8%), and to produce the raw materials for making ornaments 6 (3.6%).

5.2.1.1.2 Livestock management

Those respondents 146 (80.2%) who were engaged in livestock keeping were asked to state their livestock enterprises. Table 5.4 indicates that most farmers kept poultry in the surveyed communities, which included 33 (22.6%) in Kilosa, 25 (17.1%) in Moshi Rural, 18 (12.3%) in Mpwapwa, 17 (11.6%) in Songea Rural, 14 (9.6%) in Kasulu, and 12 (8.2%) in Karagwe. Goats, cattle and pigs were also important animal species in all districts, while sheep was mainly domesticated in Songea Rural, and donkeys were principally kept in Kilosa. Other animal species were domesticated at low rates which included rabbits, guineafowl, pigeons, and fish.

Table 5.4: Livestock management per surveyed districts (N=146)

| | Districts | | | | | | | | | | | | | |
| | Mpwapwa | | Karagwe | | Kasulu | | Moshi Rural | | Kilosa | | Songea Rural | | Total | |
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Cattle	5	3.4	11	7.5	7	4.8	27	18.5	14	9.6	3	2.1	67	45.9
Goats	11	7.5	12	8.2	11	7.5	15	10.3	14	9.6	6	4.1	69	47.3
Sheep	1	0.7	4	2.7	1	0.7	9	6.2	13	8.9	-	-	28	19.2
Poultry	18	12.3	12	8.2	14	9.6	25	17.1	33	22.6	17	11.6	119	81.5
Pigs	2	1.4	1	0.7	7	4.8	7	4.8	4	2.7	18	12.3	39	26.7
Donkeys	3	2.1	-	-	-	-	-	-	8	5.5	-	-	11	7.5

When the respondents 146 (80.2%) were asked to state the size of their livestock herds, one hundred and twenty (82.2%) responded to this question, while 26 (17.8%) did not. Table 5.5 indicates that the average size of livestock herds per farm was between three and six, with a score of 30 (47.6%) for goats, 14 (43.8%) for pigs and 27 (31.8%) for poultry.

Table 5.5: Size of livestock herds (N=120)

Herd size	Animals											
	Cattle		Goats		Sheep		Poultry		Pigs		Donkeys	
	No	%	No	%	No	%	No	%	No	%	No	%
1-2	28	46.7	11	17.5	9	36	6	7.1	13	40.6	3	50
3-6	14	23.3	30	47.6	5	20	27	31.8	14	43.8	2	33.3
7-10	2	3.3	5	7.9	4	16	23	27.1	2	6.3	1	16.7
11-20	5	8.3	12	19.0	4	16	19	22.4	2	6.3	-	-
21-40	3	5.0	3	4.8	2	8	10	11.8	-	-	-	-
41-60	3	5.0	1	1.6	-	-	-	-	1	3.1	-	-
61-500	5	8.3	1	1.6	1	4.0	-	-	-	-	-	-
Total	**60**	**100**	**63**	**100**	**25**	**100**	**85**	**100**	**32**	**100**	**6**	**100**

(Multiple responses were possible)

Those respondents 146 (80.2%) who were engaged in animal farming were asked to state the purpose of keeping livestock. Income earning with respondents 132 (90.4%) was the most important criterion for ranking livestock keeping, followed by food security 110 (75.3%) and manure to increase soil fertility 66 (45.2%). Domesticated animals were rarely used for transport 10 (6.8%), human medicine 7 (4.8%), farming 4 (2.7%), and plant medicine purposes 1 (0.7%).

5.2.1.1.3 Role of gender in farming activities

Assessing the role of gender in the farming activities was important since through their daily work, rural farmers possess a unique decision-making role and accumulate knowledge of their ecosystems, including the management of their crops and farm animals. The respondents were asked to mention their labour arrangements in the farming system, and if there were any differences on gender roles in the farming systems. Most agricultural activities were carried out by the family 92 (50.8%), followed by hired labour 67 (37%), and both family labour and hired labour 22 (12.2%).

The respondents were asked to explain if there were any differences between the roles of men and women in the farming activities. More than half of the respondents 115 (63.5%) indicated that there were no differences, while 66 (36.5%) reported that there were differences. When farmers were asked to describe various roles that women and men undertook in their farming activities, women were found to undertake most of the farming activities as compared to men although nearly two thirds of the interviewed respondents were male. For instance, in Moshi

Rural district, women were mainly involved in household chores, farming, livestock feeds, and removal of manure from animal houses, while men were involved in cutting firewood and trees, supervising hired labour in crop farming, and animal husbandry activities. In Kilosa (Twatwatwa Village), men were involved in grazing animals, animal disease treatment and guarding the family, while women were involved with housekeeping, the management of calves and poultry, and milking. In Songea Rural, both men and women were engaged in farming activities, however harvesting was a female occupation. In Mpwapwa, a large percentage of the farming was done by women as compared to men. In Karagwe, men were involved with grazing animals, while women were engaged in crop farming and household activities. Lastly, in Kasulu, both men and women were involved in crop farming, but animal farming was a male occupation.

5.2.1.1.4 Marketing of agricultural produce

The study sought to establish the places where farmers sold their produce. Most of the respondents sold their agricultural produce in the village market 80 (44.2%), and to the middlemen 78 (43.1%). Cooperative unions, district markets, farmers' houses and district markets were important places where farmers sold their produces, with a score of 50 (27.6%), 36 (19.9%), 28 (15.5%), and 11 (6.1%) respondents respectively. Few farmers sold their produce in shops 4 (2.2%), hotels 4 (2.2%), or to NGOs 1 (0.6%).

5.2.1.2 ICT ownership

This study attempted to establish whether farmers owned ICTs in order to determine the extent to which ICTs were used to manage IK and provide access to exogenous agricultural knowledge. The respondents were asked to provide details of the ICTs they owned, and to indicate if they went to places other than their homes to access ICTs, as well as the distance that they had to travel to access those ICTs.

One hundred and sixty eight (92.8%) acknowledged that they owned ICTs, while 13 (7.2%) did not. Table 5.6 indicates that radio was the predominant form of ICT owned by farmers, with a score of 31 (18.5%) in Kilosa, 28 (16.7%) in Moshi Rural, 28 (16.7%) in Mpwapwa, 27 (16.1%) in Songea Rural, 26 (15.5%) in Karagwe, and 24 (14.3%) in Kasulu. The next most owned form of ICT was a cell phone, while video cassettes were the least owned ICT. Farmers in Kasulu and Songea rural did not own television sets due to a lack of electricity.

Table 5.6: ICT ownership (N=168)

ICTs	Districts													
	Mpwapwa		Karagwe		Kasulu		Moshi Rural		Kilosa		Songea Rural		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Radio	28	16.7	26	15.5	24	14.3	28	16.7	31	18.5	27	16.1	164	97.6
Audio cassettes	5	3.0	5	3.0	-	-	4	2.4	3	1.8	8	4.8	25	14.9
Television	3	1.8	5	3.0	-	-	7	4.2	4	2.4	-	-	19	11.3
Video cassettes	2	1.2	3	1.8	-	-	1	0.6	1	0.6	-	-	7	4.2
Cell phones	13	7.7	7	4.2	5	3.0	18	10.7	19	11.3	14	8.3	76	45.2
Computers	-	-	-	-	-	-	-	-	-	-	-	-	-	-

There were very small differences in the ownership of ICTs by gender. However, there were variations on the ICT ownership by age (See Figure 5.2). ICTs were owned by young farmers aged between 26 and 36 years as compared to elderly farmers. The frequencies of young farmers' ownership of ICTs was 36 (22%) for radio, 20 (26.3%) for cell phones, and 7 (36.8%) for television. The elderly farmers aged above 66 years mainly relied on radio and cell phones.
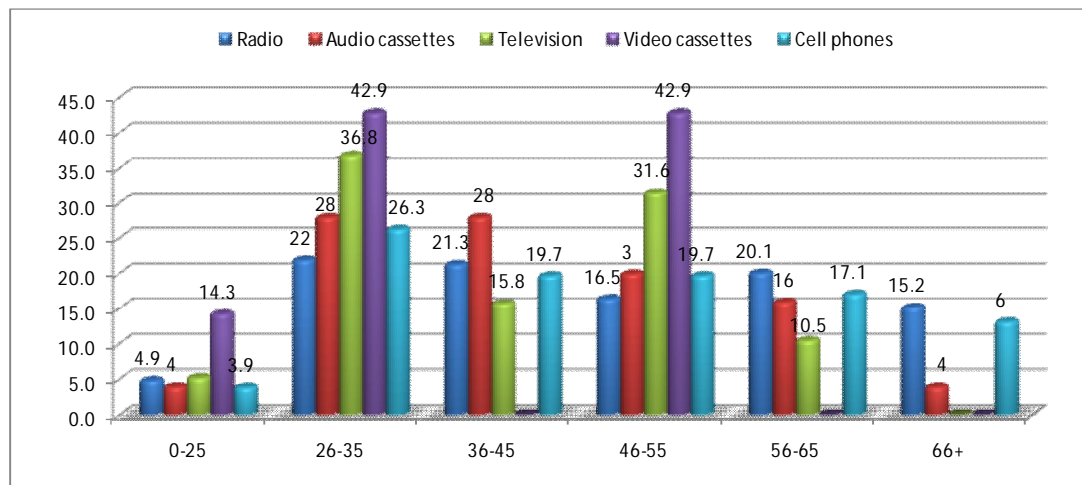
Figure 5.2: ICT ownership by age (N=168)

The respondents were asked to indicate if they accessed ICTs from other places other than their homes. One hundred and nine (60.2%) replied affirmatively that they accessed ICTs from places other than their homes, while 72 (39.8%) did not. When the 109 (60.2%) respondents were asked to indicate those ICTs, the majority of respondents 84 (77.1%) accessed television outside their homes. Other major ICTs that were accessed from elsewhere were cell phone 30 (27.5%), video cassette 12 (11%), e-mail 13 (11.9%), radio 10 (9.2%), film shows 8 (7.3%), internet 8 (7.3%),

and personal computer 5 (4.6%). The least cited ICTs in this regard were audio cassettes 4 (3.7%), landline telephones 3 (2.8%), and CDs 2 (1.8%). Personal computers were not only used for internet and email services, but also for secretarial services such as for typing farmer group's reports. Two farmers also used cell phones to access internet in Moshi Rural District.

The 109 (60.2%) respondents who accessed ICTs from places other than their homes were asked to indicate the location of those ICTs in relation to where they stayed. Table 5.7 depicts that most of the ICT tools were located within one kilometre of their home.

Table 5.7: The ICTs and the distance that farmers had to travel to access ICTs (N = 109)

ICT	Within one km		2 - 5 km		6 - 10 km		More than 11 km	
	No	%	No	%	No	%	No	%
Radio (n=10)	8	80	1	10	-	-	1	10
Television (n=84)	67	79.8	12	14.3	1	1.2	4	4.8
Cell phones (n=30)	29	96.7	1	3.3	-	-	-	-
Audio cassettes (n=4)	3	75	1	25	-	-	-	-
Video cassettes (n=12)	6	50	5	41.7	1	8.3	-	-
Personal Computers (n=18)	8	44.4	5	27.8	1	5.6	4	22.2
Film shows (n=8)	4	50	3	37.5	-	-	1	12.5
E-mail (n=13)	6	46.2	3	23.1	1	7.7	3	23.1
Internet (n=8)	4	50	-	-	1	12.5	3	37.5
Land-line phones (n=3)	3	100	-	-	-	-	-	-
CDROM (n=2)	1	50	-	-	-	-	1	50

(Multiple responses were possible)

5.2.2   Characteristics of respondents: focus groups discussions

One hundred and twenty eight smallholder farmers participated in the focus group discussions, where 65 (50.8%) were male, and 63 (49.2%) were female. A total of twelve focus groups were held in 12 villages. One focus group session was held per village. The study participants for focus groups' discussions ranged between six and twelve respondents per session depending on their availability. The mean age of the respondents was 45. Almost half of the respondents 62 (48.4%) were between 29 to 48 years, while 38 (29.7%) respondents were between 49 to 68 years, 8 (6.3%) respondents were above 69 years, and 20 (15.6%) were between 19 and 28 years. One hundred and fourteen (89.1%) respondents had some level of formal schooling and 116 (90.7%) could read and understand simple instructions. Among those 114 (89.1%) respondents

with formal schooling, male respondents accounted for 48 (41.4%) of those with primary school education, 10 (8.6%) with secondary education, two (1.7%) with post-secondary education, and one (0.9%) with adult education as indicated in Table 5.8.

Table 5.8: Highest education level by gender for the focus group discussions

Highest education level	Gender					
	Female		Male		Total	
	No	%	No	%	No	%
Primary education	51	44.0	48	41.4	99	85.3
Post-secondary education	-	-	2	1.7	2	1.7
Secondary education	3	2.6	10	8.6	13	11.2
Adult education	1	0.9	1	0.9	2	1.7
Total	55	47.4	61	52.6	116	100

Table 5.9 indicates that male respondents dominated the focus group discussions held in Karagwe 15 (11.7%), Moshi Rural 7 (5.5%) and Kilosa 14 (10.9%), while the majority of women attended the discussions held in Kasulu 15 (11.7%) and Songea Rural 11 (8.6%).

Table 5.9: Gender, age and literacy levels of the respondents in the focus groups' discussions

Demographic data	Mpwapwa	Karagwe	Kasulu	Moshi Rural	Kilosa	Songea Rural	Total
Respondents interviewed	24 (18.8%)	23 (18%)	23 (18%)	13 (10.2%)	24 (18.8%)	21 (16.4%)	128 (100%)
Respondents per focus group discussion in each village	Vinghawe 12 (9.4%) Mazae 12 (9.4%)	Katwe 12 (9.4%) Iteera 11 (8.6%)	Nyansha 12 (9.4%) Kidyama 11 (8.6%)	Lyasongoro 6 (4.7%) Mshiri 7 (5.5%)	Kasiki 12 (9.4%) Twatwatwa 12 (9.4%)	Materereka 11 (8.6%) Lilondo 10 (7.8%)	128 (100%)
Mean age	47	39	37	50	47	52	45
Male: female ratio	11 (8.6%): 13 (10.2%)	15 (11.7%): 8 (6.3%)	8 (6.3%): 15 (11.7%)	7 (5.5%): 6 (4.7%)	14 (10.9%): 10 (7.8%)	10 (7.8%): 11 (8.6%)	65 (50.8%): 63 (49.2%)
Literacy: illiteracy level	22 (17.2%): 2 (1.6%)	23 (18%)	19 (14.8%): 4 (3.1%)	13 (10.2%)	19 (14.8%): 5 (3.9%)	20 (15.6%): 1 (0.8%)	116 (90.6%): 12 (9.4%)

5.2.3 Characteristics of respondents: knowledge intermediaries

Twenty five knowledge intermediaries participated in the study, where 13 (52%) were female and 12 (48%) were male. The mean age of the respondents was 43. The majority of the

respondents 21 (84%) were between 29 – 58 years, while two (8%) respondents were above 59 years, and two (8%) respondents were below 28 years. Eight (32%) respondents had completed a college diploma, followed by five (20%) respondents with a secondary education, four (16%) respondents with a university bachelor's degree, four (16%) respondents with college certificates, and one (4%) respondent with a PhD. Eight (32%) respondents were telecentre managers, followed by Non Governmental Organisations (NGOs) officers, agro-based input suppliers, and public extension officers, with a score of four (16%) respondents each. There was a low number of officers from agricultural research institutes, two (8%), community radio, two (8%), cooperative unions, one (4%), and library, one (4%).

5.3 Various types of agricultural indigenous knowledge and the role of indigenous and exogenous knowledge in the farming systems

The first objective of the study was to identify various types of agricultural IK and to establish the role of indigenous and exogenous knowledge in the farming systems in the local communities. Data to address this objective were collected in three ways: individual semi-structured interviews, focus group discussions and non-participant observation. The following indicators were used to identify various types of agricultural IK, and to assess the extent to which indigenous and exogenous knowledge was applied in the farming systems, which included: soil fertility, planting materials, crop husbandry practices, crop preservation, control of plant diseases, pests and predators, medicinal plants, animal husbandry practices, and animal diseases control.

5.3.1 Soil fertility

An inquiry as to whether 168 (92.9%) respondents who were engaged in crop farming were using any technique to improve their soil fertility indicated that most of the respondents 164 (97.6%) used various methods to improve their soil fertility. Most of the respondents used manure 95 (57.9%) to improve their soil quality, followed by crop rotation practices 73 (44.5%), use of crop residues 58 (35.4%), and organic materials 52 (31.7%) as depicted in Figure 5.3. The least used methods were planting nitrogen fixing crops 14 (8.5%) and leaving land in long-term fallowing 4 (2.4%). Other techniques were deep tillage, mulching and cultivating at the valley bottoms.

The results from focus group discussions confirmed that traditional soil fertility maintenance approaches were the dominant methods used by farmers to rejuvenate the soil. Those approaches included animal manure, and tree and crop residues. Other major methods were crop rotation practices, use of mineral fertilizers, cultivation of nitrogen-fixing crops, short-term fallowing, use of ash and organic materials. However, few farmers used mineral fertilizers because they were either sold at high costs or they were not available in the surveyed communities. Long-term fallowing was also practiced at a low rate due to population pressure and the demand of land for other purposes, such as investment for large scale farming or tourism. For instance, the Kasiki Village focus group in Kilosa District indicated that long-term fallowing was not practiced in their village because most of the fertile land was used for large scale farming.
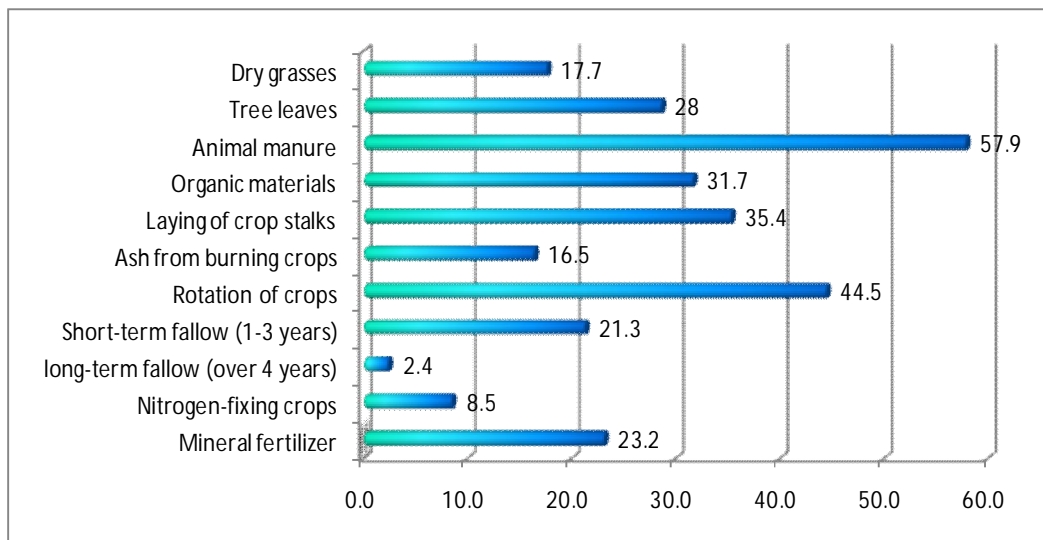
Figure 5.3: The methods used by farmers to improve the quality of soil (N= 164)

Various indicators were also used to determine changes of soil quality. Low crop yield and poor crop growth were the main indicators used by interviewed respondents to determine changes in soil fertility. Other indicators which are arranged in descending order of importance included:

- Poor growth of weeds;
- Changes of crop colour. For example, farmers in Moshi Rural, Kilosa and Mpwapwa districts determined changes in soil fertility when maize leaves developed a yellow colour;

- Layers of rotten grasses; and occurrence of certain plant species. For instance, one farmer at Nyansha Village in Kasulu reported that, "the occurrence of certain grass species known as *bichanda* in my plot show that the soil fertility has declined";

- Presence of compact soil and soil erosion; and

- Some farmers used their common sense, experiences and trial and error to evaluate soil fertility.

These findings were confirmed by data collected using focus group discussions which established that low crop yield was the main indicator used by farmers to determine changes of soil fertility. Other major indicators were poor crop growth, the occurrence of certain plants and poor weed growth. For instance, the occurrence of grasses with yellow flowers showed that soil fertility had declined at Kasiki Village in Kilosa.

5.3.2 Planting materials

The respondents were asked to provide details on the acquisition and preservation of planting materials, and techniques they preferred for preserving their planting materials.

5.3.2.1 Acquisition of planting materials

The respondents 168 (92.9%) who were engaged in crop farming were asked to state methods used to acquire planting materials in their local communities. Table 5.10 indicates that planting materials were mainly obtained through preserved seeds from the previous season, accounting for 100 (62.1% of the 161 who farmed maize), 97 (86.6% of the 112 who farmed beans), 43 (86% of the 50 who farmed groundnuts), 22 (81.5% of the 27 who farmed sorghum), 14 (66.7% of the 21 who farmed sunflowers), 12 (21.4% of the 56 who farmed coffee), and 11 (23.9% of the 46 who farmed vegetables). Other major methods of obtaining planting materials included purchasing of these materials, use of own root suckers, and borrowing planting materials from other farmers, while seedlings and cuttings were less used. Other means of obtaining planting materials were through extension officers and the collection of maize spills from the markets.

It was evident from the focus group discussions that the planting materials were mainly procured locally, often derived from seeds and germplasms that had been selected and preserved by

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farmers. Farmers mainly selected the best looking seeds (that is, maize, beans, groundnuts, sorghum) from the previous season and preserved them. Cassava, bananas, sweet potatoes and sugar cane planting materials were obtained through cuttings and root suckers. Farmers used to cultivate their own seedlings for coffee, while planting materials for banana, sweet potato, sugar cane and cassava were exchanged among farmers. On the other hand, rice seeds were always bought from input suppliers, while other seeds such as maize, sesame, groundnuts and sunflower were bought from the same suppliers but less often.

Table 5.10: The crop enterprises and the methods used by farmers to acquire planting materials (N=168)

Crop enterprises	Methods												
	Actual number of farmers per crop	Preserved		Purchase		Fellow farmer		Own seedlings		Own suckers		Own cuttings	
	No	No	%	No	%	No	%	No	%	No	%	No	%
Maize	(161)	100	62.1	84	52.2	1	0.6	-	-	-	-	-	-
Rice	(18)	10	55.6	10	55.6	-	-	1	5.6	-	-	-	-
Cowpea	(5)	4	80	1	20.0	-	-	-	-	-	-	-	-
Beans	(112)	97	86.6	16	14.3	1	0.9	-	-	-	-	-	-
Sesame	(9)	6	66.7	6	66.7	-	-	-	-	-	-	-	-
Vegetables	(46)	11	23.9	19	41.3	-	-	-	-	-	-	-	-
Irish potatoes	(5)	1	20.0	1	20.0	2	40.0	-	-	2	40.0	-	-
Groundnuts	(50)	43	86.0	11	22.0	2	4.0	-	-	-	-	-	-
Cassava	(33)	3	9.1	2	6.1	7	21.2	-	-	9	27.3	15	45.5
Sunflowers	(21)	14	66.7	12	57.1	-	-	-	-	-	-	-	-
Sorghum	(27)	22	81.5	7	25.9	1	3.7	-	-	-	-	-	-
Peas	(10)	8	80.0	3	30.0	-	-	-	-	-	-	-	-
Bananas	(79)	-	-	-	-	3	3.8	-	-	68	86.1	-	-
Coffee	(56)	12	21.4	16	28.6	1	1.8	19	33.9	1	1.8	-	-
Yams	(22)	-	-	-	-	3	13.6	-	-	16	72.7	-	-
Sugar cane	(12)	-	-	1	8.3	-	-	1	8.3	6	50.0	2	16.7
Pearl millets	(5)	3	60.0	1	20.0	-	-	-	-	-	-	-	-
Sweet potatoes	(14)	4	28.6	-	-	1	7.1	-	-	2	14.3	4	28.6

(Multiple responses were possible)

5.3.2.2 Preservation of planting materials

The methods for preserving seeds in the communities were classified in the following categories:

- Exogenous techniques

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- o Conventional facilities: Included use of non-traditional storage facilities such as sacks, drums, gallons, plastic and tin containers for preserving planting materials;
  - o Conventional inputs: Included use of synthetic chemicals such as pesticides to prevent, destroy, repel or mitigate pests;
- Indigenous techniques
  - o Traditional facilities: Included use of facilities that were locally made in the local communities for preserving plant materials such as basket, clay pot, and granaries that were located outside or within farmers houses or over the hearth;
  - o Local herbs: Included use of botanical pesticides which were extracted from various plant parts (stems, seeds, roots, leaves and barks) of different plant species; and
  - o Cultural inputs and practices: Included use of locally available inputs (such as burnt goat dung, cattle dung, kitchen ash, anthill soil), and cultural practices (such as some crops were left in the soil, and selected cobs were hung over a tree) for preserving planting materials.

Table 5.11 shows that most farmers used conventional facilities for preserving their planting materials in the surveyed districts, which included 84 (52.2% of the 161 who farmed maize), 87 (77.7% of the 112 who farmed beans), 36 (72% of the 50 who farmed groundnuts), 11 (40.7% of the 27 who farmed sorghum), 12 (66.7% of the 18 who farmed rice), and 12 (57.1% of the 21 who farmed sunflowers). Other major methods were synthetic insecticides, traditional facilities, local herbs and cultural inputs and practices. Both local and conventional inputs, and both conventional and traditional facilities were less used.

While conventional inputs were important for preserving planting materials in the surveyed districts, local herbs and cultural inputs and techniques also played a key role in preserving these materials across the districts. The application of local herbs and cultural inputs and practices varied across the districts. With regard to local herbs, farmers mainly used similar plant parts from particular species such as leaves, roots, bark and husks. Most farmers used chilli pepper (*capsicum annum*) and neem which is called as "mwarobaini" in Swahili (*Azadirachta indica*) plant parts to preserve their planting materials across the districts.

Table 5.11: The crop enterprises and the methods used by farmers to preserve their planting materials (N=168)

Crop enterprises	Actual number of farmers per crop	Conventional facilities		Local herbs		Conventional inputs		Traditional facilities		Cultural inputs & practices		Local & conventional input		Conventional & traditional facilities	
	No	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Maize	(161)	84	52.2	12	7.5	32	19.9	25	15.5	9	5.6	3	1.9	5	3.1
Rice	(18)	12	66.7	-	-	-	-	-	-	-	-	-	-	-	-
Cow pea	(5)	2	40.0	-	-	-	-	-	-	1	20.0	-	-	-	-
Beans	(112)	87	77.7	14	12.5	27	24.1	5	4.5	3	2.7	2	1.8	2	1.8
Sesame	(9)	6	66.7	-	-	1	11.1	-	-	-	-	-	-	-	-
Vegetables	(46)	5	10.9	-	-	-	-	3	6.5	1	2.2	-	-	2	4.3
Coffee	(56)	5	8.9	-	-	-	-	1	1.8			-	-	-	-
Sweet potatoes	(14)	-	-	-	-	-	-	1	7.1	3	21.4	-	-	-	-
Peas	(10)	6	60.0	2	20.0	2	20.0	2	20.0	-	-	-	-	-	-
Groundnuts	(50)	36	72.0	-	-	1	2.0	8	16.0	-	-	-	-	1	2.0
Cassava	(33)	-	-	-	-	-	-	1	3.0	3	9.1	-	-	-	-
Sunflowers	(21)	12	57.1	-	-	-	-	-	-	-	-	-	-	-	-
Sorghum	(27)	11	40.7	6	22.2	2	7.4	7	25.9	2	7.4	1	3.7	4	14.8
Pearl millets	(5)	4	80.0	1	20.0	-	-	1	20.0	-	-	-	-	-	-

(Multiple responses were possible)

Further, the findings showed that similar local inputs (such as chilli pepper, and neem) were used in various districts to preserve the same planting materials. For instance, chilli pepper was used to preserve maize seeds in Moshi Rural and Kasulu, and bean seeds in Moshi Rural and Kasulu. Neem was used to preserve maize seeds in Mpwapwa and Songea Rural. The use of local herbs and cultural inputs and practices across the surveyed districts is described in the following text.

For maize seeds, Moshi Rural's farmers mixed their best seeds with a variety of local herbs, such as chilli pepper only, or a mixture of chilli pepper and leaves of *mabangi mwitu* or African marigold (*Tagetes erecta*) and stored the seeds in a closed drum or tank. In Karagwe, farmers mixed maize seeds with *masaka* tree leaves, or ash from *kajashi* plant and put the seeds in a sack or granaries which were located outside their houses. In Mpwapwa, farmers mixed maize seeds with ground neem leaves, or *msakasaka* (*Rhus natalensis)* tree leaves, or with a concoction of burnt goat dung and maize cob ash. These seeds were then stored in polythene bags or granaries which were located outside farmers' houses. In the same district, roots of a tree known as *mkunguni* (*Salvadora persica)* were put at the bottom and the middle of granaries which were filled with maize grains to preserve maize seeds. In Kasulu, farmers mixed maize seeds with chilli pepper, or a mixture of *mshindwi* (*Anisophyllea pomifera*) tree ash and chilli pepper, or a mixture of any tree ash and chilli pepper, and the mixture was put in a sack. In Songea Rural, maize seeds were mixed with ground neem tree leaves and they were put in polythene bags.

For bean seeds, farmers in Moshi Rural selected the best seeds, and mixed them with either a mixture of chilli pepper and wild tobacco (*Nicotiana tabacum*), or a concoction of chilli pepper and *mabangi mwitu* leaves, or a mixture of *urutupa* or alcohol tree and *mabangi mwitu* plant leaves, or chilli pepper only, or a mixture of *mfifina* (*Commiphora zimmermannii Engl*) tree leaves and chilli pepper and stored the seeds in a closed drum. In Karagwe, farmers mixed bean seeds with either chilli pepper, or a mixture of *kajai* and *msonobali* (*Senna siamea*) tree leaves and put the mixture in sacks or granaries which were located outside their houses. In Kasulu, farmers mixed bean seeds with either chilli pepper, or *teletele* tree dust, or *mshindwi* tree ash, or a mixture of chilli pepper and *mshindwi* tree ash, or a mixture of chilli pepper and ash from any type of tree and put the mixture in sisal bags or polythene bags.

For preserving peas seeds, Kasulu farmers' mixed chilli pepper *(capsicum annum)* and ash from any type of tree with peas seeds and put the mixture in sacks. In addition, farmers mixed sorghum seeds with *msakasaka* tree leaves, or a mixture of ash from pearl millet and groundnut leaves, and stored the seeds in granaries which were located outside their houses in Mpwapwa. In the same district, sorghum seeds were mixed with ground neem tree leaves, or *mkunguni* tree ash and the seeds were stored in polythene bags. For pearl millets production in Mpwapwa, farmers selected the best seeds from harvests and mixed them with a mixture of ash from pearl millet and groundnut leaves and stored the mixture in granaries.

Farmers had extensive base of knowledge on the cultural inputs and practices that they used for preserving their planting materials. For instance, kitchen ash was mixed with bean seeds in Moshi Rural and Mpwapwa, maize seeds in Kilosa and Karagwe, and peas and sorghum seeds in Mpwapwa for storage purposes. Sorghum seeds were stored in the bags together with their bran without winnowing in Mpwapwa. Anthill soil was mixed with bean seeds for storage purposes in Karagwe. Burnt goat dung and maize cob ash were mixed with maize or sorghum seeds for storage purposes in Mpwapwa. Selected maize cobs were hung over trees in Mpwapwa, Karagwe and Kasulu. Selected planting materials for cowpea, cassava, sweet potato and vegetable were left in the ground for preservation purpose in Mpwapwa. Kilosa farmers' also left sweet potatoes and cassava in the ground for storage purposes.

Granaries that were situated over the hearth were used to preserve vegetables in Moshi Rural, and maize seeds in Mpwapwa, Karagwe, Moshi Rural, Kilosa and Kasulu Districts. On the other hand, granaries that were situated inside farmers' houses were used to store maize seeds in Mpwapwa, and bean and unshelled groundnut seeds in Songea Rural. Further, granaries that were located outside farmers' houses were used to store bean seeds in Karagwe, and maize seeds in Karagwe, Mpwapwa and Kasulu. Farmers in Kasulu and Karagwe had two types of granaries that were located outside their houses. The first type was called *Kichanja* in Swahili or locally called *yinza* which was open at the top to expose maize cobs and sorghum heads to sunlight to enhance drying. The second type was locally called *kihenge* which was fully closed. In Kasulu, these granaries were used to store hulled maize, peas, cassava, unshelled groundnut and sweet

potato. These granaries (*kilindo*) were also used to store vegetable, sorghum, pearl millet and unshelled groundnut seeds in Mpwapwa.

These findings were confirmed by data collected using the focus group discussions. The data indicated that most farmers used conventional facilities to preserve planting materials in the surveyed districts. Other major methods that were used to preserve planting materials included both local and conventional methods (medicine, facilities and practices), and local herbs and cultural inputs and practices. Local herbs that emerged from the focus group discussions that were not mentioned in the interviews included the following: burnt rice ash was mixed with maize seeds for storage purposes in Kilosa. In Karagwe, a mixture of ground tree leaves of *kaswagala* and *kajai* was used to preserve maize seeds, while *mluku* tree leaves was used store maize and bean seeds during the evening, since sunlight could reduce its power. Various cultural inputs and techniques were used by farmers to preserve maize, bean and sorghum seeds. For instance, ash was used to preserve maize and bean seeds in Karagwe, Songea Rural and Kilosa. Ash was also applied to preserve maize seeds in Mpwapwa and sorghum seeds in Karagwe. In Karagwe, farmers used either dry cattle dung, or clay soil, or a mixture of ash and cattle dry dung to preserve maize or bean seeds. The mixture of ash and cattle dry dung was also used to preserve sorghum in the same district. Granaries that were situated outside the farmers' houses were also used to preserve bean and groundnut seeds in Songea Rural.

5.3.2.3 Methods preferred by farmers to preserve their planting materials

The 168 (92.9%) respondents who were engaged in crop farming activities were asked to indicate their preferred technique for preserving planting materials. Seventy (41.7%) respondents preferred to use indigenous methods to preserve their seeds, followed by the exogenous techniques 66 (39.3%), and a mixture of indigenous and exogenous methods 16 (9.5%), while 16 (9.5%) of the respondents did not express a preference for any method.

It was evident from the focus group discussions that farmers mainly preferred to use indigenous methods to preserve their seeds. Although interview findings established that the mixture of local and conventional approaches 16 (9.5%) was the least preferred method, the focus group discussions showed that the conventional techniques were the least popular approaches preferred

by farmers for preserving their planting materials. Despite the discrepancies, a broad pattern can be drawn that farmers mainly preferred to use both indigenous and exogenous methods to preserve their planting materials because the interview results showed that there were slight differences between farmers who preferred to use indigenous methods 70 (41.7%) and those ones who preferred to use exogenous approaches 66 (39.3%). Further, interview findings regarding the methods used by the communities to preserve their planting materials presented in Table 5.11 indicated that there was a preference for more conventional facilities and synthetic insecticides than indigenous methods.

The major reasons in relation to the use of exogenous methods as indicated in the focus groups were that not all indigenous methods were effective to preserve seeds in the communities. For instance, some farmers stated that clay soil was not effective to preserve their maize and bean seeds in Karagwe although most of them used these inputs to store their seeds. At the same time, the major reasons in relation to the use of indigenous methods were that traditional seeds were resistant to diseases, and local herbs were effective, available, affordable and safe unlike chemical pesticides. For instance, the Iteera Village focus group in Karagwe district indicated that, "we use *kaswagala* and *kajai* tree leaves because they can effectively preserve bean seeds for one year".

5.3.3 Crop husbandry practices

The assessment of crop husbandry practices was important to establish the extent to which indigenous and exogenous knowledge was applied into the farming activities. The respondents were asked to give details on criteria used for selecting land for crop farming, their cropping system (either mono-cropping or inter-cropping), crop planting strategies (either random or row sowing or transplanting or broadcasting), weed control methods and irrigation system.

5.3.3.1 Selection of arable land for crop farming

With reference to whether the 168 (92.9%) respondents who were involved in crop farming were using any criteria to assess the quality of arable land showed that the type of soil 81 (48.2%) and soil fertility 73 (43.5%) were the major criteria used by farmers to select land for crop farming. Other major criteria included: suitability of the plot for specific crops 54 (32.1%), water holding capacity 37 (22%), and agro-ecological condition 38 (22.6%). Criteria such as occurrence of

certain types of plants 4 (2.4%), distance from the village 2 (1.2%), and land altitude 1(0.6%) were less considered by farmers when selecting land for crop farming. For instance, farmers at Kasiki Village in Kilosa selected arable land for crop farming according to the occurrence of certain types of vegetation such as *koroga* and *mbagalala*, or *mapungapunga* and *pyapya*.

The findings from the focus group discussions established that the type of soil and soil fertility were important criteria used by farmers to assess the quality of arable land for crop farming. Other major criteria included: good water holding capacity, the suitability of a plot for a specific crop, agro-ecological condition, and growth of certain shrubs. For instance, farmers at Kasiki Village in Kilosa reported that, "The occurrence of certain types of grasses such as *sanze*, or *mitaruka*, or green grasses show that the soil is fertile and suitable for planting maize, cowpea and cassava crops. On the other hand, the occurrence of *ndungu* grasses or salty trees indicates that the soil has high water holding capacity which is suitable for rice cultivation".

5.3.3.2 Cropping systems

An inquiry of the cropping systems among 168 (92.9%) crop farmers indicated that most farmers used the inter-cropping system which is inherent to the indigenous farming system as depicted in Table 5.12. The frequencies were 105 (65.2% of the 161 who farmed maize), 77 (68.8% of the 112 who farmed beans), 71 (89.9% of the 79 who farmed bananas), 54 (96.4% of the 56 who farmed coffee), 29 (58% of the 50 who farmed groundnuts), 27 (58.7% of the 46 who farmed vegetables), 21 (95.5% of the 22 who farmed yams), 19 (57.6% of the 33 who farmed cassava), and 16 (59.3% of the 27 who farmed sorghum). The mono-cropping system was the second most applied method in the farming system in the local communities, while the mixture of mono-cropping and inter-cropping systems was less used.

The respondents were asked to state the reasons of applying an inter-cropping system in their farms. Of 168 (92.9%) crop farmers, 68 (40.5%) indicated that the shortage of land, lack of funds to purchase extra land, or to hire land were the major reasons for practicing inter-cropping in their farms. Other major reasons for practicing inter-cropping included: inherited practice 18 (10.7%), plant diversification 15 (8.9%), early maturity 12 (7.1%), soil fertility 10 (6%), to provide shade 3 (1.8%), to reduce risks 3 (1.8%), to increase income by cultivating more than

one type of crop 1 (0.6%), and to prevent plant diseases 1 (0.6%). Other reasons were: trial and error, to provide support for other crops, unreliable weather, to reduce disease outbreaks, and to conserve soil moisture.

The respondents were asked to provide reasons for practicing mono-cropping on their farms. Of 168 (92.9%) crop farmers, twenty five (14.9%) respondents indicated that they practiced mono-cropping methods on their farms in order to avoid competition with other crops. Other reasons were to avoid suppressing other crops 13 (7.7%), to increase yield 12 (7.1%), to ensure good exposure of crops to sunlight 12 (7.1%), to simplify field operations 9 (5.4%), to rotate crops 6 (3.6%), to increase soil fertility 3 (1.8%), to prevent plant pests 3 (1.8%), to mature early 2 (1.2%), and to carry small scale farming 1 (0.6%).

Table 5.12: The crop enterprises and the types of cropping systems used by farmers in the local communities (N=168)

Crop enterprises	Methods						
	Actual number of farmers per crop	Inter-cropping system		Mono-cropping system		Both inter-cropping and mono-cropping systems	
	No	No	%	No	%	No	%
Maize	(161)	105	65.2	43	26.7	14	8.7
Rice	(18)	3	16.7	15	83.3	-	-
Cow pea	(5)	3	60.0	2	40.0	1	20.0
Beans	(112)	77	68.8	22	19.6	15	13.4
Sesame	(9)	3	33.3	4	44.4	1	11.1
Vegetables	(46)	27	58.7	18	39.1	1	2.2
Bananas	(79)	71	89.9	10	12.7	1	1.3
Coffee	(56)	54	96.4	3	5.4	2	3.6
Yams	(22)	21	95.5	2	9.1	-	-
Irish potatoes	(5)	1	20.0	2	40.0	-	-
Sweet potatoes	(14)	4	28.6	8	57.1	1	7.1
Sugar cane	(12)	10	83.3	5	41.7	-	-
Peas	(10)	10	100	-	-	1	10
Groundnuts	(50)	29	58.0	22	44.0	4	8
Cassava	(33)	19	57.6	13	39.4	-	-
Sunflowers	(21)	9	42.9	10	47.6	2	9.5
Sorghum	(27)	16	59.3	13	48.1	-	-
Bambara	(2)	-	-	3	150	-	-
Pearl millets	(5)	-	-	2	40	-	-

(Multiple responses were possible)

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The focus group discussions established that most of the respondents applied an inter-cropping system on their farms, followed by mono-cropping and the mixture of mono-cropping and inter-cropping systems. An inter-cropping system, arranged in descending order of importance, was practiced in order to cultivate maize, cowpeas, beans, sesame, bananas, coffee, sweet potatoes, sunflowers, groundnuts, cassava, sorghum and peas. On the other hand, mono-cropping system was practiced in order to cultivate beans, rice, vegetables, sweet potatoes, cassava, sorghum and *bambara*. Farmers applied an inter-cropping system on their farms mainly due to the shortage of land and in order to diversify their plants. Other major reasons were to conserve soil moisture, ensure food security, improve soil fertility, an inherited practice, provide shade, reduce weeding costs and the suitability of a plot for certain crops. Accordingly, mono-cropping was mainly practiced in the communities in order to increase yield, avoid competition for nutrients and to suppress other crops and control plant pests. Other reasons were availability of land, inherited practice and ecological requirements for certain types of crops.

5.3.3.3 Crop planting systems

On the techniques used for planting crops, farmers mainly used random planting techniques which are inherent to indigenous farming in the surveyed communities, which included beans 84 (75% of the 112 who farmed beans), maize 56 (34.8% of the 161 who farmed maize), bananas 49 (62% of the 79 who farmed bananas), coffee 37 (66.1% of the 56 who farmed coffee), groundnuts 22 (44% of the 50 who farmed groundnuts), vegetables 15 (32.6% of the 46 who farmed vegetables), yams 14 (63.6% of the 22 who farmed yams), and cassava 13 (39.4% of the 33 who farmed cassava). Another major technique was row planting without proper spacing, accounting for maize 89 (55.3% of the 161 who farmed maize), sorghum 19 (70.4% of the 27 who farmed sorghum), groundnuts 19 (41.3% of the 50 who farmed groundnuts), beans 19 (38% of the 112 who farmed beans), sunflower 16 (76.2% of the 21 who farmed sunflowers), cassava 14 (42.4% of the 33 who farmed cassava) and bananas 10 (12.7% of the 79 who farmed bananas). Other major techniques were broadcasting and row spacing. Broadcasting techniques were used for planting rice, beans and groundnuts. Row spacing was used for planting maize, groundnuts, sorghum, sunflower, sesame, banana, coffee, and pearl millets. Both row and random sowing, row sowing without proper spacing, and row transplanting techniques were less used. The predominant use of indigenous techniques was aggravated by the lack of funds,

inherited plots with crops which were randomly planted, and the lack of knowledge on row spacing.

5.3.3.4 Weed control

The 168 (92.9%) interviewed respondents who practiced crop farming were asked to give details on methods that were used to control weeds. The majority of the respondents 152 (90.5%) used selective weeding to control weeds because it was inherent to the indigenous farming techniques. Other major techniques were crop rotation 76 (45.2%), intercropping 53 (31.5%), short-term fallowing 26 (15.5%), and mulching with dry leaves 36 (21.4%) and organic matter 26 (15.5%). Other techniques such as herbicides 9 (5.4%) were only used by rice farmers to control weeds in Kilosa (Kasiki Village). Long-term fallowing technique 3 (1.8%) was less practiced across the districts.

5.3.3.5 Irrigation

When the 168 (92.9%) interviewed respondents who practiced crop farming were asked to indicate if they practiced irrigation, 45 (26.8%) respondents indicated that they irrigated their crops. Watering cans 32 (66.7%) and water hoses 11 (22.9%) were the main tools used to irrigate gardens, while furrows 6 (12.5%) were used at a low rate to irrigate rice and maize crops.

5.3.4 Preservation of crops

An inquiry into whether the 168 (92.9%) crop farmers were preserving their crops indicated that the majority of the respondents 162 (96.4%) preserved their crops. Table 5.13 depicts that farmers mainly used conventional facilities to preserve their crops, which included maize 122 (75.8% of the 161 who farmed maize), beans 89 (79.5% of the 112 who farmed beans), groundnuts 40 (80% of the 50 who farmed groundnuts), sorghum 11 (40.7% of the 27 who farmed sorghum), rice 17 (94.4% of the 18 who farmed rice), and sunflowers 12 (57.1% of the 21 who farmed sunflowers). Other major methods were conventional inputs, traditional facilities and local herbs. The least used methods were indigenous practices, both local and conventional inputs, and both traditional and conventional facilities.

Table 5.13: The crop enterprises and the methods used by farmers to preserve their crops in the local communities (N=168)

Crops enterprises	Actual number of farmers per crop	Conventional inputs		Local herbs		Traditional facilities		Conventional facilities		Indigenous practices		Local and conventional inputs		Conventional & traditional facilities	
	No	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Maize	(161)	53	32.9	21	13.0	23	14.3	122	75.8	13	8.1	7	4.3	14	8.7
Rice	(18)	-	-	-	-	-	-	17	94.4	-	-	-	-	-	-
Beans	(112)	29	25.9	16	14.3	6	5.4	89	79.5	9	8.0	5	4.5	4	3.6
Sesame	(9)	1	11.1	-	-	1	11.1	5	55.6	-	-	-	-	-	-
Vegetables	(46)	-	-	-	-	3	6.5	1	2.2	1	2.2	-	-	-	-
Coffee	(56)							8	14.3	-	-	-	-	-	-
Sweet potato	(14)	-	-	-	-	1	7.1	2	14.3	-	-	-	-	-	-
Peas	(10)	2	20.0	1	10.0	-	-	6	60.0	-	-	-	-	-	-
Groundnuts	(50)	2	4.0	-	-	7	14.0	40	80.0	1	2.0	-	-	1	2.0
Cassava	(33)					1	3.0	2	6.1	4	12.1	-	-	-	-
Sunflowers	(21)	1	4.8	-	-	5	23.8	12	57.1	-	-	-	-	-	-
Sorghum	(27)	5	18.5	4	14.8	7	25.9	11	40.7	1	3.7	1	3.7	10	37.0
Bambara	(2)	-	-	-	-	1	50.0	-	-	-	-	-	-	-	-
Pearl millets	(5)	-	-	-	-	1	20.0	2	40.0	-	-	-	-	-	-

(Multiple responses were possible)

Despite the fact that conventional inputs and facilities were the major means used by farmers to preserve their crops, local herbs, cultural inputs and practices and traditional facilities also played a key role in the preservation of crops in the surveyed communities. Overall, the application of these local herbs, cultural inputs and practices and traditional facilities varied across the surveyed districts. Most farmers applied similar plant parts from particular species such as leaves, roots, barks, and husks to preserve crops. Similar local herbs and cultural inputs (such as chilli pepper and ash) were applied in various districts to preserve the same crops. For instance, chilli pepper was used to preserve bean and maize crops in Moshi Rural and Kasulu.

Various local herbs were used to preserve crops across the surveyed districts. For instance, burnt rice ash was used to store maize in Kilosa. In Moshi Rural, farmers preserved bean or maize crops with either chilli pepper, or wild tobacco, or a concoction of chilli pepper and *mabangi mwitu* leaves, or a mixture of *urutupa* and *mabangi mwitu* leaves, or chilli pepper. In Kasulu, farmers stored maize or bean crops with *mshindwi* tree ash, or a mixture of chilli pepper and *mshindwi* tree ash, or *mtundu* tree ash, or a concoction of chilli pepper and ash from any tree. In Mpwapwa, farmers preserved maize or bean crops with either *msakasaka* plant leaves, or ground neem leaves. In Karagwe, farmers stored maize crops with *kajai* plant leaves, or *kajashi* tree ash, or *masaka* plant leaves, or the mixture of *kaswagala* and *kajai* tree leaves.

In the same Mpwapwa district, farmers preserved bean crops with either *kajashi* tree ash, or *kajai* tree leaves, or *mluku* tree leaves, or a mixture of *msonobali* and chilli pepper. For preserving peas, farmers in Kasulu mixed their crops with a concoction of chilli pepper and ash from any tree and stored the crops in sacks. For preserving sorghum, Karagwe's farmers used either *kajai* plant leaves or *mluku* tree leaves.

Farmers also used a wide range of cultural inputs and practices. For example, maize cobs were stored on top of trees in Kasulu and Karagwe. Kitchen ash was used to preserve maize (Kilosa, Karagwe and Songea Rural), bean (Moshi Rural, Karagwe, Kasulu and Songea Rural) and sorghum crops (Mpwapwa). Farmers either used mud or dry cow dung to preserve maize in Karagwe. In the same district, farmers used dry cow dung or anthill soil to store bean crops. Ash

from goat dung and maize cobs was also used to store maize and sorghum crops in Mpwapwa. Farmers also sliced cassava and boiled them with salt, and preserved them after sun drying in Kilosa.

For traditional facilities, clay pots and granaries were used to preserve a wide range of crops across the surveyed districts. For instance, clay pots were used to store maize crops in Mpwapwa, and maize and bean crops in Karagwe. Granaries that were situated over the hearth or the kitchen were used to preserve the following: maize in Kilosa; cowpeas, beans, groundnuts and maize in Karagwe; beans, sorghum and maize in Mpwapwa; and vegetables in Moshi Rural. Granaries situated within farmers' houses were used to store the following: maize in Kilosa; beans in Kasulu; maize, sunflowers, sorghum, bambara and groundnuts in Mpwapwa; and groundnuts in Songea Rural. Granaries that were situated outside farmers' houses were used to store the following: maize, sunflowers, sorghum, pearl millets and groundnuts in Mpwapwa; and maize and beans in Karagwe where both *vichanja (yinza)* and *vihenge* were used. In Kasulu, this technique was used to store maize, cassava and beans where both *vichanja (yinza or kingelengele)* and *vihenge* were used. Granaries that were situated outside farmers' houses (*ngokho*) were also used to store maize in Songea Rural and Kilosa. However, this method was no longer common because such storage facilities needed to be kept outside and there had been cases of rampant theft.

5.3.5 Plant diseases, pests and predators
The assessment of plant diseases, pests and predators were important to determine the extent to which conventional and local inputs were applied to control plant diseases, pests and predators in the communities. The respondents were asked to give details on the measures that were used to control plant diseases, pests and predators.

5.3.5.1 Control of plant diseases
More than half of the respondents 105 (62.5% of 168 crop farmers) identified twenty plant diseases where bean fungal diseases and banana panama diseases posed a major threat in the surveyed communities as shown in Table 5.14. Among those farmers 105 (62.5%) who identified plant diseases, most of them reported that they did not use any measure to control those plant diseases, which included bean fungal diseases 31 (27.7% of the 112 who farmed beans), banana

panama disease 18 (22.8% of the 79 who farmed bananas), maize fungal diseases 15 (9.3% of the 161 who farmed maize), maize viral disease 12 (7.5% of the 161 who farmed maize), groundnut viral diseases 11 (22% of the 50 who farmed groundnuts), and rice fungal disease 8 (44.4% of the 18 who farmed rice) as shown in Table 5.14. However, when the use of local herbs and conventional inputs was compared in the control of plant diseases and pests, the latter was more commonly used than the former. Both conventional and local inputs were less used to control plant diseases.

Table 5.14: Plant diseases and various measures that were used to control plant diseases (N=105)

Plant diseases	Methods								
	Actual number of farmers per crop	Conventional inputs & practices		Local herbs & cultural practices		Acknowledged facing the disease but they did not use any measure to control diseases		Both conventional and local inputs	
	No	No	%	No	%	No	%	No	%
Maize viral diseases	(161)	3	1.9	3	1.9	12	7.5	-	-
Maize fungal disease	(161)	3	1.9	1	0.6	15	9.3	-	-
Rice fungal diseases	(18)	5	27.8	1	5.6	8	44.4	-	-
Bean fungal diseases	(112)	9	8.0	3	2.7	31	27.7	1	0.9
Sesame fungal diseases	(9)	4	44.4	-	-	-	-	-	-
Vegetable fungal diseases	(46)	2	4.3	7	15.2	3	6.5	-	-
Banana panama diseases	(79)	1	1.3	19	24.1	18	22.8	-	-
Coffee fungal diseases (Coffee Berry Diseases)	(56)	11	19.6	8	14.3	6	10.7	-	-
Irish potato fungal diseases	(5)	-	-	1	20.0	3	60.0	-	-
Peas fungal diseases	(10)	-	-	-	-	1	10.0	-	-
Peas wilting	(10)	-	-	-	-	1	10.0	-	-
Groundnut viral diseases transmitted by aphids	(50)	1	2.0	-	-	11	22.0	-	-
Groundnut fungal diseases	(50)	-	-	-	-	2	4.0	-	-
Cassava viral diseases	(33)	1	3.0	-	-	3	9.1	-	-
Yam bacterial diseases	(22)	-	-	-	-	1	4.5	-	-
Sunflower fungal diseases	(21)	-	-	-	-	2	9.5	-	-

Sunflower viral diseases	(21)	-	-	-	-	4	19.0	-	-
Sorghum fungal diseases	(27)	-	-	-	-	6	22.2	-	-
Tomato fungal diseases	(46)	2	4.3	-	-	1	2.2	-	-
Onion fungal diseases	(46)	1	2.2	-	-	1	2.2	-	-
Carrot fungal diseases	(46)	1	2.2	-	-	-	-	-	-
Eggplant fungal diseases	(46)	1	2.2	-	-	-	-	-	-

(Multiple responses were possible)

Many farmers did not use any measure to control plant diseases due to lack of access to knowledge and inputs for controlling those diseases. For instance, farmers in Moshi Rural stated that, "nothing has been discovered by the coffee research institute on how to control the banana panama disease". Another farmer at Kasiki Village in Kilosa reported that, "I do not know what solution to use when my maize are infected by a viral disease (maize streak disease)". Secondly, lack of purchasing power also inhibited farmers from using any inputs to control plant diseases. For instance, one farmer at Mshiri Village in Moshi Rural said that, "chemical pesticides are expensive, and I do not use any traditional techniques to control Coffee Berry Disease (coffee fungal disease) because they are not effective". Lastly, some of the local techniques and herbs were not effective to cure plant diseases, and thus some farmers did not use any technique to control plant diseases. For instance, one farmer at Mshiri Village in Moshi Rural reported that, "I always clean my agricultural tools (example, hand hoe) which I have used for farming activities. However, this technique is not effective to control *kisori* (banana panama) disease".

While farmers mainly used synthetic insecticides to treat plant diseases, they also used local remedies such as cultural practices to control the diseases. In Moshi Rural, farmers uprooted the infected banana plants and put ash in the pit as an insecticide and left the pit open for six months to control *kisori* (panama) diseases. Other farmers uprooted the infected banana plant and left the pit open for some time before using it again to control *kisori* (panama) diseases. Other farmers mixed ash with animal manure and put the mixture in the pit where the banana plants were uprooted to control *kisori* (panama) diseases. Kitchen ash was also used to control maize leaf rust disease (Maize fungal disease) in Moshi Rural. A mixture of human urine and paraffin, or cattle urine was also used to control Coffee Berry Disease (CBD) in Moshi Rural. In Kilosa, farmers

uprooted the infected crops to control maize streak disease (maize viral disease) and bean aranthcnose (beans fungal disease). Ash was also used to control bean fungal attack in Kilosa.

Farmers described a variety of local herbs that they used to control plant diseases. In general, various plant parts (barks, roots, leaves) were used alone, or in combination with other ingredients such as water, or cattle urine, or kitchen ash to control plant diseases. For instance, in Moshi Rural, farmers used various local herbs to control vegetable fungal diseases, which included the following: a mixture of ash and ground *mabangi mwitu* tree leaves; a concoction of *ufori* (cattle's urine) and ground *mabangi mwitu* leaves and water; and a mixture of water and ground wild sunflowers. To control coffee berry disease, Moshi Rural farmers' used the following herbs: a mixture of chilli pepper, *mabangi mwitu* and water; and a mixture of ground plant leaves of *mabangi mwitu*, *urutupa* and cattle urine. In Kasulu, a mixture of chilli pepper and ash from *mshindwi* tree was also used to control vegetable fungal diseases. Local herbs were applied as insecticides by farmers due to their affordability, simplicity and safety. One farmer in Moshi Rural indicated that, "I have stopped to use blue copper pesticide for controlling CBD because the chemicals are not safe to human health. I currently use the mixture of chilli pepper and *mabangi mwitu* leaves to control the same disease".

Although interview results established that conventional inputs were the main methods used by farmers to control plant diseases, the focus group discussion showed that local herbs and cultural practices were the major methods used by farmers to control plant diseases, followed by conventional inputs and practices. The divergence of the findings from interviews and focus groups are elaborated in Section 6.3.1 of Chapter Six. A few farmers did not use any method to control plant diseases due to the unavailability and high cost of conventional inputs, lack of awareness, and the ineffectiveness of some of the local techniques. Local herbs and cultural practices were applied as insecticides by farmers due to their affordability, simplicity and safety.

5.3.5.2 Control of plant pests
The majority of the respondents 149 (88.7% of 168 crop producers) identified various pests and measures that were used to control pests in their local communities. Table 5.15 indicates that

maize stalk borer, rodents, maize weevils, birds, bean American bollworms, bean beetle, coffee leaf minors, and groundnut aphids posed a serious problem to farmers across the districts.

The control measures for plant pests were classified into the following categories:

- Conventional inputs: Included the use of synthetic chemicals such as pesticides which were used for preventing, destroying, repelling or mitigating pests;

- Local herbs: included the use of botanical pesticides which were extracted from various plant parts (stems, seeds, roots, leaves and flower heads) of different plant species; and

- Cultural practices: included the use of various local inputs (such as kitchen ash, cattle urine, milk, goat dung, maize cobs ash, paraffin and clay soil), and cultural practices such as trapping, scaring, and construction of trenches around the farms.

The majority of the respondents did not use any measure to control plant pests, which included maize stalk borers 38 (23.6% of the 161 who farmed maize), groundnut aphids 19 (38% of the 50 who farmed groundnuts), bean beetles 13 (11.6% of the 112 who farmed beans), and bean American bollworms 11 (9.8% of the 112 who farmed beans) as indicated in Table 5.15. On the other hand, conventional inputs and cultural or indigenous practices were the dominant approaches used by farmers to control plant pests. Conventional inputs were mostly used to control maize stalk borers 34 (21.1% of the 161 who farmed maize), bean American bollworms 14 (12.5% of the 112 who farmed beans), and rodents 9 (15.5% of the 168 crop farmers), while cultural inputs and practices were used to control rodents 34 (58.6% of the 168 crop farmers), birds 29 (90.6% of the 168 crop farmers), and maize weevils 13 (8.1% of the 161 who farmed maize). Other major approaches used to control plant pests were local herbs. Few farmers used both conventional inputs and local herbs to control plant pests. Most farmers did not use any measure to control plant pests due to the unavailability of synthetic pesticides during farming season, and lack of knowledge on the use of both conventional and local inputs for controlling plant pests.

Table 5.15: Plant pests and various measures that were used to control plant pests (N=149)

Plant pests	Methods									
	Actual number of farmers per crop	**Conventional inputs**		**Local herbs**		**Both conventional and local inputs**		**Non-use of local and conventional inputs**		**Cultural inputs and practices**	
	No	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Maize stalk borers	(161)	34	21.1	16	9.9	4	2.5	38	23.6	6	3.7
Maize weevils	(161)	8	5.0	3	1.9	2	1.2	10	6.2	13	8.1
Maize cutworms	(161)	1	0.6	-	-	-	-	-	-	7	4.3
Maize armyworms	(161)	2	1.2	-	-	-	-	2	1.2	2	1.2
Rice armyworms	(18)	1	5.6	-	-	-	-	1	5.6		0.0
Cow pea beetles	(5)	-	-	1	20.0	-	-	-	-	-	-
Bean aphids	(112)	3	2.7	-	-	-	-	2	1.8	-	-
Bean American bollworms	(112)	14	12.5	-	-	1	0.9	11	9.8	-	-
Bean beetles	(112)	4	3.6	3	2.7	2	1.8	13	11.6	-	-
Sesame aphids	(9)	3	33.3	-	-	-	-	1	11.1	-	-
Sesame nematodes	(9)	-	-	-	-	-	-	2	22.2	-	-
Green vegetable cutworms	(46)	2	4.3	-	-	-	-	-	-	-	-
Green vegetable insects	(46)	-	-	4	8.7	-	-	1	2.2	-	-
Green vegetable aphids	(46)	-	-	-	-	-	-	1	2.2	-	-
Banana root Nematodes	(79)		-	-	-	-	-	1	1.3		-
Banana weevils	(79)		-	-	-	-	-	1	1.3	4	5.1
Coffee leaf minors	(56)	8	14.3	7	12.5	-	-	4	7.1	1	1.8
Sweet potato weevils larva	(14)		-	-	-	-	-	2	14.3	-	-
Sugar cane stem borers	(12)	-	-	-	-	-	-	1	8.3	-	-
Peas weevils	(10)	1	10.0	-	-	-	-	-	-	-	-
Peas insects	(10)	-	-	-	-	-	-	2	20.0	-	-
Groundnut aphids	(50)	1	2.0	1	2.0	-	-	19	38.0	-	-
Groundnut termites	(50)	-	-	1	2.0	-	-	3	6.0	-	-
Sunflower American Bollworms	(21)	-	-	-	-	-	-	2	9.5	1	4.8
Sorghum stalk borers	(27)	1	3.7	1	3.7	1	3.7	5	18.5	-	-
Sorghum armyworms	(27)	-	-	-	-	-	-	1	3.7	1	3.7
Sorghum weevils	(27)	2	7.4	-	-	1	3.7	1	3.7	-	-
Tomato American boll worms	(46)	1	2.2	-	-	-	-	2	4.3	-	-

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Eggplant	(46)	1	2.2	-	-	-	-	1	2.2	-	-
American borers											
Rodents	(168)	9	5.4	4	2.4	11	6.5			34	20.2
Birds	(168)	2	1.2			1	0.6			29	17.3

(Multiple responses were possible)

Farmers used various local herbs to control plant pests across the surveyed districts. Farmers either used various parts of plants (roots, barks, leaves) alone, or in combination with other inputs. For instance, in Moshi Rural, farmers sprayed a mixture of fermented cattle urine, chilli pepper and soap on maize to control stalk borer pests. Ground *msesewe* (*Rauvolfia caffra*) tree leaves were used to control maize stalk borers. Farmers applied various methods to control cutworms in vegetables, which included: a mixture of ash and *mabangi mwitu* leaves; or a mixture of *mabangi mwitu*, *msesewe* tree leaves, cattle's urine and water. A mixture of wild sunflowers, water and milk; or a mixture of wild sunflowers, water and chilli pepper were also used to control *shipitiri* pests (vegetable insect pests). A concoction of ground plant leaves of *mabangi mwitu*, urutupa and cattle's urine was fermented for seven days, and then it was used to control *shipitiri* (vegetable insect pests) or coffee leaf minors.

In Songea Rural, a concoction of ground *mtutu* (*Bridelia micrantha*) tree leaves and water was poured into the maize funnel to kill *mbengimbengi* (stalk borer pests). In Mpwapwa, a mixture of goat dung, maize cob ash and leaves from *msakasaka* tree was used to control maize stalk borers and weevils as well as *vimungu* or *surenje* or *scania* (stalk borers) in sorghum. In Karagwe, farmers used *kafaya* plant leaves, or ash from *kajashi* tree to control *kamsokoine* pests (maize stalk borers). In the same region, farmers also used *rugwe mwani* plants to control maize weevils. In Kasulu, ash from *mshindwi* tree, or a mixture of ash and chilli pepper was used to control *dumuzi* pest (beetle) from attacking beans. A mixture of ash and chilli pepper was also used to control banana weevils in Kasulu.

Farmers also cultivated certain plants that repel rodents in Moshi Rural. For instance, *maasa* plant was planted near banana trees to prevent *fuko* (rodents) from attacking the banana plantations. The *urutupa* plant was also planted around the farm to prevent *fuko* (rodents) from

attacking banana, maize, bean, sweet potato, yam and Irish potato crops. Farmers also used ground neem tree leaves to prevent rodents from attacking maize or sesame crops in Kilosa.

Similar to local herbs, there were also variations on the use of cultural inputs and practices to control plant pests across the surveyed districts. For instance, in Moshi Rural, ash was mixed with animal urine to control vegetable cutworms and *shipitiri* pests (vegetable insects). Farmers also used theft pins and paraffin or water to catch *kimatira* (leaf minor pests) and kill them in the coffee fields. Water or cattle's urine was also used to prevent rodents from attacking the banana fields in Moshi Rural. Locally designed traps were used to control rodents in Moshi Rural, Songea Rural and Kilosa. Other farmers made noises to scare birds from attacking the following crops: maize and rice in Kilosa; maize in Songea Rural and Kasulu; and maize, sunflowers, groundnuts and sorghum in Mpwapwa.

Ash was also used to control maize stalk borers and rodents in Kilosa, while they were used to control maize stalk borers, and bean American bollworms in Songea Rural. In Mpwapwa, ash was used to control cowpea beetles, maize weevils, stalk borers, groundnut termites, and sorghum stalk borers. In the same district, other farmers relied on heavy rain to control sunflower American bollworms. In Karagwe, farmers used either soil or a mixture of ash and soil to control *kamsokoine* pests (stalk borers) in the maize fields. Clay soil was used to control *ohuruka* pests (beetle) from attacking beans. In the same district, farmers mixed kitchen ash, soil and thiodan insecticide to control *kamsokoine* pests (maize stalk borers) and *ohuruka* pests (beans beetles). In Kasulu, farmers put soil over the maize funnel to kill stalk borers. In the same district, farmers also uprooted the infected banana plants to control weevils.

Data obtained from focus group discussions established that conventional inputs were the main method used by farmers to control plant pest, followed by local herbs and indigenous practices.

5.3.5.3 Control of plant predators
Fifty three (31.5% of 168 crop producers) respondents reported using various measures to control predators. Monkeys were declared by 53 (31.5%) respondents as most serious predator for maize, beans, sorghum, sunflowers, and cassava, followed by wild pig, accounting for eight

(4.8%). The 53 (31.5%) respondents were asked to indicate measures that were used to control plant predators. Local herbs and cultural practices were the major methods used to control monkeys 53 (93 %) and wild pigs seven (87.5%), followed by conventional inputs, accounting for 4 (7%) monkeys, and one (12.5%) wild pigs. A variety of indigenous techniques were used to control predators, which included frequent guarding, scaring, and chasing. Some farmers made noises, or used guns, or bells, to scare monkeys and wild pigs from entering onto their farms. Other farmers paid someone to guard their farms or used dogs to control monkeys from attacking their crops such as maize. Local traps were also used to control monkeys in Mpwapwa. Trees such as *kajai, kafai* and *mitoma* (*Ficus thonningii*) were planted around the farm to prevent monkeys from attacking crops such as maize and banana in Karagwe. For conventional approaches, farmers used poison to kill monkeys and wild pigs in Karagwe.

5.3.5.4 Methods preferred by farmers to control plant pests and diseases
When 168 (92.9%) crop farmers were asked to state methods they prefer for controlling plant pests and diseases, the majority of the respondents preferred to use conventional techniques 69 (41.1%), followed by indigenous methods 56 (33.3%). The major reasons were that indigenous techniques lacked prescribed procedures, and some techniques were not effective to control plant pests and diseases. Few farmers preferred to use of both conventional and indigenous techniques 9 (5.4%) to control plant pests and diseases, while 34 (20.2%) did not prefer any method.

These findings were confirmed by data collected using focus group discussions that farmers mainly preferred to use conventional inputs and practices to control plant diseases and pests, followed by indigenous methods. The major reasons were that conventional inputs were effective, and well researched. On the other hand, the major reasons for preferring indigenous inputs were that conventional inputs were expensive. Focus group at Kasiki village in Kilosa reported that, "we do not prefer to use any chemical pesticides to control sesame fungal disease because they are expensive and thus we get low crop yields. Few people in our community are able to buy pesticides to control this disease". Conventional inputs also had toxicity and hazardous effects on farmers' health. For instance, Kilosa's focus group (Kasiki village) reported that, "we use insecticides to control plant diseases and pests on crops such as tomatoes but they are not safe as compared to local herbs which have no toxic effects to our health".

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5.3.6 Medicinal plants

The respondents were asked to indicate if they domesticated medicinal plants that repel insects, and control plant diseases and pests, and animal diseases, and if they used any wild plants to control plant and animal diseases, and to preserve their crops.

The respondents were asked to indicate if they grew plants that repel insects on their farms. Out of 168 (92.9%) crop producers, twenty four (14.3%) respondents indicated that they grew plants that repel insects on their farms. The twenty four (14.3%) respondents who indicated that they grew plants that repel insects were asked to name those plants. The majority of the respondents grew *mabangi mwitu* 9 (37.5%), followed by yellow flowers 4 (16.7%), *maasa* 4 (16.7%), red flower 3 (12.5%), *urutupa* 3 (12.5%), coffee (robusta) 3 (12.5%), and neem 2 (8.3%). Other plants that repel insects were *kafau*, tobacco, wild sesame (*Sesamum calycinum)*, rosemary, *kajai*, and *mitoma*, accounting for one (4.2%) respondent each. Most of these plants were grown in Moshi Rural district, followed by Karagwe, Kilosa and Songea Rural.

When 168 (92.9%) crop farmers were asked to indicate if they domesticated medicinal plants to control plant diseases and pests, eight respondents (4.4%) acknowledged that they domesticated medicinal plants to control plant diseases, while 173 (95.6%) did not. Most of the respondents who domesticated medicinal plants were based in Moshi Rural district, accounting for 7 (87.5%) of the respondents, followed by Kilosa, with one (12.5%) respondent.

On whether the wild medicinal plants were used to control plant diseases and pests, ten (5.5%) respondents reported that they used wild medicinal plants, while 171 (94.5%) did not. Most of the respondents were from Karagwe and Kasulu districts, with a score of three (30%) respondents each, followed by Moshi Rural two (20%), Songea Rural one (10%) and Mpwapwa one (10%).

An inquiry as to whether farmers domesticated medicinal plants to control animal diseases indicated that thirty six (24.7%) respondents grew medicinal plants, while 145 (80.1%) did not. The majority 14 (38.9%) of the respondents who domesticated these medicinal plants were from

Moshi Rural district, followed by Kilosa 9 (25%), Mpwapwa 8 (22.2%), Karagwe 2 (5.6%), Songea Rural 2 (5.6%), and Kasulu 1 (2.8%).

On whether farmers used wild medicinal plants to control animal diseases indicated that thirty nine (21.5%) respondents used wild medicinal plants, while 142 (78.5%) did not. Most of these respondents were based in Moshi Rural 16 (41%), followed by Kilosa 9 (23.1%), Karagwe 6 (15.4%), Kasulu 4 (10.3%), Mpwapwa 3 (7.7%) and Songea Rural 1 (2.6%).

Asked to mention if they used any medicinal plants to preserve their crops, 33 (18.2%) respondents indicated that they used wild medicinal plants to store their crops, while 148 (81.8%) did not. Most of the respondents who used wild medicinal plants to preserve their crops were based in Kasulu, accounting for nine (27.3%) of the respondents, followed by Moshi Rural, eight (24.5%), Karagwe, eight (24.2%), Mpwapwa, six (18.2%), and Kilosa, two (6.1%).

5.3.7 Animal husbandry practices
The respondents were asked to identify their animal feeding approaches, and breeding management practices in order to assess the application of exogenous and indigenous knowledge in animal husbandry practices.

5.3.7.1 Animal feeding
The respondents were asked to provide details on animal feeding strategies, and whether they grew fodder and provided special feeds to their animals. Those respondents 146 (80.2%) who reported that they were engaged in livestock keeping were asked to mention the methods used to feed their animals. Most farmers used zero grazing system to feed their animals, which included pigs 39 (100% of the 39 who kept pigs), cattle 35 (52.2% of the 67 who kept cattle), poultry 35 (29.4% of the 119 who kept poultry), goats 24 (34.8% of the 69 who kept goats), and sheep 10 (35.7% of the 28 who kept sheep). Other major methods were free grazing and free range, while the tethering method was less used.

An inquiry into whether farmers grew livestock fodder indicated that few respondents grew fodder 31 (21.2%), while 115 (78.8%) did not. Further, when 146 (80.2%) respondents were asked to state if they gave special feeds to their animals, almost half of the respondents 64

(43.8%) indicated that they provided special supplements to their animals. Mineral supplements 48 (75%) were the major special feeds given to farm animals, followed by concentrates 41 (64.1%) and vitamins 14 (21.9%). In general, special feeds were mainly given to cattle and pig, while poultry, goat and sheep were given special feeds at a low rate.

5.3.7.2 Animal breeding

The respondents were asked to give details on strategies that were used to control breeding, reasons for controlling breeding, special feeds given to the breeders and criteria for selecting animals for breeding purposes. Those 146 (80.2%) livestock keepers were asked to indicate if they controlled their animal breeding. More than half of the respondents 95 (65.1%) controlled their animal breeding, while 51 (34.9%) did not. Most of the respondents relied on the natural mating system which was not effective in ensuring genetic improvements through the introduction of exotic blood. The major reasons for controlling breeding, which are arranged in descending order of importance, were to: improve the quality of animals; prevent disease outbreak and inheritable diseases; increase income levels; eliminate bad traits; and to reduce the number of male animals in order to avoid competition between bulls during the mating period.

Those respondents 95 (65.1%) who reported that they controlled breeding were asked to describe their breeding management strategies. Arranged in descending order of importance, those breeding management strategies included: destocking of animals with bad traits through live sales, slaughtering, donations, gift, dowry and exchange, castration and fattening of male animals to attain high marketing prices, and identification of best male animals from within or outside the communities for breeding purposes.

The 95 (65.5%) respondents who acknowledged that they controlled their animal breeding were asked to provide details on the criteria used to select male animals for breeding purposes. The findings showed that farmers mostly used physical appearance, behaviour and performance characteristics to select male animals for breeding purposes. These findings showed that farmers had extensive base of IK on the criteria used to select male animals for breeding purposes. Body size was the main criterion used by farmers to select male animals for breeding purposes, which included goats 32 (46.4% of the 69 who kept goats), cattle 31 (46.3% of the 67 who kept cattle),

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poultry 29 (24.4% of the 119 who kept poultry), pigs 26 (66.7% of the 39 who kept pigs) and sheep 10 (35.7% of the 28 who kept sheep). Other major criteria were appearance, temperament and history of ancestors. Breed type and age were the least considered criteria for selecting male animals for breeding purposes. Other criteria were that animals should not be related, and a high libido should show in early stages of growth (1-2 years) for cattle.

The focus discussion group discussions confirmed that large body size was the main criterion used by farmers to select male animals for breeding purposes. Good temperament and appearance were important criteria for selecting male cattle, goats, poultry and pigs for breeding purposes. On the other hand, good history of ancestors was the important criterion used by farmers to select male cattle, goats, sheep and pigs, while resistance to diseases was important criterion used by farmers to select male cattle, goats and sheep for breeding purposes.

Those 95 (65.5%) interviewed respondents who indicated that they controlled their animal breeding were asked to provide details on the criteria used to select female animals for breeding purposes. Again, body size was the main criterion used by farmers to select female animals for breeding purposes, which included cattle 23 (34.3% of the 67 who kept cattle), goats 26 (37.7% of the 69 who kept goats), poultry 20 (16.8% of the 119 who kept poultry), and pigs 12 (30.8% of the 39 who kept pigs). Temperament, milk production, appearance, history of ancestors, prolificacy[3], and not related were also important criteria used by farmers to select female animals for breeding purposes. Few farmers used age and breed type criteria to select female animals for breeding purposes. Other criteria that were used by farmers to select female animals for breeding purposes included: good rearing ability for poultry, goats and pigs, good hatching ability for poultry, a big udder for cattle and goats, and large number of udders for goats and pigs.

The focus group discussion confirmed that big body size was the main criterion used by farmers to select female animals (cattle, goats, poultry, pigs and sheep) for breeding purposes. Good temperament, high milk production, appearance, prolific and good ancestral history were important criteria used by farmers to select cattle and goats for breeding purposes. On the other

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[3] Producing offspring in great abundance, and sustaining vigorous and luxuriant growth.

hand, good temperament, prolificacy, history of ancestors and appearance were important criteria used by farmers to select pigs for breeding purposes. Other criteria included large number of udders for pigs, and a big udder for cattle.

5.3.8 Control of animal diseases

The respondents were asked to provide details on major animal diseases and measures used for controlling and preventing animal diseases.

5.3.8.1 Measures used to control animal diseases

The interviewed respondents had an extensive knowledge base on the diseases afflicting their livestock, where 133 (91.1% of 146 livestock keepers) identified animal diseases and measures for controlling these diseases. From the description of animal disease symptoms by interviewed farmers and known disease patterns, major animal diseases could be coded (Table 5.16). Poultry viral diseases, cattle viral diseases, cattle East Coast Fever (ECF), pig external parasites and cattle protozoa diseases posed a major threat to animals in the surveyed communities.

Table 5.16 indicates that the conventional inputs and practices were the dominant methods used by farmers to control animal diseases, which included cattle viral diseases 60 (89.6% of the 67 who kept cattle), cattle East Coast Fever (ECF) 42 (62.7% of the 67 who kept cattle), pig external parasites 39 (100% of the 39 who kept pigs), cattle protozoan diseases 20 (29.9% of the 67 who kept cattle), and poultry viral diseases 18 (15.1%). Other major methods were local herbs and cultural inputs and practices, while both conventional and local inputs were less used by farmers to control animal diseases. Farmers mainly applied conventional inputs to treat cattle and pig diseases, while local inputs were used to cure cattle and poultry diseases. Both conventional and local herbs were mainly used to control cattle and poultry diseases, while most farmers did not apply any medication to treat poultry diseases. Local inputs were not used to control pig diseases.

While farmers mainly used external inputs to control animal diseases, they also used locally available herbs and cultural inputs and practices to control animal diseases. The application of local herbs and cultural inputs and practices varied across the districts. In local herbs, farmers used various parts of plants, such as leaves, barks, fruits and roots to control animal diseases. The

plants were either used alone or in combination with any of the following local inputs: soda ash, soap, water, salt, charcoal, kitchen ash, contents from torch batteries, and bran. Farmers mainly used neem and chilli pepper plants to control animal diseases.

Table 5.16: Animal diseases and various measures used by farmers to control animal diseases (N=133)

Animal diseases	Methods								
	Actual number of farmers per livestock	Conventional input		Local herbs and cultural practices		Both conventional and local inputs		Non-use of local and conventional inputs	
	No	No	%	No	%	No	%	No	%
Cattle protozoan disease	(67)	20	29.9	7	10.4	-	-	-	-
Cattle viral disease	(67)	60	89.6	8	11.9	2	3.0	-	-
Cattle East Coast Fever	(67)	42	62.7	6	9.0	2	3.0	2	3.0
Cattle bacterial disease	(67)	4	6.0	2	3.0	-	-	1	1.5
Cattle external parasites	(67)	11	16.4	3	4.5	7	10.4	-	-
Cattle mastitisc	(67)	-	-	-	-	1	1.5	-	-
Cattle Bloat	(67)	1	1.5	3	4.5	-	-	-	-
Cattle injury	(67)	-	-	1	1.5	-	-	-	-
Cattle kerato-conjunctivitis	(67)	-	-	-	-	-	-	1	1.5
Cattle retained placenta	(67)	-	-	1	1.5	-	-	-	-
Goat East Coat Fever	(69)	6	8.7	-	-	-	-	-	-
Goat external parasites	(69)	12	17.4	3	4.3	5	7.2	-	-
Goat viral diseases	(69)	5	7.2	-	-	-	-	-	-
Goat foot rot	(69)	-	-	2	2.9	-	-	-	-
Sheep external parasites	(28)	1	3.6	-	-	-	-	-	-
Pig external parasites	(39)	39	100	-	-	-	-	-	-
Pig lameness	(39)	1	2.6	-	-	-	-	-	-
Pig Foot and Mouth Disease	(39)	1	2.6	-	-	-	-	-	-
Pig fever	(39)	1	2.6	-	-	-	-	-	-
Poultry viral diseases	(119)	18	15.1	27	22.7	10	8.4	13	10.9
Poultry protozoan diseases	(119)	2	1.7	2	1.7	1	0.8	-	-
Poultry lice	(119)	2	1.7	-	-	-	-	-	-

(Multiple responses were possible)

For instance, farmers in Moshi Rural used aloe vera (*Aloe Barbadenis*) plants to cure *ndigana moto* (ECF) in cattle. A mixture of ground *lelema* (*Basella alba L)* leaves and *magadi* (soda ash)

was given to cattle to cure *ndigana baridi* (protozoan disease - anaplasmosis) and *ndigana moto* (ECF). A mixture of ground mlatangao (*Calpurnia aurea Ait. Benth*) tree leaves and water was given to cattle to treat roundworms, and *ndasura* or *ndigana baridi* (protozoan disease - anaplasmosis). *Mabangi mwitu* leaves or a concoction of ground *mlatangao* tree leaves and soda ash was given to cattle as insecticide to control bloat disease such as indigestion.

External parasites such as worms in goat and cattle were treated by using a mixture of water and ground *mfurufuru* or *msesewe* tree leaves or barks. The ground wild sunflower was fed to cattle as a de-wormer. *Mabangi mwitu* leaves were used to cure external parasites such as flea in goats. A concoction of hot water and *iyari* leaves was used to massage cattle when injured. A mixture of ground *kilawe* tree leaves and soda ash was filtered, and cattle were given one or two bottles per day depending on their age to cure viral disease, while ground fungi plants were given to cattle as dewomers. In the same district of Moshi Rural, farmers used various herbs to control *kideri* (poultry viral disease, such as Newcastle), which included: squeezed cream from ground leaves of *ufuta pori* (wild sesame) plants; boiled sisal leaves; wild sunflower; mother in law hand (*mkono wa mama mkwe*) tree leaves; a mixture of ground *mabangi mwitu* plant leaves; wild sunflower leaves and water; a concoction of ground wild sunflower, chilli pepper and water; a mixture of ground aloe vera leaves and chilli pepper; boiled aloe vera leaves; and a mixture of *ngaponi* leaves, chilli pepper and water. Boiled aloe vera leaves were administered to poultry before the disease was in its advanced stages.

In Kilosa, pastoralists in Twatwatwa Village used various local herbs to cure their animal diseases. *Orkuluku* (Foot and Mouth Disease) disease in cattle was treated by using various local herbs which included the following: a mixture of ground *oti* and *mkambala* (*Acacia Mellifera*) tree barks and salt; a concoction of ground *oti* and *mkambala* tree barks, salt, charcoal and contents from batteries; or a mixture of boiled *olkiloriti* (*Acacia nilotica*) tree barks, salt and ash. A mixture of *enguruoni* tree ash, and salt or soda ash, or a mixture of ground and burnt *olaiturday* tree fruits was smeared on cattle's feet and mouth to control *Orkuluku* (Foot and Mouth Disease (FMD). In the same district, *ortikana losedeli* (East Coast Fever) disease in cattle was treated by using a mixture of tobacco leaves and water, while ECF for calves was controlled

by using neem tree juice. *Urmukatani* tree roots were boiled and given to calves to treat *ortikana losedeli* (ECF) or *orkikanopi* (Protozoan disease - anaplasmosis). On the other hand, in Kilosa (Kasiki Village), *mdonde* disease (viral disease such as Newcastle) in poultry was controlled by using various herbs which included: a mixture of neem tree leaves and maize bran; a concoction of neem tree leaves and water; a mixture of ground *madaka* tree roots and water; a mixture of chilli pepper and water; neem tree juice; and *madaka* tree leaves.

In Mpwapwa, neem tree leaves were used to treat viral diseases such as Contagious Bovine Pleural Pneumonia (CBPP) in cattle and *kitoga* (Newcastle) diseases in poultry. A mixture of crushed *takalang'onyo* plant and water was also used to cure *kitoga* or *mdonde* (Newcastle) disease in poultry. *Mzenge* tree leaves were smeared on poultry eyes to control viral disease such as fowlpox. In Karagwe, *kibirizi* tree leaves were given to goat and cattle as de-wormers. *Chibilize* tree leaves or *Mubanga* tree barks were given to goat as de-wormers. Sisal fluids and chilli pepper was fed to poultry to treat coccidiosis (protozoan disease). On the other hand, in Songea Rural, a concoction of ground *mgwino* tree, sisal, eucalyptus tree, water and livestock feeds such as maize bran was given to poultry to control *kideri* disease (viral disease such as Newcastle). Tobacco was also used to treat *kideri* disease (Newcastle) in poultry.

Farmers also expressed extensive knowledge on cultural inputs and practices which were used to control animal diseases. For instance in Moshi Rural, farmers used cooking oil, or a mixture of water and soap to cure *ndigana baridi* (protozoan disease such as anaplasmosis) in cattle. Sunflower oil was given to cattle to treat *ndigana moto* disease (East Coast Fever). Bloat disease was treated by using human urine or cooking oil which was given to cattle and they were pushed to run as a healing process. Farmers also rebuilt the animal house and designed a flat floor to prevent miscarriages in cattle. In the same district, a concoction of contents from torch batteries and water was applied on the washed goat's hooves to control foot rot disease. On the other hand, farmers in Kilosa injected cattle with paraffin to treat bloat disease. Ash was applied on cattle's feet and mouth to treat *orkuluku* (viral disease such as FMD). In addition, cattle were given a concoction of ash and water to treat retained placenta disease. In Mpwapwa, cattle were given hot water three times a day to cure FMD disease. In Kasulu, farmers used a mixture of

paraffin and ground *teletele* tree leaves to treat injuries in goat. Consequently, Kilosa farmers used taramise drugs and paraffin to treat East Coast Fever (ECF) in cattle, while antibiotics and neem tree juice were used to control *mdonde* (Newcastle) disease in poultry.

It was established from the focus group discussions that farmers mainly used conventional inputs to control their animal diseases, followed by local inputs and practices. However, lack of awareness on the available inputs and high cost of inputs limited the use of these external inputs to treat animal diseases in the surveyed communities. For example, focus group at Vinghawe Village in Mpwapwa reported that they had never used any input to treat viral disease such as anthrax in cattle because they were not aware of the available solution.

Other local herbs which were not mentioned in the interviews are explained in the following text. In Karagwe, tobacco and *mluku* tree leaves were mixed with soap and four litres of water, then boiled for 20 minutes and mixed again with fourteen litres of water and given to cattle to control ECF disease. In the same district, poultry infected with Newcastle were given neem tree juice to drink. In Songea Rural, *mtununga* tree leaves were used to control cattle's and pig's external parasite diseases. A mixture of water and ground *litupala* and *liyangayanga* plant leaves was given to poultry to cure Newcastle disease. In Mpwapwa, *muhenjele* plant leaves were mashed and added to hot water and the mixture was used to treat bacterial disease such as foot rot disease in cattle. In Kilosa, *mavumbazi* plant leaves were used to control *utitiri* (mites) in poultry. Additionally, a concoction of chilli pepper and water, or a mixture of neem tree barks or leaves and water, or a mixture of maize bran and *usibi* tree leaves were given to poultry to treat viral diseases such as Newcastle. Boiled neem tree barks or leaves were also fermented for a full day and given to poultry to control Newcastle (viral disease) and protozoan diseases such as coccidiosis. In Moshi Rural, boiled wild sisal or aloe vera leaves were also used as de-wormers in cattle. In the same district, farmers used either boiled *mfuru* (*Vitex micrantha*) tree leaves, or *lelema* leaves, or a mixture of water and ground *lelema* leaves to control *ndigana baridi* (protozoan disease - anaplasmosis) in cattle. Paraffin was also used to control *mdonde* disease (Newcastle) in poultry in Kilosa.

Farmers also used a wide range of cultural practices to control animal diseases, such as to pour hot water at the back of the cattle to treat *ndigana baridi* (protozoan disease - anaplasmosis) in Mpwapwa. In Karagwe, farmers believed that pigs could be cured from fever when they put grass on the floor of the animal house. Kilosa farmers always cleaned their animal houses to control mites and *mdonde* disease (Newcastle) in poultry.

5.3.8.2 Prevention of animal diseases

The 146 (80.2%) livestock keepers were asked to indicate if they used any prevention mechanism to protect their animals from diseases. One hundred and six (72.6%) respondents replied affirmatively that they used various means to prevent animal diseases, while 40 (27.4%) did not. Those 106 (72.6%) respondents who reported the use of various methods to prevent animal diseases were asked to provide details of those methods. Again, conventional inputs and practices were the dominant approach used by farmers to prevent animal diseases, with a score of 75 (70.8%) respondents, followed by local herbs and practices 22 (20.2%), and both conventional and local inputs 9 (8.5%). High use of conventional inputs was mainly attributed to the government which provided free vaccinations to some of the animal diseases in the surveyed districts. For instance, the government provided free vaccinations to prevent poultry Newcastle disease, cattle viral diseases (Foot and Mouth Disease (FMD) and Contagious Bovine Pleural Pneumonia (CBPP)) in Moshi Rural.

Data from non-participant observation established that there was low use of local herbs and practices to prevent animal diseases due to the lack of validated inputs, and awareness on the effective inputs and practices. Knowledge was possessed by elderly farmers who were not willing to pass on their knowledge to the young ones. At the same time, young farmers were not interested in learning about local herbs and practices because some inputs were not effective. Some respondents preferred to use conventional inputs rather than local inputs because they were not effective, and animals were procured at a high cost.

While conventional inputs were the main techniques used by farmers to prevent their animal diseases, local herbs also played a key role in preventing animal diseases. In Moshi Rural, cattle were often given ground plant leaves of *lelema* to prevent them from *ndigana moto* disease

(ECF). In Kilosa, a mixture of chilli pepper *and madaka* plant leaves, or a concoction of ground neem tree leaves, water and maize bran was given to poultry to prevent *mdonde* (Newcastle) disease. In Mpwapwa, local vaccine of *msakasaka tree* roots was crushed, added to water and fed to poultry to prevent them from viral diseases. Neem tree leaves and *takalang'onyo* plant leaves were given to poultry to prevent Newcastle disease. In Karagwe, goats were protected from roundworms by using ground *kibirizi* tree leaves as a vaccine.

Cultural practices were also used to protect animals against diseases. For instance, farmers ensured that their animal houses and feeds were clean to prevent their animals from disease outbreaks in Mpwapwa, Moshi Rural, Songea Rural, and Kasulu. Further, farmers in Karagwe and Kilosa isolated their infected animals from the rest of the herd to prevent disease outbreak. Karagwe and Kilosa farmers' also prevented their animals from eating young grasses because they believed that young grasses were contaminated. For instance, one farmer at Twatwatwa Village in Kilosa explained that "my cattle always suffer from *ndigana baridi* accompanied with fever if they eat a certain type of grass, which is called *oseiyai*". A mixture of mature and immature grasses in livestock feeds was also believed to cause *ndigana baridi* disease (protozoa diseases- anaplasmosis) and fever to cattle in Moshi Rural, and roundworms to goats in Kasulu. Kilosa farmers' also mixed charcoal with livestock feeds to prevent poultry from contracting Newcastle disease.

5.3.8.3 Methods preferred by farmers to control animal diseases

The 146 (80.2%) livestock keepers were asked to indicate their preferable measures for controlling animal diseases. The majority of the respondents 103 (70.5%) preferred to use conventional inputs and practices, while 28 (19.2%) respondents preferred to use local herbs and practices, five (3.4%) preferred both conventional and local inputs, while ten (6.8%) did not prefer any method. The major reasons for this preference were that, chemical pesticides were always available and effective to treat animal diseases unlike some of the local herbs and practices. It was also indicated that some of the local herbs had to be administered in early stages before the disease had advanced, otherwise there would be little chances of controlling the disease. Typical response was that "… soaked neem leaves may be given to the infected poultry,

but they need to be administered early otherwise poultry may die from *mdonde* (Newcastle) disease".

Consequently, the major reason for the preferences for local herbs and practices was lack of medical assistance from veterinary officers to control animal diseases. One farmer at Nyansha Village in Kasulu explained that, "I went to the agricultural office at the district headquarter to seek for medical advice regarding Newcastle disease, but I did not get any assistance. Thus, local herbs have been the only solution for controlling the disease". Data obtained from non-participant observation also proved that veterinary officers were few, and thus they were not always available to solve farming problems in the surveyed communities. In addition, in some districts (for example Moshi Rural), the crop extension officers also served as veterinary officers and thus they were not effective to control animal diseases. Other reasons were related to high cost of conventional inputs, and ineffectiveness of some of the conventional inputs. Typical response regarding the ineffectiveness of conventional inputs was that, "…I have tried to vaccinate my poultry against Newcastle disease by using conventional inputs but they died. Thus local herbs (that is, neem tree leaves, or wild sunflower leaves, or boiled aloe vera) have been the only solution to prevent the Newcastle disease in poultry".

Focus group discussions confirmed that conventional inputs and practices were the major methods preferred by farmers to control animal diseases, followed by local herbs and practices, and both conventional and local inputs. Despite the fact that most farmers preferred to use conventional inputs to control animal diseases, some farmers were not satisfied with the use of conventional inputs due to the following: unavailability, some inputs were not effective to control some of the animal diseases, lack of awareness on the available conventional inputs, and high costs of inputs. At the same time, some of the local herbs were also not effective to control animal diseases in the communities. For instance, neem tree juice was not effective to cure poultry infected with Newcastle diseases in Karagwe, despite the fact that it was widely used in other districts such as Kilosa to control the same disease. Lack of awareness on the available local herbs contributed to low preferences of these inputs by farmers.

5.4 The management of agricultural indigenous knowledge

This section presents study findings of the research objectives two and three which were analysed in this study in relation to KM processes. These KM processes include the following: knowledge needs and identification, acquisition, sharing, preservation and application of indigenous knowledge for farming activities. The results of the role of knowledge intermediaries in managing agricultural IK in the local communities are also presented.

5.4.1 The management of agricultural indigenous knowledge: data obtained from local communities

The management of agricultural IK was explored by assessing the identification of farmers' knowledge and information needs, information seeking patterns, and acquisition, sharing, preservation and use of agricultural IK in the communities. Semi-structured interviews, focus groups, and non-participant observation were applied in the local communities.

5.4.1.1 Knowledge and information needs and information seeking patterns

The study findings of the research objective three pertaining to knowledge needs and identification are presented in this section as follows: farmers' knowledge and information needs, information seeking patterns, and the role of intervening variables. Farmers' information and knowledge needs and information seeking patterns were explored in three ways, which included individual semi-structured interviews, focus group discussions and non-participant observation.

5.4.1.1.1 Farmers' knowledge and information needs

In the semi-structured interviews, data was drawn from the variables that were measured to establish the types of knowledge required for farming activities that were difficult to obtain in the surveyed communities. The study demonstrated that while knowledge is needed for all farming activities, the following categories were the main knowledge gaps for the small scale farmers as shown in Table 5.17: control of plant diseases and pests 120 (66.3%), marketing 107 (59.1%), credit and loan facilities 106 (58.6%), and control of animal diseases 99 (54.7%). Irrigation practices 53 (29.3%) had low rate of responses. Other knowledge gaps were early warning and environmental conservation.

However, knowledge needs varied across the surveyed districts as shown in Table 5.17. Control of plant diseases and pests was a major knowledge need for farmers in Kasulu 24 (13.3%), Karagwe 24 (13.3%), and Moshi Rural 22 (12.2%). Agricultural marketing was the main knowledge need for farmers in Kilosa 32 (17.7%), and Karagwe 27 (14.9%). Knowledge on credit facilities and control of animal diseases was a great concern for farmers in Kilosa 34 (18.8%). Soil classification 18 (9.9%) was a main knowledge need for Songea Rural's farmers.

Although data collected through interviews showed that plant diseases was the major concern for farmers in the surveyed communities, data from the information maps which were gathered during focus group discussions indicated that knowledge on agricultural markets, value added technique, and credit were the main knowledge needs in the communities. Despite the discrepancies, broad categories can be drawn that the following were the major knowledge gaps in the communities: plants and animal diseases, markets, value added technique, credit, and animal breeding management. The data from the focus group discussions indicated the following knowledge needs, which are arranged in descending order of importance: reliable markets; value added techniques, credits; animal disease control, animal breeds and crop varieties; plant diseases and pest control, agricultural tools; soil classification and fertility; irrigation practices, land rights and leases; crop husbandry practices, animal husbandry practices; environmental conservation; formation of farmer groups; and early warning.

Table 5.17: Farmers' information and knowledge needs (N=181)

Information and knowledge needs	Districts													
	Mpwapwa		Karagwe		Kasulu		Moshi Rural		Kilosa		Songea Rural		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Soil classification	8	4.4	6	3.3	9	5	11	6.1	20	11	18	9.9	72	39.8
Crop varieties	11	6.1	11	6.1	18	9.9	17	9.4	22	12.2	8	4.4	87	48.1
Crop husbandry	6	3.3	8	4.4	8	4.4	13	7.2	20	11	3	1.7	58	32
Irrigation	4	2.2	3	1.7	13	7.2	12	6.6	19	10.5	2	1.1	53	29.3
Agricultural tools	16	8.8	22	12.2	14	7.7	11	6.1	21	11.6	5	2.8	89	49.2
Animal feeding	2	1.1	8	4.4	8	4.4	19	10.5	31	17.1	2	1.1	70	38.7
Animal breeding	4	2.2	3	1.7	8	4.4	13	7.2	31	17.1	2	1.1	61	33.7
Credit facilities	10	5.5	17	9.4	16	8.8	15	8.3	34	18.8	14	7.7	106	58.6

Land preparation	6	3.3	3	1.7	11	6.1	13	7.2	20	11	1	0.6	54	29.8
Soil fertilization	7	3.9	14	7.7	20	11	12	6.6	21	11.6	13	7.2	87	48.1
Value added	10	5.5	4	2.2	10	5.5	12	6.6	22	12.2	7	3.9	65	35.9
Marketing	7	3.9	27	14.9	11	6.1	15	8.3	32	17.7	15	8.3	107	59.1
Animal housing	2	1.1	5	2.8	8	4.4	13	7.2	27	14.9	2	1.1	57	31.5
Animal diseases	11	6.1	16	8.8	19	10.5	16	8.8	34	18.8	3	1.7	99	54.7
Plant diseases and pests	21	11.6	24	13.3	24	13.3	22	12.2	17	9.4	12	6.6	120	66.3

Further analysis shows that there were slight variations in the information and knowledge needs across gender categories as depicted in Figure 5.4. Females mainly needed knowledge on value added techniques, crop planting, and irrigation with a score of 29 (42%), 25 (36.2%), and 23 (33.3%) respondents respectively. While, males needed knowledge on agricultural marketing, and soil fertility as compared to women, accounting for 70 (62.5%), and 57 (50.9%).
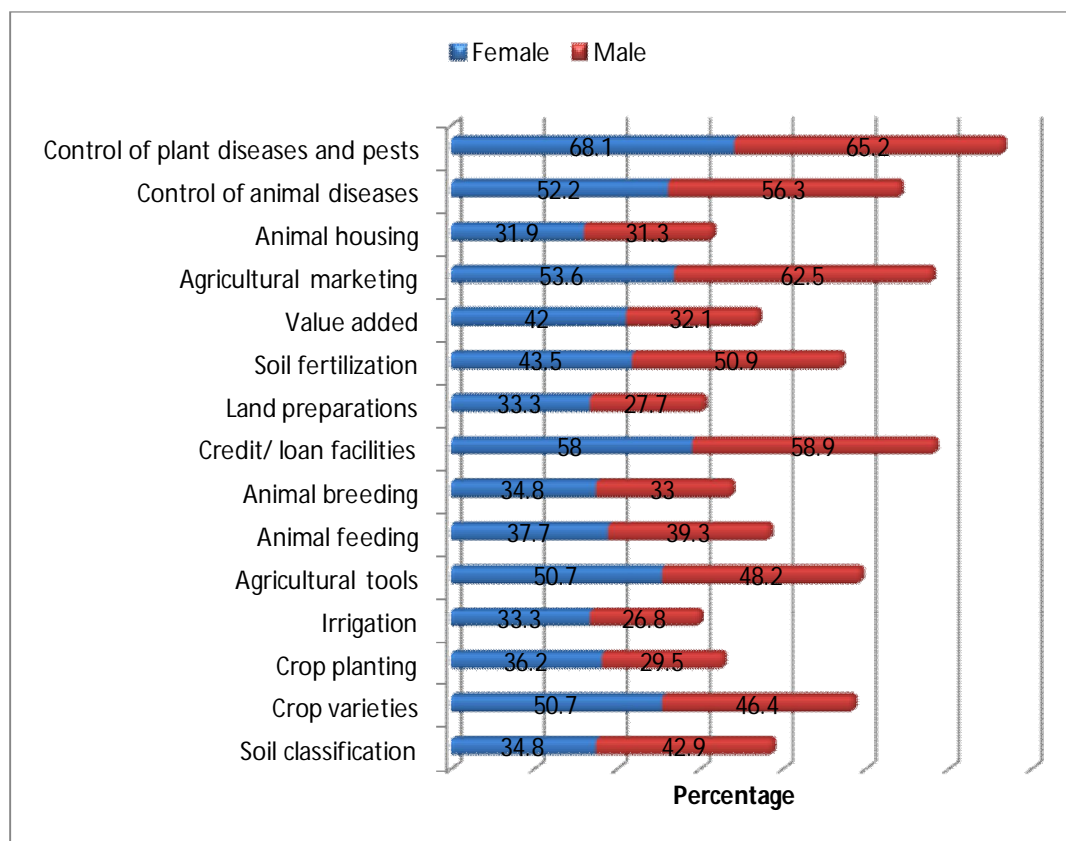
Figure 5.4: Farmers' information and knowledge needs by gender (N=181)

5.4.1.1.2 Information-seeking patterns

Slightly more than half of the respondents 93 (51.4% of 181 respondents) had tried to look for ways to solve their knowledge and information problems, while 88 (48.6%) had not. The 93 (51.4%) respondents were asked to mention which sources they consulted to solve their knowledge problems. This was an open-ended question and that is why the responses were low. Farmers largely sought knowledge from friends/neighbours 40 (43%). Extension officers 33 (35.5%), agricultural inputs suppliers 16 (17.2%) and family/parents 16 (17.2%) were also important sources of knowledge in which farmers consulted. Other knowledge sources included farmer groups 11 (11.8%), personal experience 10 (10.8%), village leaders 7 (7.5%), NGOs 4 (4.3%), district officials 4 (4.3%), radio 4 (4.3%), village meetings 3 (3.2%), middlemen 3 (3.2%), and cooperative unions 2 (2.2%). Farmers made little use of knowledgeable farmers, printed materials, and television, with a score of 1 (1.1%) each.

Those 93 (51.4%) respondents who indicated that they had tried to find ways to solve their knowledge problems were also asked to indicate what happened when they tried to access knowledge. More than half of the respondents 53 (57%) acknowledged that they had managed to solve a portion of their information and knowledge problems.

Data obtained from the information maps which were collected during focus group discussions confirmed that most of the respondents had tried to look for ways to solve their farming problems. For their information and knowledge needs, farmers mainly consulted the extension officers and village leaders. Neighbours and district authorities were also important sources of knowledge and information in which farmers consulted. Little consultation was made of agricultural input suppliers, libraries and agricultural researchers. The focus groups showed that extension officers were largely consulted by farmers in Moshi Rural (Mshiri Village), Karagwe (Iteera Village), and Kasulu (Nyansha Village). Village leaders were important in Karagwe (Iteera Village), and Mpwapwa (Mazae and Vinghawe Villages). For instance, farmers in Karagwe (Iteera Village) indicated that, "we have a procedure of informing the extension officer or village leaders in case of a problem such as plant disease outbreaks, for example banana panama". Farmers in Mpwapwa (Mazae Village) also reported that, "we follow a normal channel where we discuss our problems at the village meetings, and then we forward them to the ward,

division and district meetings. However, the district authority has been too slow to respond to our needs". Further, the focus groups also showed that information seeking patterns were location specific. Neighbours were important sources of knowledge in case of farming problems in Kasulu (Nyansha Village), and Mpwapwa (Mazae Village). District authorities were largely consulted by farmers in Kilosa (Kasiki Village), and Mpwapwa (Mazae Village), while agricultural input suppliers were important in Karagwe (Katwe Village) and Kilosa (Twatwatwa Village). Libraries were consulted by farmers in Kilosa (Kasiki Village), and agricultural researchers were important in Songea Rural (Materereka Village).

5.4.1.1.3 Role of intervening variables

In this study, there were several variables that inhibited farmers from seeking agricultural information and knowledge. Data from semi-structured interviews indicated that unavailability of the extension officers was the major problem that hindered farmers from seeking knowledge. Other problems, arranged in descending order of importance included the following:

- Unavailability of the public extension officers: Most of the surveyed communities either lacked extension officers or they had only a few extension officers to assist them when they had problems. In Moshi Rural (Lyasongoro Village), for example one respondent indicated that "extension officers are not available most of the time, and thus I rely on my neighbours for advice in case of a problem". In Kilosa (Kasiki Village), another respondent reported that "there is no need to seek information or consult veterinary officer to control animal diseases because they are few". Farmers in Karagwe (Iteera and Katwe villages), and Kasulu (Nyansha and Kidyama villages) did not have extension officers, and they lacked funds to travel to the district headquarters for consultations with the extension officers in case of problems;

- Lack of awareness: Farmers were not aware of their right to consult formal sources of knowledge such as extension officers or district officers through their village leaders once they had a problem. Thus, most of them depended on the informal sources of knowledge such as family, neighbours and friends, who at times were not knowledgeable or reliable to solve their problems. For instance, in Kilosa (Kasiki Village), one respondent indicated that, "I am scared to apply for a loan because I'm illiterate, old and there are difficult conditions to

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access credits". Another respondent in Kasulu (Nyansha) reported that, "lack of understanding on where else to get information apart from my family and neighbours has hindered me to solve some of the problems I encounter in my farming activities";

- Location: Concerns were raised about the long distance that farmers had to travel to consult the extension officers at the district headquarters or in other villages, or to negotiate prices with middlemen. For instance, farmers in Kasulu and Karagwe were located very far from district headquarters and they lacked village extension officers. The Songea Rural's farmers were also located very far from the district market, and thus it was difficult for them to access reliable market information. For instance, one farmer in Songea Rural reported that, "the market is too far to get reliable information on markets. Thus, I only consult my neighbours and friends who do not have accurate information";

- False promises and slow response from the government and village leaders: More often, the government leaders promise to solve the farmers' problems during an election but they never fulfill their promises. One farmer in Moshi Rural, (Mshiri Village) reported that, "government leaders always promise to bring exotic cattle breeds when they are campaigning for elections. However, they never fulfill their promises once they are elected". Another farmer in Kilosa (Twatwatwa Village) indicated that, "we have tried to approach district officials for information on how to start a Savings and Credit Co-operative Society (SACCOS) but they have never conducted that training". Village leaders were also unable to solve farmers' problems. For instance, one farmer in Kilosa (Kasiki Village) indicated that "we had reported to the village authority that we need knowledge on how to control predators, but they have never managed to solve the problem";

- Social factors: Socio-economic status and age limited some farmers to seek knowledge from their fellow farmers, farmer groups, village authorities and extension officers. One respondent in Songea Rural (Lilondo Village) reported that, "I'm discouraged to seek knowledge from village or district authorities due to my low income, since they will ignore my needs". Other farmers especially in Songea Rural, Moshi Rural, Kilosa, and Kasulu reported that they were too old to seek information and knowledge from various sources that existed within and outside their villages. For instance, one farmer in Kilosa (Kasiki Village) indicated that, "I am not able to join any farmer groups because I'm too old. Thus, I rely on

my neighbours and family for advice when I have a problem". Another farmer in Kasulu (Kidyama village) said that, "I am too old to attend village meetings about agriculture. Therefore, I rely on my neighbours and family for advice when I have a problem";

- Resistant to change: Some farmers were resistant to change in order to adopt new knowledge due to ignorance and lack of encouragement from their leaders to seek and adopt new information and knowledge. In Kilosa (Twatwatwa Village) for example, some respondents indicated that they were not willing to learn from other farmers because they preferred their personal experiences. Other farmers in Kasulu (Kidyama Village) indicated that they were not encouraged or motivated by their village leaders to consult their fellow farmers in case of farming problems;

- Inability of some experts to solve problems: Some farmers in Moshi Rural and Kilosa were discouraged to seek information and knowledge from within and outside their villages because some of that knowledge was not effective to solve their problems. Typical responses included:

  "….I contacted the extension officer and she told me to uproot the banana plant and leave the banana pit open in order to treat *kisoli* (banana weevil) disease. However, I have not been successful to control the disease".

  "……I consulted the agricultural input supplier and I was told to use vaccines for Newcastle poultry disease. However, I have not been successful to control the disease";

- High cost of inputs and tools: Some farmers acknowledged that they knew the kinds of interventions they had to take, however the agricultural tools (such as oxen-drawn plow) and agricultural inputs (like improved seeds, fertilizers, and pesticides) were expensive;

- Selfishness: Some farmers were selfish about sharing their knowledge, which limited other farmers in seeking knowledge and information. For instance, one farmer in Kilosa (Kasiki Village) reported that there was little cooperation from neighbours when one wants advice on agricultural activities. Some farmers indicated that others would benefit if they shared their knowledge;

- Small-scale farming: Most farmers felt that there was no need to seek information and knowledge to solve their farming problems because they were on a small-scale basis;

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- Technology: One respondent in Kilosa (Kasiki Village) indicated that, "it is difficult to access knowledge through radio because one has to memorize what is aired from the radio programmes. Instead, I would prefer knowledge to be delivered through printed format such as newspapers for future reference"; and

- Lack of skills on indigenous farming: Some farmers were discouraged to seek knowledge and information from formal sources such as extension officers because they were ignorant about indigenous farming techniques.

Some data collected through information maps which were gathered during focus group discussions confirmed findings obtained from the interviews. The focus groups confirmed that the unavailability of extension officers was a major problem which limited farmers from seeking knowledge and information. Factors that inhibited farmers from seeking knowledge and information in their communities are explained in the following text, which are arranged in descending order of importance: unavailability of public extension services; poor response from government authorities; lack of awareness on the available sources of knowledge and information and their right to seek knowledge and information; poor knowledge sharing culture; and high library services charges. Other factors included selfishness; socio-economic factors; high cost and unavailability of inputs and tools; illiteracy; and lack of funds to purchase printed materials or to travel to other villages or district headquarters for consultations with extension officers.

5.4.1.2 Acquisition of agricultural indigenous knowledge from tacit and explicit sources of knowledge

The respondents were asked to mention tacit and explicit sources of agricultural indigenous knowledge (IK), frequency of accessing that knowledge and type of IK obtained from tacit and explicit sources of knowledge. On the acquisition of IK, Table 5.18 indicates that the primary sources of agricultural IK were predominantly local, which included parents or family 170 (93.9%), neighbours and friends 156 (86.2%), and personal experience 154 (85.1%). Other major sources of IK were also local sources, which included social group gatherings 66 (36.5%), demonstration and observation 57 (31.5%), and farmer groups 44 (24.3%).

Table 5.18: Tacit and explicit sources of agricultural indigenous knowledge by district (N=181)

Knowledge sources	Districts													
	Mpwapwa		Karagwe		Kasulu		Moshi Rural		Kilosa		Songea Rural		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Personal experience	22	12.2	25	13.8	17	9.4	28	15.5	33	18.2	29	16.0	154	85.1
Parents/ guardian/family	28	15.5	30	16.6	23	12.7	28	15.5	36	19.9	25	13.8	170	93.9
Neighbour/Friends	24	13.3	28	15.5	25	13.8	28	15.5	28	15.5	23	12.7	156	86.2
Women meetings	-	-	1	0.6	1	0.6	3	1.7	5	2.8	2	1.1	12	6.6
Livestock headers	9	5.0	-	-	3	1.7	2	1.1	8	4.4	-	-	22	12.2
Demonstration and observation	9	5.0	1	0.6	3	1.7	21	11.6	14	7.7	9	5.0	57	31.5
Newsletters	-	-	1	0.6	-	-	9	5.0	1	0.6	2	1.1	13	7.2
Posters	-	-	-	-	-	-	-	-	3	1.7	2	1.1	5	2.8
Church/mosque	-	-	2	1.1	1	0.6	9	5.0	5	2.8	1	0.6	18	9.9
Social group gatherings	3	1.7	1	0.6	15	8.3	24	13.3	16	8.8	7	3.9	66	36.5
Village leaders	1	0.6	6	3.3	2	1.1	4	2.2	9	5.0	-	-	22	12.2
Farmers' groups	-	-	2	1.1	5	2.8	12	6.6	6	3.3	19	10.5	44	24.3
Village meetings	-	-	3	1.7	2	1.1	5	2.8	6	3.3	-	-	16	8.8
Newspapers	1	0.6	3	1.7	-	-	-	-	4	2.2	2	1.1	10	5.5
Books	-	-	3	1.7	-	-	3	1.7	2	1.1	5	2.8	13	7.2
Seminars	-	-	5	2.8	-	-	2	1.1	1	0.6	4	2.2	12	6.6
Agricultural shows	1	0.6	3	1.7	3	1.7	3	1.7	2	1.1	-	-	12	6.6
NGOs	-	-	1	0.6	1	0.6	10	5.5	-	-	-	-	12	6.6
Researchers	-	-	-	-	-	-	4	2.2	-	-	-	-	4	2.2
Extension officers	-	-	-	-	-	-	3	1.7	-	-	1	0.6	4	2.2
Cooperatives	-	-	-	-	-	-	1	0.6	-	-	-	-	1	0.6

(Multiple responses were possible)

Farmers made little use of formal sources of knowledge, which included Non Government Organisations (NGO) 12 (6.6%), seminars 12 (6.6%), agricultural shows 12 (6.6%), public extension officers, four (2.2%), agricultural researchers, four (2.2%), and cooperative union, one (0.6%). Similarly, printed materials were less considered by farmers as important sources of agricultural indigenous knowledge.

However, responses varied across the districts. Table 5.18 shows that personal experience was a major source of IK for farmers in Kilosa 33 (18.2%), Songea Rural 29 (16%), and Moshi Rural 28 (15.5%), while parents were the main source of knowledge for farmers in Kilosa 36 (19.9%), Karagwe 30 (16.6%), Moshi Rural 28 (15.5%), and Mpwapwa 28 (15.5%). Neighbours were the major sources of IK for farmers in Moshi Rural 28 (15.5%), Kilosa 28 (15.5%), and Karagwe 28 (15.5%). Formal sources of knowledge such as NGO, agricultural researchers, extension officers and farmer groups were important in Moshi Rural, while farmer groups were significant in Songea Rural.

Figure 5.5 shows that there were slight differences in access to IK across gender categories. Males had access to a much larger set of formal sources of knowledge, including seminars 8 (7.1%), agricultural shows 8 (7.1%), and newspapers 8 (7.1%), as compared to females. Women relied on NGOs 8 (11.6%), and local sources of knowledge, which included personal experience 60 (87%), parents/family 67 (97.1%) and neighbours/friends 60 (87%).
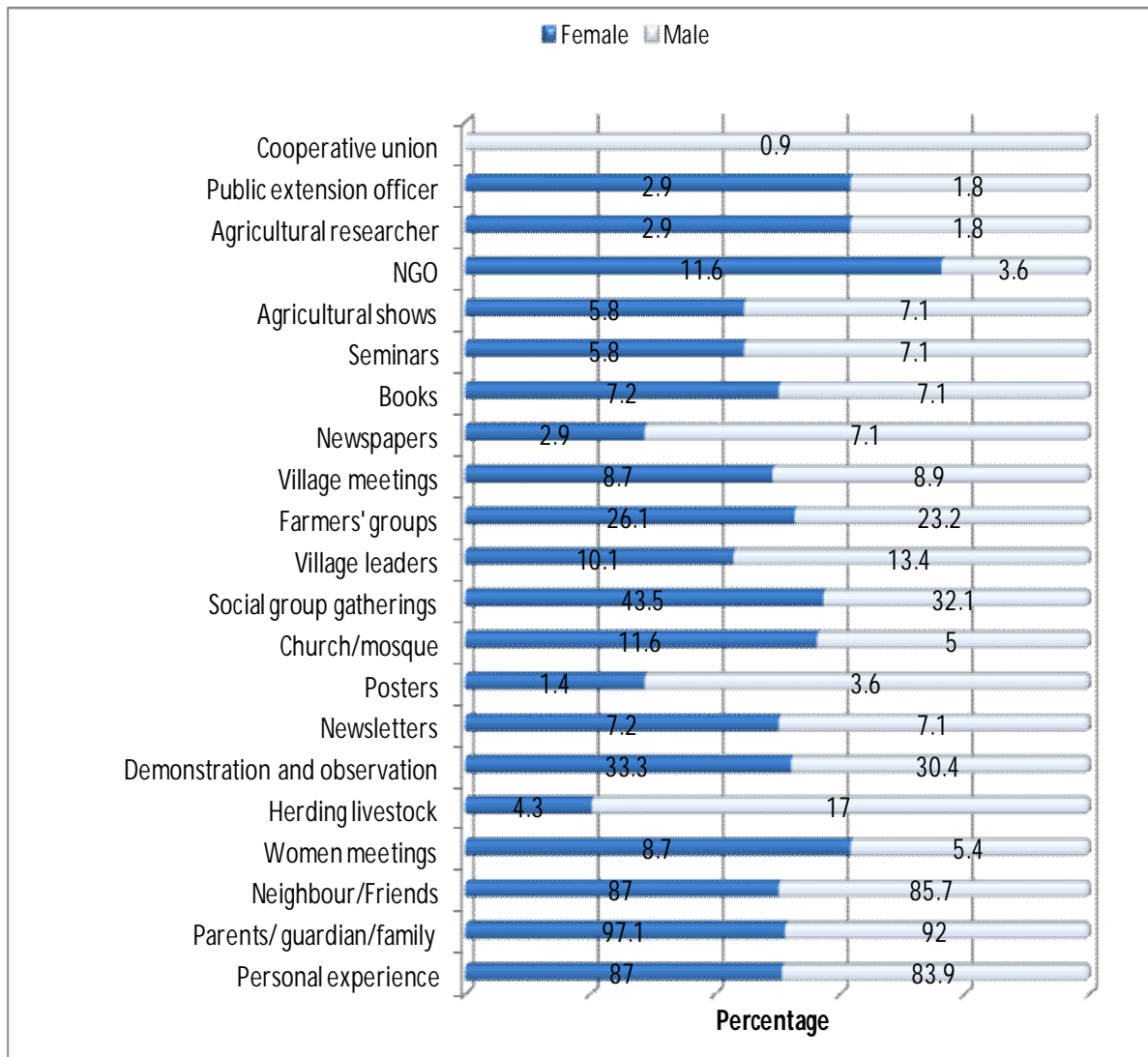
Figure 5.5: Explicit and tacit sources of agricultural indigenous knowledge used by gender (N=181)
(Multiple responses were possible)

5.4.1.2.1 The frequency of acquiring agricultural indigenous knowledge

For each of IK sources, the respondents were asked to indicate frequency of accessing agricultural IK from tacit and explicit sources of knowledge. The responses highlight again the predominance of the parents/family, neighbour/friends, social groups and farmer groups as primary sources of IK they most frequently consulted as depicted in Table 5.19. The frequencies were 107 (64.1%) for parent/family, 99 (62.7%) for neighbours/ friends, 45 (66.2%) for social group gatherings, and 14 (38.9%) for farmer groups. Farmers were also in frequent contact with

the parents/family 42 (25.1%), neighbours/friends 40 (25.3%), social group gatherings 17 (25%), farmer groups 16 (44.4%), and NGOs 10 (83.3%). Farmers were in less contact with the printed materials, public extension officers, agricultural researchers and agricultural shows.

Table 5.19: Tacit and explicit sources of agricultural indigenous knowledge and the frequency of access (N=181)

Sources of indigenous knowledge	Very often		Often		Neither often nor seldom		Seldom		Very seldom	
	No	%	No	%	No	%	No	%	No	%
Parent/family (n=167)	107	64.1	42	25.1	11	6.6	5	3	2	1.2
Neighbour/friends (n=158)	99	62.7	40	25.3	12	7.6	5	3.2	2	1.3
Social group gatherings (n=68)	45	66.2	17	25	4	5.9	1	1.5	1	1.5
Religious leaders (n=13)	2	15.4	4	30.8	4	30.8	1	7.7	2	15.4
Women's meetings (n=5)	5	100	-	-	-	-	-	-	-	-
Farmer groups (n=36)	14	38.9	16	44.4	4	11.1	-	-	2	5.6
Livestock headers (n=15)	11	73.3	4	26.7	-	-	-	-	-	-
Village meetings (n=15)	3	20.0	2	13.3	9	60	1	6.7	-	-
Agricultural shows (n=10)	-	-	-	-	4	40	4	40	2	20
Newspapers (n=8)	1	12.5	1	12.5	3	37.5	1	12.5	2	25
Books (n=13)	2	15.4	3	23.1	3	23.1	2	15.4	3	23.1
Newsletters (n=12)	-	-	8	66.7	1	8.3	1	8.3	2	16.7
Seminars (n=10)	1	10	2	20	2	20	2	20	3	30
Posters (n=4)	2	50	-	-	-	-	-	-	2	50
NGOs (n=12)	-	-	10	83.3	1	8.3	1	8.3	-	-
Researchers (n=4)	-	-	3	75	1	25	-	-	-	-
Extension officers (n=4)	1	25	-	-	2	50	1	25	-	-
Observation (n=34)	3	8.8	27	79.4	3	8.8	1	2.9	-	-
Village leaders (n=12)	2	16.7	-	-	9	75	-	-	1	8.3

(Multiple responses were possible)

5.4.1.2.2 Types of agricultural indigenous knowledge

The respondents were asked to indicate the types of agricultural IK they obtained from tacit and explicit sources of knowledge. Their multiple responses are shown in Appendix 15. The majority of respondents obtained knowledge on crop husbandry from tacit and explicit sources of knowledge, which included parents 100 (55.2%), neighbours 73 (40.3%), social groups 21 (11.6%), and farmer groups 10 (5.5%). Other major types of IK that were obtained from these sources were knowledge on new varieties and techniques, and value added techniques. Few farmers obtained IK on agricultural tools from tacit and explicit sources of knowledge.

5.4.1.3 Knowledge development

Further analysis of the individual interviews showed that farmers used their own knowledge or combined their knowledge with other indigenous or exogenous knowledge to create new knowledge, better ideas, and new effective agricultural processes. Farmers carried out their local experiments in order to seek solutions to their problems, out of curiosity, and as an adaptation to new technology. Firstly, farmers carried out local experiments in order to seek solutions to their problems such as shortage of land, and to control animal diseases. Typical responses included:

"...I planted vegetables on the hills due to shortage of land where I was able to produce high yields afterwards" Moshi Rural (Lyasongoro Village).

"I injected the cattle with a mixture of salt and water in order to treat body wounds. However, it was not effective to treat the disease because the fluid did not spread within the body. However, the cattle's condition got worse and as a result it had abscess" (Kilosa, Twatwatwa Village).

Secondly, new knowledge was generated through experiments driven by personal curiosity. Through experience, farmers conducted local experiments to test if their own ideas would work in their farms. Farmers in Kilosa (Kasiki Village) and Songea Rural (Lilondo Village) based on their personal experiences and trial and error to select land for planting their crops, and after some experiments they were successful to select arable land for farming. Kilosa farmers' were able to determine that rice grows well in lowlands with high presence of water after some trial and error. Other farmers tested various techniques in order to control animal diseases, and improve soil fertility. Typical responses included:

"I tried to intercrop maize and beans in my farm to see if I would improve my crop production. Later, I found out that I was able to improve my crop yields" (Songea Rural, Materereka Village).

"..I tried to use two different measures to cure the Newcastle disease in poultry. I used vaccines to treat the disease to some poultry, and I gave the neem tree juice to other poultry. Later on, I found out that the vaccines were effective to control the disease as compared to neem tree juice, because some of the poultry died due to the use of neem tree juice". (Kasiki village, Kilosa)

"…I mixed animal manure and mineral fertilizers (i.e. NPK) in order to improve animal manure. Later on, I was able to improve my crop yields due to increased soil fertility" (Mshiri village, Moshi Rural).

Thirdly, farmers carried out experiments by adapting and transferring new knowledge to new environment, which included new crop varieties and crop husbandry. For instance, one farmer in Moshi Rural (Lyasongoro Village) acknowledged to planting traditional pumpkin called *majani ya maboga (Cucurbita pepo L.)* to test if it would work on her farm after she heard about it from another village. The findings showed that one farmer in Moshi Rural (Mshiri Village) learnt the technology from a different village about the use of polythene bags to cultivate vegetables. However, the farmer was not sure if the external knowledge would help her to improve her vegetable production. Thus, she tested the new knowledge by planting pumpkins on the polythene bags, and planted other vegetables in the garden. The results showed that the vegetables which were planted in the polythene bags had high yields as compared to those which were planted in the garden. Other farmers acknowledged to applying new indigenous technologies to see if they work in their farming systems. Another farmer in Kasulu (Nyansha Village) also planted local maize varieties on her farm to test if they would improve her crop yields after she was informed by her neighbour about those varieties.

5.4.1.4 Sharing and distribution of agricultural indigenous knowledge

The respondents were asked to provide details on methods that were important in sharing IK in their communities, which included folklore practices, farmer groups, apprenticeships, and initiation rites during adolescence age.

5.4.1.4.1 Folklore practices

This section sought to establish the role of folklore in sharing agricultural IK. The respondents were asked to describe types of folklore performed in their communities, occasions on which the folklore were performed, the purpose of performing those aspects of folklore, the attendance at these activities relating to folklore and the performers who presented the folklore activities.

5.4.1.4.1.1 Types of folklore

When asked to indicate if activities in relation to folklore were practiced in their communities, seventy nine (43.6%) respondents replied affirmatively that folklore activities were still practiced, while 102 (56.4%) did not. The 79 (43.6%) respondents who had indicated that folklore activities were still practiced in their communities were asked to state kinds of folklore that were practiced in their communities. Songs were the major form of folklore practiced across the districts, with a score of 69 (87.3%) respondents. Other forms of folklore were dance 56 (70.9%), storytelling 45 (57%), drama 26 (32.9%), puppet shows 12 (15.2%), plays 9 (11.4%), debates 7 (8.9%), and poetry 4 (5.1%). Further, there were variations of the folklore activities practiced across the regions. Songs were the major folklore activities practiced in Mpwapwa 25 (31.6%), Moshi Rural 21 (26.6%) and Kilosa 17 (21.5%). Story telling was mainly practiced in Mpwapwa 16 (20.3%) and Kilosa 13 (16.5%). Traditional dances were mainly practiced in Mpwapwa 22 (27.8%), Kilosa 18 (22.8%) and Moshi Rural 11 (13.9%). Other folklore activities such as drama and reciting proverbs were mainly performed in Mpwapwa, with a score of 17 (21.5%) and 15 (19%) respondents respectively.

5.4.1.4.1.2 The occasion of folklore activities

The 79 (43.6%) respondents who reported that folklore was still practiced in their communities were asked to indicate the occasion on which folklore was practiced. Figure 5.6 indicates that various forms of folklore were mainly practiced during social-cultural events in the communities. Songs 42 (53.2%), dance 39 (49.4%), and reciting proverbs 18 (22.8%) were the major types of folklore activities practiced in the socio-cultural events. These social-cultural events mainly included wedding ceremonies, initition rites during adolescence age, and cultural ceremonies, followed by funerals, entertainment, circumcision, and new born ceremonies. Other major occasions where various forms of folklore were practiced included the following: during harvesting season, political events, evening, farming season, and tourism season. Various forms of folklore were less performed during religious events, development projects events, agricultural shows and health events. Story-telling mainly took place during the evening 44 (55.7%). Proverbs were mainly performed at the social-cultural events 18 (22.8%), followed by harvesting seasons 6 (7.6%) and political events 4 (5.1%). Other types of folklore were less performed at all occasions, which included drama, debates, plays, poetry and puppet shows.
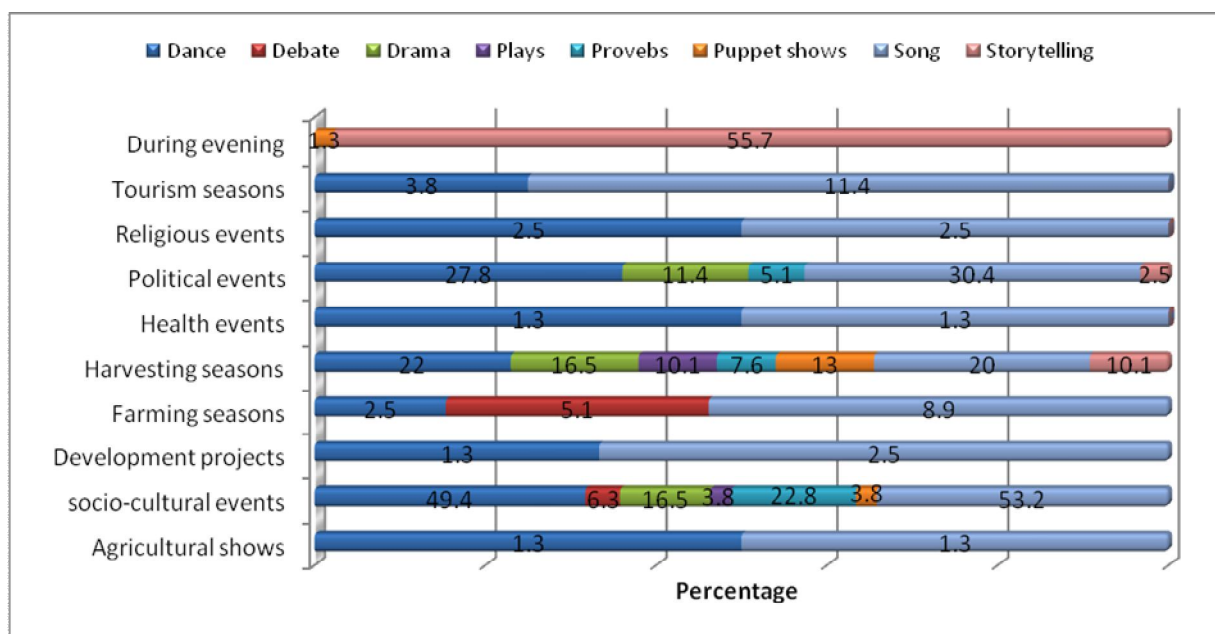
Figure 5.6: The occasion of folklore activities (N=79)
(Multiple responses were possible)

5.4.1.4.1.3 The purpose of practicing folklore activities

The 79 (43.6%) respondents were asked to indicate the purpose of practicing folklore activities. Various forms of folklore were performed for social purposes, which included songs, traditional dances, story telling, and proverbs. Other major purpose for performing various types of folklore were cultural, agricultural, political, and historical. Folklore were practiced at a low rate for tourism, religion, and health pupoes. Songs and traditional dances were mainly performed for cultural, social, agricultural and political issues, while story-telling were carried out mainly for agricultural, social, historical and cultural issues. Reciting proverbs, story telling, songs and traditional dances were important in disciplining the communities, while drama was mainly performed for cultural, political and agricultural purposes.

The study findings showed that despite the importance of folklore for cultural issues, they were significant for sharing agricultural knowledge in the surveyed communities. For example, a song from chagga ethnic group in Moshi Rural shows how songs were used to encourage farming in the local communities.

"…..Oyahe, wilewile wileleoya, mangi kaghambalewai oya, kaghamba lukape matuta oya, matuta mali gha serekalie oya, oyahe wilewile wilelee oya"

Translation:

"……Chief has said that lets design terraces for farming purposes. The design of these terraces is an instruction from the government".

An inquiry into whether everybody was allowed to attend folklore performances indicated that almost everyone was allowed to attend there. There were few cases were the attendance to folklore activities was restricted to selected members of the communities. For instance, children were the major audience for storytelling across the districts, and tourists were the major audience for folklore (dances and songs) which were performed for tourism purposes in the Moshi Rural district. Certain types of folklore such as dances and songs which were performed for socio-cultural issues such as weddings and initiation rites were restricted to invited people or elders across the surveyed districts. Despite the fact that the attendance at most of the folklore was not restricted, it emerged that the attendance to these folklore activities was very low due to ignorance and poor recognition of folk media, and the advancements of technologies such as radio and television broadcasts which had replaced the traditional dances and storytelling.

Asked to indicate if everybody was allowed to perform folklore in the communities showed that almost everybody was allowed to perform all types of folklore. There were special entertaining groups in Moshi Rural, Kilosa, Karagwe and Mpwapwa which were used to perform songs, and traditional dances. Special entertaining groups were less used to perform drama, puppet shows and poetry. Further, elders mainly facilitated storytelling in the surveyed communities for historical, socio-cultural, agricultural and political purpose.

5.4.1.4.2 Farmer groups

The study sought to establish the role of farmer groups in sharing IK in the communities. The respondents were asked to indicate the objectives of their farmer groups, frequency of holding meetings in the farmer groups, location of holding farmer groups meetings, sharing of groups decisions, and the relationship among farmer groups.

5.4.1.4.2.1 The objectives of farmer groups

The respondents were asked to indicate if they were members of any associations that existed in their communities, the type of farmer groups they were attached to, if those farmer groups were registered, and objectives of those farmer groups. The study findings showed that 74 (40.9%) respondents were involved in the associations that existed in their communities, while 107 (58%) were not. The respondents were asked to indicate if those associations were related to agricultural activities. Sixty three (85.1%) of the respondents were involved in agricultural related associations, while 14 (18.9%) were involved in non-agricultural related groups, which included entertainment, health, cookery, religious, tourism, and social groups.

Those 63 (85.1%) respondents who indicated that they were involved in agricultural related groups were asked to indicate if their groups were registered. The majority of the farmer groups were registered 49 (77.8%), while 17 (27%) were not.

The 63 (85.1%) respondents were asked to indicate the objective of their farmer groups. The majority of the farmer groups were involved in agricultural production, with a score of 40 (42.6%) respondents in formal groups, and 15 (75%) respondents in the informal groups. The second highest objective was to access credits, accounting for 33 (35.1%) of formal groups, and one (5%) of informal groups. The third highest objective was to market their agricultural produce, with a score of 17 (18.1%) respondents in the formal groups and two (10%) respondents in the informal groups. The least cited objectives were knowledge about securing land rights, accounting for one (1.1%) of formal groups, and fabrication of agricultural tools, with a score of one (5%) for informal groups.

The study sought to establish the extent to which the sharing of agricultural IK in the farmer groups took place. Of 40 (63.5%) respondents who were involved in formal farmer groups, nine (22.5%) respondents were involved in organic farmer groups which promote the use of local inputs and technologies, while five (12.5%) respondents were involved in farmer field schools which focus on prioritizing farmers' needs and knowledge. The remaining respondents 26 (65%) in the formal farmer groups were focused on the application of conventional technologies in the farming systems. On the other hand, farmers learnt about IK through informal groups engaged

with agricultural production 15 (23.8%), environment 1 (3.2%) and fabrication of agricultural tools 1 (1.6%).

5.4.1.4.2.2 How group members and non-members found out about the groups' decisions

When the 63 (85.1%) respondents were asked to indicate how they found out about their farmer group's decisions, the majority of the respondents knew about their farmer group decisions through group meetings, accounting for 45 (71.4%) of formal farmer groups and six (9.5%) of informal farmer groups. Other ways of accessing information on groups decisions were through group leaders, eight (14.5%), posters, one (1.8%) and church announcements, one (1.8%) for the formal farmer groups category. Further, the 63 (85.1%) respondents were asked to describe how they shared their group decisions with other farmers in the communities. Group members were a major source of knowledge in the communities regarding group decisions, accounting for 26 (41.3%) of formal farmer groups, and two (33.3%) of informal farmer groups as indicated in Figure 5.7. Group leaders were the next most listed sources of knowledge to the communities regarding groups decisions, accounting for 14 (22.2%) of formal farmer groups, and one (16.7%) of informal farmer groups. Extension officers, posters and village leaders were less considered as important sources of farmer groups' decisions in the surveyed communities.
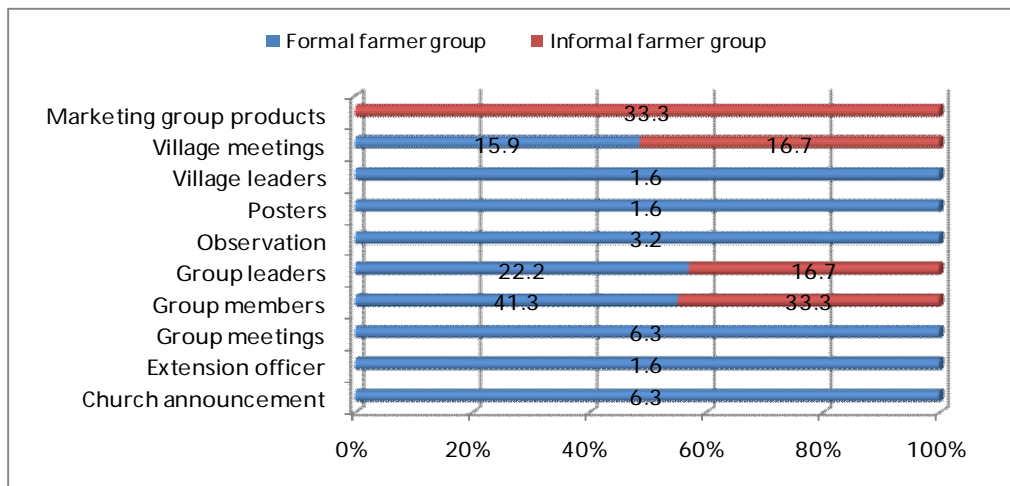
Figure 5.7: How farmer group non-members found out about groups' decisions (Formal farmer groups = 63, Informal farmer groups = 6) *(Multiple responses were possible)*

5.4.1.4.2.3 Relationship among farmer groups

Farmer groups were found to collaborate with each other, although at a minimal rate. NGOs in Moshi Rural and Songea Rural enabled the formal farmer groups to cooperate with each other because the groups were all organised under these NGOs. In Kilosa and Songea Rural, NGOs also enabled farmers to form relationships with other farmer groups in different villages through exchange visits. The researchers also enabled the collaboration among formal farmer groups in Moshi Rural. Village meetings, fund raising or any developmental issue provided a forum in which various farmer groups were able to share their experiences in Moshi Rural. On the other hand, informal farmer groups were found to collaborate and share ideas through village meetings in Karagwe (Iteera village) and Kilosa (Twatwatwa village).

5.4.1.4.3 Apprenticeships

An inquiry into whether respondents were practising apprenticeships indicated that they were practiced at a low rate, with a score 47 (26% of 181 respondents). When the 47 (26%) respondents were asked to indicate kinds of apprenticeships that existed in their communities, those for blacksmiths 33 (70.2%) were the predominant form of apprenticeship practiced in the communities, followed by wood carving 13 (27.7%), bead making, eight (17%), clay pot making, six (12.8%), gourd making, three (6.4%), basket making, two (4.3%), and tailoring, two (4.3%). The least cited apprenticeships were bicycle repairing, house building, car repairing, weaving, and traditional irrigation system, with a score of one (2.1%) each.

Most of these apprenticeships focused on instilling agricultural indigenous techniques and practices in children and the community at large, with exception of a few apprenticeships such as those for weaving, house building, bead making, tailoring, car and bicycle repair, and some of the wood carving practices (for making utensils and ornaments) and iron smithing for making utensils and string beds. The major aim of most of these apprenticeships was to improve agricultural production, through the fabrication of agricultural tools, storage structures for crops and seeds varieties, traps for controlling pests, and use of traditional irrigation system. Those apprenticeships that focused on the use of agricultural indigenous techniques and practices are described in the following text, which are arranged in descending order of importance:

- Blacksmith work involved the art of making agricultural tools such as hand hoe, axe, panga, sickles, chisels, cattle nose pins by using traditional tools and methods across the districts. Apart from handheld implements, the Mpwapwa blacksmith also made ox-ploughs, utensils, and string beds. This occupation also involved fabrication of knives and spears for security purpose by the Maasai ethnic group in Kilosa (Twatwatwa Village);

- Wood carving involved making sticks for herding livestock (*omudi*) at Twatwatwa Village in Kilosa, as well as for making traps for controlling pests such as rodents, and utensils such as sugar ports, teaspoons, toys, hand mills, wooden spoons, and ornaments in Moshi Rural. It also involved hand hoe handle making in Kilosa, Songea Rural, and Mpwapwa;

- Clay pots were also made for preserving seeds and for cooking across the surveyed communities;

- Gourd (*kalabashi*) making was practiced by the Maasai ethnic group (Twatwatwa village, Kilosa) in order to store milk for 24 hours;

- Baskets were made for preserving crops and for other domestic purposes across the districts; and

- The network of irrigation furrows (*mfongo*) which collects water from the mountain's streams and transports it over long distances to the fields below was practiced in Moshi Rural. The irrigation system was used for irrigating crops, drinking water for livestock, and for controlling plant pests such as rodents (*fuko*). However, the survival of these irrigation systems was threatened due to development, such as the introduction of water pipes and road construction.

There was no specific period for learning these apprenticeships. Children of the appropriate age were initiated with the long processes of learning until they became knowledgeable enough to start practicing on their own. However, with the advent of the formal education system, children became apprentices as soon as they completed their primary education. All children were allowed to learn most of these apprenticeships with the exception of blacksmithing, which was restricted to certain families or clans in some of the surveyed communities. For example, the *Makundi* clan was specialized in making of iron tools in Moshi Rural, while the *Olokononi* in the Maasai community in Kilosa (Twatwatwa Village) were devoted to the fabrication of knives and

blades for security purposes. A typical response from Twatwatwa Village (Kilosa) was that, "all children are supposed to learn all kinds of apprentices (beads making, gourds, cattle noise pins, sticks for grazing animal) with exception of the iron smith where few people from identified families are allowed to learn".

These apprenticeships were also allocated according to gender. For instance, young girls and children were allowed to learn how to build a house, and make beads and milk gourds in the Maasai community (Twatwatwa Village, Kilosa), and making of baskets, clay pots in the surveyed communities, while young boys and children of appropriate ages were allowed to learn about blacksmith work, traditional irrigation systems, wood carving, and car and bicycle repairing. On the other hand, anybody was allowed to learn about weaving and tailoring in the communities.

5.4.1.4.4 Initiation rites during adolescence age

The respondents were asked to indicate if initiation rites during adolescence age were used to share agricultural IK in the local communities. Thirty two (17.7%) respondents indicated that initiation rites were used to share agricultural IK, while 149 (82.3%) did not. The 32 (17.7%) respondents were asked to state the kinds of agricultural knowledge that was shared in the initition rites. Animal production 30 (94%) was the most cited knowledge type shared through initiation rites in the communities, followed by crop production 20 (63%), and selling of produce 17 (53%). Initiation rites during adolescence age were used at a low rate to share agricultural IK, since their main aim was to prepare young women and men for adolescence and responsible sexual and reproductive behaviour.

Despite the fact that initition rites were practiced across all research sites, they were used to share agricultural knowledge only in four districts, which were Kilosa, Mpwapwa, Karagwe and Kasulu as shown in Figure 5.8. Kilosa district was the most cited district in the initition rites practices, accounting for 14 (43.8%) of animal production, two (6.3%) of crop production and one (3.1%) of selling produce. The least cited district was Kasulu, accounting for four (12.5%) of animal production, crop production, and selling produce.
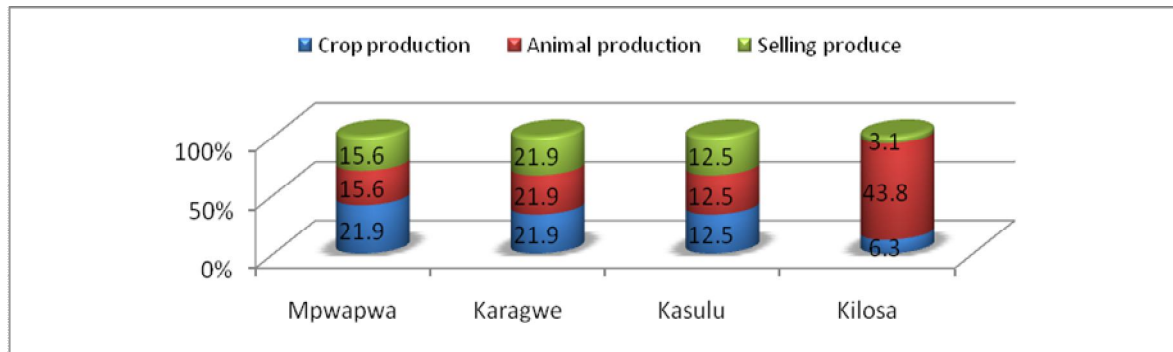
Figure 5.8: The distribution of types of initiation rite practices in sharing of agricultural indigenous knowledge by districts (Mpwapwa=7, Karagwe=7, Kasulu=4, Kilosa=14)
(Multiple responses were possible)

5.4.1.4.5 Creating the right conditions for sharing and distributing agricultural knowledge in the local communities

This section primarily focuses on the following factors: culture, trust, status, and context and space as they influence sharing of indigenous and exogenous knowledge in the communities. The results are presented from focus group discussions, interviews and non-participant observation.

5.4.1.4.5.1 Traditional culture and customs

The existing structures and norms were also found to enable sharing of agricultural knowledge in the surveyed communities. Data from observation, focus group discussions and interviews showed that the cultural structures and norms determined access to knowledge in four ways, which included: public knowledge; discretionary knowledge, which was accessed through clan-based structures (such as the blacksmith); secret knowledge, which was accessed through inheritance (such as knowledge about local herbs); and social knowledge, which was accessed through social structures such as initiation rites, and age-set system. The following sections will describe these cultural norms which provide access to public, secretive, and social knowledge, with exception of the access to discretionary knowledge (such as the blacksmith) since it is already presented in Section 5.4.1.4.3.

Most of the indigenous knowledge on farming systems was made public, through cultural norms and structures such as folklore, seed and animal exchanges, messages on women's print cotton wraps "kangas", and the animal lending system. These customs and traditions are explained in the following text, with exception to folklore which is already presented on section 5.4.1.4.1.

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Although seed and bull exchanges were practiced at a low rate, they still played a great role in the sharing of IK on planting materials and animal breeds in the communities. Of 168 (92.2%) interviewed respondents who were involved with farming activities, 22 (3.1%) of the respondents obtained their planting materials from their fellow farmers, while the majority of the respondents either preserved or purchased their planting materials, with a score of 338 (47.9%) and 193 (27.4%) respondents respectively. Other farmers obtained their planting materials through their own seedlings 21 (3%), suckers 104 (14.8%), cuttings 21 (3%), extension officers 5 (0.7%), and collection of spills from market 1 (0.6%). Similarly, of 146 (80.2%) respondents who were engaged with livestock production, 36 (24.7%) obtained their animal breeds through family, while most of the respondents purchased their animals 122 (83.6%). Other farmers acquired their animal breeds through gifts 16 (11%), exchanges with other farmers 9 (6.2%), buying from neighbours 6 (4.1%), and government agents 1 (0.7%).

The women's print cotton wrap, *kanga* was a popular formal dress for women in the country usually printed along the bottom hem to help the wearer to convey the message which the cloth depicted. Data from non-participant observation showed that *kanga* were also used to pass on agricultural knowledge in order to encourage farming activities in the local communities. Such words which were printed on kanga included the following:

" ufugaji bora" or improved livestock keeping

"…ukulima wa kisasa" or conventional farming practices

Animal lending systems were practiced in Moshi Rural district to enable farmers who had neither plots to grow fodder nor funds to purchase fodder to lend their animals to other farmers. This system was practiced on the agreement that the borrower retains the first offspring and returns the animal with other calves to the lender. The system enabled farmers to share and exchange knowledge on livestock management.

With regard to secret knowledge, data from focus group indicated that this knowledge was specifically transmitted through inheritance to selected individuals in the family, and thus it was

not disclosed to the public, such as knowledge on local animal and plant medicine. Typical responses included:

"……knowledge on local herbs is normally transmitted in our community from grandmother or grandfather to the grandchild. It is actually not transmitted to any grandchild, but to the one who can be trusted and who has shown interest in learning about local herbs" (Iteera Village, Karagwe).

"……….IK holders would not show other farmers how to prepare various herbs, instead they prepare the local herbs and give farmers the instructions on how to apply those herbs into their farms" (Katwe Village, Karagwe).

"…..knowledge on animal and human medicines is inherited in the clan or family only, so very few people know about them due to customs or taboos in the clan" (Mshiri Village, Moshi Rural).

"….knowledge on local herbs is inherited within the clan and those experts can even provide herbs for stealing animals from other communities" (Twatwatwa Village, Kilosa).

For accessing IK through social structures, data from non-participant observation and focus group discussions indicated that the existing structures, (such as initiation rites, apprenticeships, and age-set system) were used to provide access to this knowledge. This section presents data on age-set system, while data on apprenticeships and initiation rites are already presented on sections 5.4.1.4.3 and 5.4.1.4.4 respectively.

Data from non-participant observation and focus group discussions showed that knowledge about culture, livestock management and ethno-veterinary was shared through a specified social system, known as "age-set system" in the Maasai ethnic group in Kilosa (Twatwatwa Village). This structure allowed the transmission of knowledge from one age group to another. The traditional leader called *laibon* directed each group, concerning livestock management and socio-cultural issues. Another traditional leader, *Laigwenan* was the supreme chief concerning all socio-cultural and livestock management issues.

Age-set system also determined access to knowledge according to gender in the Maasai community. While young boys and men were educated on livestock issues through age-set

system, young girls and women learnt about livestock management and animal treatment from their mothers or any family members. Wives learnt from their husband on the use of local herbs to cure animals. This age-set system is explained in the following text:

- 0 - 15 ages: Children helped parents at home to acquire various skills about livestock keeping. Young boys or *rayon* were sent out to graze calves and lambs, while young girls were left at home to help with the household chores such as cooking and milking, which they learnt from their mothers;

- 16 - 30 years: Young boys were initiated and circumcised to enter into warrior age-set from boyhood, and they were named as junior warrior (*Morani*). They were mainly taught about tribal customs, livestock management, animal disease diagnosis and treatment, protection of the community and animals, and searching for pasture and water for animals. Some of them were engaged with blacksmith work (*olokononi*). Young girls were also circumcised and initiated to prepare them for marriage;

- 31 - 45 years: These were senior warriors who were involved in marketing animals, advising the use of animal treatment, and overseeing other community matters;

- 46 – 50: Junior elders (*Irpayiani*) were involved in marketing animals, and advising livestock management issues;

- 51 – 65 years: Senior elders (*Iseuri*) were authorized to make decisions about livestock management and socio-cultural issues; and

- 66 years and above: these were senior elders and they were responsible for directing and advising about livestock management and socio-cultural issues.

5.4.1.4.5.2 Trust
The focus group discussions established that parents/family were the most reliable sources of knowledge in the communities. Despite their infrequent contact with extension officers, farmers considered them as the most reliable sources of knowledge, followed by neighbours/friends, personal experience, religious leaders, village meetings and agricultural shops. Farmer groups, NGOs, cooperative unions, and agricultural researchers were considered reliable sources of knowledge in those communities in which they were active. However, agricultural input suppliers and neighbours/friends were not seen as reliable sources of knowledge in some

communities. The respondents reported that neighbours/friends were not reliable contacts because they were selfish and jealous. Agricultural input suppliers were not reliable sources of knowledge because their services were market oriented, and thus farmers' needs were not catered for. Seminars held by NGOs and extension officers were also not regarded as reliable sources of knowledge because they were rarely organised in the communities. Despite their unavailability, farmers considered printed materials as reliable sources of knowledge, which included books, newsletters and posters.

On the use of ICTs, the focus groups discussions established that radio was the most reliable source of knowledge in the communities, followed by cell phones, television and internet. At the same time, some communities indicated that radio, television, cell phone, internet, and email were not reliable sources of knowledge. Radio and television agricultural programmes were not trustworthy because they were not consistently aired, a short time was allotted to the programmes, and there was poor reception of their broadcasts. Cell phones were regarded as not reliable sources of knowledge because some middlemen used to deliver incorrect market prices in order to buy produce at low prices. Internet was not reliable due to the lack of local content, and low level of awareness and ICT skills.

5.4.1.4.5.3 Status

This section presents results in relation to wealthy, politically well-placed, and knowledgeable farmers as they affect access to agricultural knowledge in the local communities. Data obtained from non-participant observation showed that the village chairpersons generally lacked authority in the villages they were supposed to head, although they had institutional power invested in them. For example, it was difficult to organize focus groups at Mshiri Village in Moshi Rural because the village leader was not able to convince farmers to come and attend the meetings. In other discussion groups in Kilosa, most people did not concentrate on most of the things the village chairperson was saying. In some villages, the village chairperson was a poor person and people looked down on him because he was poor (for example, Moshi Rural (Mshiri Village), and Kasulu (Kidyama Village), but in other villages such as Twatwatwa Village in Kilosa, the chairperson was a wealthy person who was more influential in making all the decisions regarding village matters.

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Other influential people were either progressive farmers, or more affluent people or knowledgeable farmers. The knowledgeable farmers also had influence regarding knowledge sharing, however the importance of their power was exercised once they knew that they had that influence. For instance, one farmer in Songea Rural (Matetereka Village) was more knowledgeable than other farmers who served as a model farmer in that village according to the extension officer. Further, in some focus group discussions, the knowledgeable farmers dominated the discussions since they knew a lot more than others, such as in Karagwe (Kitwe Village), Moshi Rural (Lyasongoro Village), and Songea Rural (Matetereka Village). Wealthy people regardless of whether they occupied a position or not, also dominated the discussions in the focus groups held in Songea Rural (Matetereka Village) and Karagwe (Kitwe Village). For instance, one wealthy farmer in Karagwe (Kitwe Village) was more knowledgeable than others, and was ranked as a rich farmer and was used as a councillor for most of the agricultural issues.

It was also observed that people with political positions such as village leaders in some of the communities (such as Kasiki Village in Kilosa, Mshiri and Lyasongoro Villages in Moshi Rural) dominated most of the discussion groups, or they wanted their views to acquire more serious consideration than others regarding areas that they were concerned about.

5.4.1.4.5.4 Context and space

The respondents were asked to indicate the purpose of sharing their knowledge. The majority of respondents shared their knowledge for farming purposes, accounting for 102 (56.4%) of the respondents, followed by political 93 (51.4%), social 81 (44.8%), and agri-business purposes 58 (32%).

For farming purposes, farmers mainly met at the farm fields to share knowledge, with a score of 45 (44.1% of 102 respondents) respondents, followed by homestead 15 (14.7%) and village office 14 (13.7%). Other major places that farmer met to share knowledge on farming activities were open ground 8 (7.8%), NGO office 8(7.8%), grazing land 7 (6.9%), social clubs 3 (2.9%), visiting neighbour 3 (2.9%), under a big tree 2 (2%), house of a *balozi wa nyumba kumi* or ten cell leader 2 (2%), ward office 2 (2%), and school 2 (2%). The least cited places that farmers met to share knowledge on farming activities were the church, on the road, and the farmer groups leader's house, accounting for one (1%) of the respondent each.

For agri-business purpose, most of the respondents met at the village markets 37 (63.8% of 58 respondents), followed by the homestead 7 (12.1%), NGO offices 5 (8.6%), open ground 4 (6.9%), and the village offices 4 (6.9%). The least cited places were on the road 2 (3.4%), cooperative unions 2 (3.4%), and school 1 (1.7%).

Those respondents 63 (85.1%) who were involved in farmer groups were asked to indicate where they met to share knowledge. Farmer groups' offices 20 (33%) were the dominant places that formal farmer groups met to hold their meetings, followed by village offices, nine (15.3%) and church, eight (13.6%). Other places that formal farmer groups met to hold their meetings include the following: group leaders house 7 (11.9%), farm fields 3 (5.1%), community telecentre 2 (3.4%), group members house 2 (3.4%), hotel 2 (3.4%), and open space 2 (3.4%). The least cited places that formal farmer groups met to hold their meetings were auction market, school, under a big tree and ward office, accounting for one (1.7%) respondent each. On the other hand, informal farmer groups mainly used the groups members' houses and grazing fields to hold their meetings, accounting for five (8.5%) and four (6.3%) respondents respectively. Other places that informal farmer groups met to hold their meetings include the following: open space 2 (3.4%) and school 1 (1.7%). Formal farmer groups had more access to village facilities such as village and ward offices than informal farmer groups.

5.4.1.5 The preservation of agricultural indigenous knowledge

When asked to indicate if they preserved their agricultural IK, few respondents 24 (13.3%) replied affirmatively that they preserved their knowledge, while 157 (86.7%) did not. The 24 (13.3%) respondents were asked to provide details on how agricultural IK was preserved. Written format was the dominant method used by farmers to preserve agricultural IK, with a score of 21 (87.5%) respondents, followed by carvings, four (16.7%), and still pictures, two (7.4%). Carvings included locally made traps for controlling plant pests, utensils, toys, ornaments, and drawings on clay pots, hand mills and pestles.

5.4.1.6 The application of agricultural indigenous technologies

The respondents were asked to provide details on the application of agricultural indigenous technologies that they had obtained from various sources of knowledge. Most farmers 157 (86.7% of 181 respondents) acknowledged that they applied indigenous techniques in their

farming systems. The 157 (86.7%) respondents who indicated that they had applied agricultural indigenous techniques were asked to provide details of those techniques. IK on crop husbandry was the most adopted technique in the farming systems, with a score of 99 (63.1%) respondents, followed by new varieties and techniques from other communities 40 (25.5%), and animal husbandry 38 (24.2%). Other indigenous techniques that were adopted by farmers included the following: control of animal diseases 29 (18.5%), value added techniques 24 (15.3%), and soil fertility 19 (12.1%). The least applied indigenous techniques were control of plant diseases 11 (7%), agricultural tools 9 (5.7%) and environmental conservation 3 (1.9%).

Although the interviews showed that knowledge on crop husbandry was the most adopted technique, the focus groups established that knowledge on how to improve soil fertility was the most applied indigenous technology in the communities, followed by the value added technologies, and control of plant pests and diseases and crop husbandry techniques. New varieties and techniques were the least adopted indigenous techniques in the communities. Despite the discrepancies, major patterns can be identified that farmers applied indigenous techniques on crop production rather than those on animal husbandry. These techniques were related to crop husbandry, soil fertility, new varieties and techniques, value added technologies, and control of plant pests and diseases.

Those 157 (86.7%) respondents who indicated that they had applied agricultural indigenous techniques in their farming activities were asked to provide reasons for applying those techniques into their farming systems. Their multiple responses are depicted in Figure 5.9. The effectiveness of the indigenous techniques was the major reason for applying indigenous technologies on some aspects in their farming activities such as manure, with a score of 67 (42.7%) respondents. Other major reasons were increased productivity 39 (24.8%), and lack of access to knowledge on alternative technologies such as conventional farming 33 (21%). The least cited reasons were trial and error to find out if indigenous techniques were effective; to inherit farm plots and farm animals from their parents; an instruction from leaders to use manure; to preserve indigenous practices for future generations; and to prevent soil erosion, with a score of one (0.6%) respondent each.
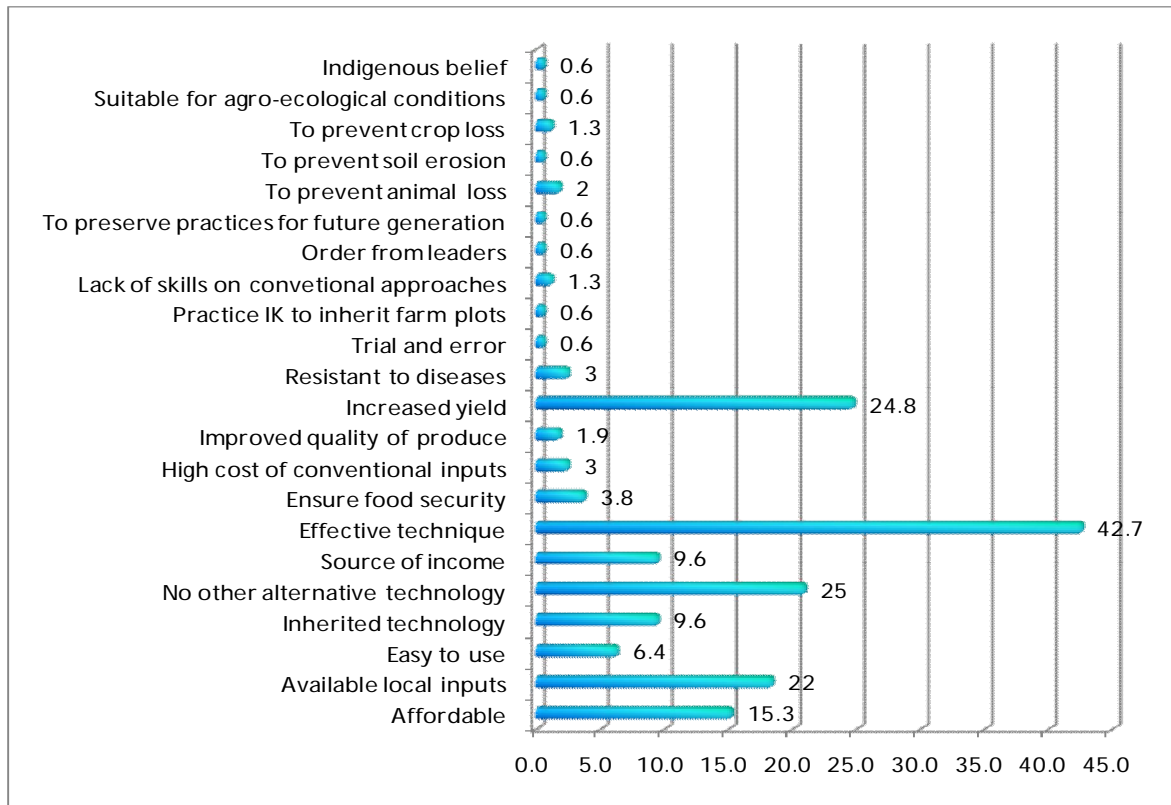
Figure 5.9: Reasons for the application of indigenous knowledge obtained from tacit and explicit sources of knowledge (N=152)

Although the interview results showed that the effectiveness of the indigenous technologies was the main reason for the application of indigenous techniques in the farming systems, the focus group discussions indicated that increased agricultural production was the major reason for the application of indigenous technologies in the farming systems especially techniques on crop husbandry, and soil fertility. It can thus be concluded that the effectiveness of the indigenous technologies, and increased agricultural production were the major reasons for adopting IK because there were slight differences between the major reasons for adopting IK which were observed from the interviews and from the focus group results. Another major reason for the application of indigenous techniques in the farming systems as indicated in the focus groups was that the indigenous technologies were cheap, such as local herbs for preserving crops and controlling plant diseases. Other reasons included: local inputs were safe such as local herbs for controlling plant diseases and preserving crops; source of income; high cost of improved crop varieties; the only alternative available such as botanical pesticides; local seeds were disease

resistant; and there was no significant changes on food palatability due to the use of indigenous techniques for preserving crops.

5.4.1.7 The non-application of indigenous technologies in the farming systems

This section sought to establish the extent to which the agricultural indigenous practices obtained from tacit and explicit sources of knowledge were not applied in the farming activities in the communities. The respondents were asked to indicate if there were any indigenous technologies that they were not applying in their farming systems. Sixty nine (38.1% of 181 respondents) farmers replied affirmatively that they did not apply indigenous techniques in their farming system. Those 69 (38.1%) respondents were asked to provide details of those agricultural indigenous techniques which they did not apply in their farming systems. More than half of the respondents 40 (58%) did not apply indigenous techniques on crop husbandry, followed by animal husbandry 13 (18.8%) and new varieties and techniques 12 (17.4%). Other techniques that were not applied by farmers included: knowledge on value added technologies 10 (14.5%), control of plant diseases 2 (2.9%), and control of animal diseases 2 (2.9%). The agricultural tools and methods for the improvement of soil fertility were the least cited techniques, with a score of one (1.4%) respondent each.

Data collected using focus group established that knowledge on soil fertility and crop husbandry were the most non-applied technologies in the farming systems. Other techniques which were not applied in the farming systems were value added techniques, environmental conservation, and new varieties and techniques.

Those 69 (38.1%) respondents were asked to provide reasons for the non-application of agricultural indigenous techniques that they obtained from various sources of knowledge in their community. Low agricultural production was the major reason for the non-application of agricultural indigenous technologies on some aspects of farming systems, such as random sowing, with a score of 23 (33.3%) respondents. Other major reasons for the non-application of agricultural indigenous techniques included: ineffectiveness of some indigenous techniques such as local herbs for plant and animal diseases 21 (30.4%); difficulties in carrying out field operations due to the use of traditional crop husbandry techniques such as random sowing, and

big ridges 13 (18.8%); shortage of land inhibited long-term fallowing 8 (11.6%); outdated taboos 6 (8.7%) such as preventing women to close animal sheds and the use of cow dung to wash hands when assisting animals to deliver in Kilosa (Twatwatwa Village); unavailability of local inputs such as seeds and herbs 3 (4.3%); poor recognition of IK 3 (4.3%); and widespread cases of theft due to the use of granaries which were located outside farmers' houses 3 (4.3%). Other reasons for the non-application of agricultural indigenous techniques included: labour intensive such as the use of the hand hoe; high incidences of plant pests; environmental impact of some techniques such as field burning; food insecurity; land disputes which limited farmers from practicing free grazing; local herbs were time demanding; some techniques were not suitable for large scale farming such as local herbs; and lack of access to adequate information on indigenous techniques such as the use of local herbs for controlling plant diseases, accounting for one (1.4%) respondent each.

Although the interview findings indicated that low productivity was the main reason that limited farmers in applying indigenous techniques in their farming systems, the focus groups established that the ineffectiveness of some indigenous techniques was the major reason for the non-use of agricultural IK in the communities. Despite the discrepancies, major patterns can be discerned, namely that farmers did not apply indigenous techniques due to low production and ineffectiveness of some indigenous techniques, because there were slight differences between the major reasons for the non-use of agricultural IK which were observed from the interviews and from the focus group results.

The findings from the focus groups showed that farmers did not apply indigenous techniques in their farming systems because they were not effective, such as use of big ridges in Songea Rural, random sowing and broadcasting in Kasulu, and value added techniques such as use of clay soil for preserving seeds and crops in Karagwe. Other reasons of importance included: environmental conservation; disappearance of some indigenous techniques such as how to determine soil fertility in Karagwe; shortage of land in Moshi Rural; low crop yield; and local inputs such as pesticides were time demanding and labour intensive and took a lot of time to be prepared.

5.4.2 The management of agricultural indigenous knowledge: data from knowledge intermediaries

The study sought to establish whether the knowledge intermediaries managed agricultural IK in the communities. The respondents were asked to indicate methods used for acquiring, preserving, and disseminating agricultural IK in the communities.

5.4.2.1 Acquisition of agricultural indigenous knowledge

The majority of the respondents 20 (80% of 25 respondents) were aware that farmers possessed agricultural IK. When asked to specify if they had collected agricultural IK in the local communities, most of the respondents 18 (72%) had collected IK in the local communities, while seven (28%) had not. An inquiry about the methods used to capture agricultural IK in the communities showed that most of the respondents used personal visits, seven (38.9%), farmer groups, six (33.3%), demonstration plots, five (27.8%), training, five (27.8%), and farmer field schools, four (22.2%). Knowledge intermediaries also collected IK when farmers sought information to solve their farming problems and by collaborating with various stakeholders, accounting for two (11.1%) of the respondents each. Few intermediaries captured IK from books, farmer forums, and on farm trials, with a score of one (5.6%) respondent each.

The 18 (72%) respondents who reported accessing IK in the local communities were asked to indicate the purpose of collecting IK in the communities. Twelve (48%) respondents identified extension services as their major purpose for collecting IK. Other purposes were interest in managing IK six (24%), research six (24%), marketing agricultural inputs four (16%), to raise the profile of IK three (12%), and to purchase crop and animal produce two (8%).

An inquiry into the types of IK that were obtained from the local communities indicated that half of the respondents obtained knowledge on the control of plant diseases nine (50%). Other types of IK were crop husbandry, eight (44.4%), value added techniques, six (33.3%), animal disease control, five (27.8%), local crop varieties, five (27.8%), soil improvement, four (22.2%), and agro-forestry, three (16.7%). The least cited IK types were credit, environmental conservation, and traditional irrigation systems, accounting for one (5.6%) of the respondent each.

5.4.5.2 Preservation and dissemination of agricultural indigenous knowledge

Ten (40% of 25 respondents) respondents reported that they used some means to preserve agricultural IK. Six (60%) respondents used written notes to preserve IK, followed by newsletters three (30%), leaflets one (10%), and books one (10%). Further, more than half of the respondents 15 (60%) indicated that they disseminated IK in the local communities, while 10 (40%) did not. When asked to indicate strategies for disseminating agricultural IK in the communities, the majority of the respondents used personal visits and training to disseminate IK, with a score of 11 (73.3%), and 10 (66.7%) respondents respectively as depicted in Figure 5.10. On-farm trials, village notice boards, webpage printouts, handouts, and pamphlets were the least used methods, accounting for one (6.7%) of the respondent each.

The respondents were asked to rank the effectiveness of oral communication channels in disseminating IK in the communities. Half of the respondents ranked oral communication channel as an effective mechanism for disseminating agricultural IK in the communities, with a score of seven (28%) and five (20%) in the effective and very effective categories. Few respondents considered oral communication mechanisms as probably effective two (8%) and not effective two (8%), while nine (36%) did not have any opinion.

When the 15 (60%) respondents who reported that they disseminated IK in the communities were asked to indicate whether print materials were effective to disseminate agricultural IK, the majority of the respondents indicated that print materials were effective 9 (60%) and very effective 4 (26.7%) to disseminate agricultural IK. Few respondents ranked print materials as probably effective and not effective, accounting for one (6.7%) respondent each.

More than half of the respondents indicated that they had successfully contributed to the management of IK in the communities. The remaining respondents stated that they had not made any contribution to the management of agricultural IK in the communities due to the following reasons: lack of funds, lack of policy on IK issues at the national and institutional levels, lack of adequate extension officers, and lack of facilities such as transport and equipments.
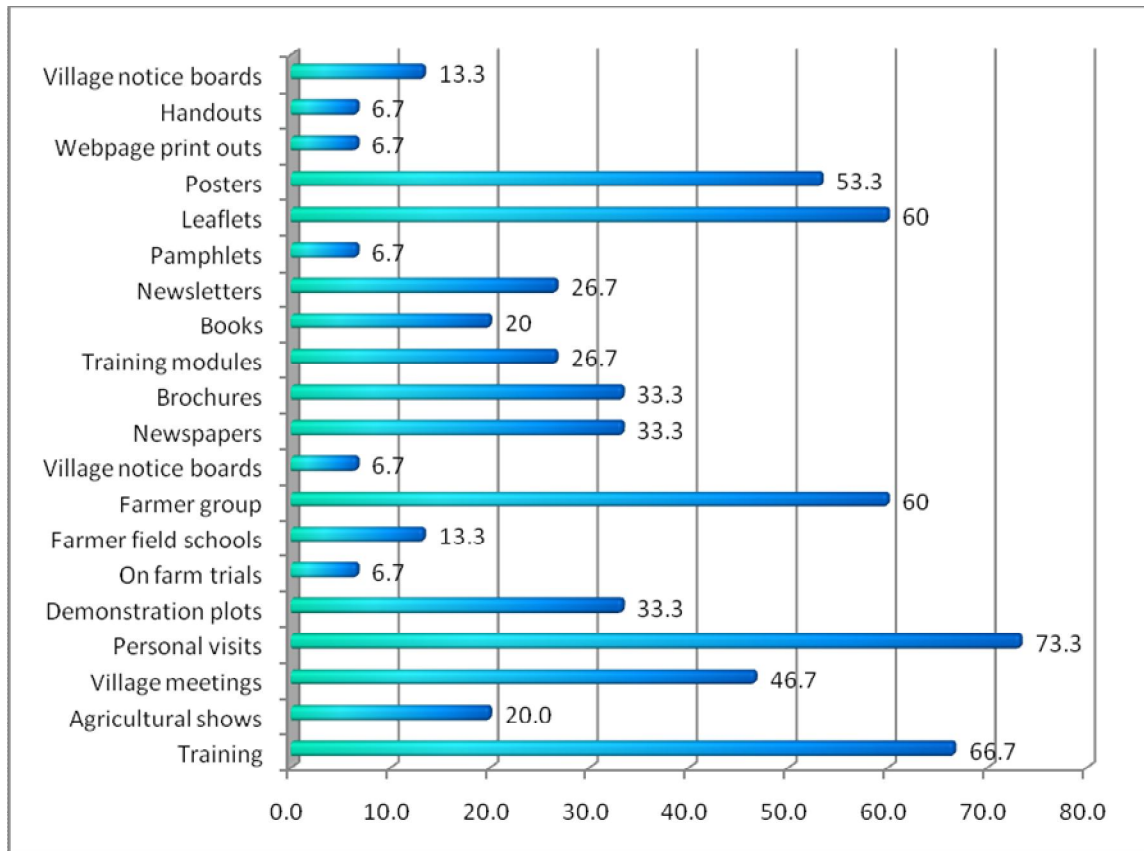
Figure 5.10: Methods used by knowledge intermediaries to disseminate agricultural indigenous knowledge in the communities (N=15)

5.5 The relevance of the legal frameworks for the protection of agricultural indigenous knowledge in Tanzania

The eighth objective of the study sought to investigate the policies and legal frameworks that were relevant for protecting agricultural IK in Tanzania. All three categories of respondents were interviewed in this aspect, which included farmers, knowledge intermediaries, and policy makers. The policy makers were asked to provide the current state of policies and IPR in protecting agricultural IK in the country. Farmers and knowledge intermediaries were asked to provide details on the awareness of IPR, and the importance of instituting IK policies in the country.

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5.5.1 Relevance of the legal frameworks for the protection of agricultural indigenous knowledge: data from IK policy makers

The current status of intellectual property rights (IPR) and policies was established by assessing the strength and weakness of the existing IPR and policies, concerns raised by the communities and the way forward for effective protection of agricultural IK in the local communities. Four officers who were involved with IK policy making in the country were interviewed.

5.5.1.1 The current state of policies in protecting agricultural indigenous knowledge

All respondents in the policy makers' category indicated that the existing policy framework inadequately recognised and protected agricultural IK. These sectoral policies included the National Strategy for Growth and Reduction Poverty (NSGRP), agriculture and livestock policy of 1997, forest policy of 1998, cultural policy of 1997, environmental policy of 1997, fisheries policy of 1997, ICT policy of 2003, and wildlife policy of 1998. For instance, one respondent in the policy makers' category reported that, "the government believes that the cultural policy covers IK issues, but it inadequately addresses IK issues". Most of these policies were not well coordinated and they were not backed by implementation instruments, such as strategies and laws. Further, even when those laws were there, they inadequately protected access to IK and genetic resources. One respondent stated that, "The environment law emphasizes the importance of Tanzanians to have land rights, and rights over their natural resources in order to conserve environment and heritage. However, it inadequately protects access and benefit sharing of genetic resources in the country". Further, the respondents indicated that the intellectual property rights were supposed to be expressed in policies, but there was no policy that governed IPRs in the country. Thus, IK had not received adequate attention in the entire policy framework due to lack of coordination between policies and IPR in the country.

All respondents in the policy makers' category agreed that it was important to establish a policy that would deal with IK issues. Most respondents reported that there were some initiatives on the ground to steer the establishment of IK policy. However, these initiatives were not well coordinated and thus they had not managed to come up with a significant IK policy document for institutionalization in the country. For instance, the Ministry of Trade, Industries and Marketing had established a committee, preceding the time of the survey, to steer the formulation of a

policy on IK issues after the failure of IPR forum in 2007. The IPR forum was established by the government to foster the establishment of IK policy, but it failed to accomplish the task. This newly established committee was aiming at formulating national policies and laws based on the African Regional Intellectual Property Organisation (ARIPO) instrument. This committee had been established under the Business Registration and Licensing Agency (BRELA), at the Ministry of Trade, Industries and Marketing.

The IK trust fund was another initiative established by FAO, and other public organisations (Commission for Science and Technology in Tanzania, and Tanzania Food and Nutrition Centre) in 2005 to foster the establishment of IK policy in the country. There was an interim committee of executive officers, preceding the time of the study whose objectives were to steer the formulation of IK policy and promote use of IK in the country. However, the trust fund had not managed to formulate policy on IK issues due to lack of funds and poor coordination among the trust members. Slow progress in formulating IK policy was also aggravated by the lack of political will, awareness and poor coordination among different governmental agencies that deal with IK issues.

5.5.1.2 The current state of intellectual property rights in protecting agricultural indigenous knowledge

The respondents in the policy makers' category were asked to identify the IPR instruments which dealt with the protection of IK issues within the country. Most of the respondents consistently identified IPR in three categories, which included international, national, and institutional based IPRs.

Internationally, ARIPO had established an IPR instrument which aimed at protecting IK in African countries. The instrument had already been adopted by the council of ministers in Africa. All African countries were involved in the formulation of the instrument and the individual countries were supposed to ratify the ARIPO instrument. The instrument was presumed to work well in protecting the misappropriation of IK in the African countries. The newly established committee under the Business Registration and Licensing Agency (BRELA), at the Ministry of

Trade, Industries and Marketing was supposed to formulate IK policies and IPR based on the ARIPO instrument.

Nationally, the respondents in the policy makers' category identified a number of IPRs which were already in existence to protect agricultural IK, which included the following:

- Copyright and Neighbouring Act of 1998, part 3: This act was administered by Copyright Society of Tanzania (COSOTA) and it had a provision for protecting the cultural expressions and folklore;

- National Art Council of 1984: The National Art Council was responsible for the management of the expression of folklore;

- Patent Act of 1987: This act was administered by BRELA and it was aimed at promoting and protecting inventivity and innovation through patents; and

- Plants Breeders Rights and Plant Varieties Act of 2004: It was administered by the Ministry of Agriculture and Food Security under the plant breeder registrar section. It provided provisions for the protection of plant varieties inventions. It also provided incentives for creativity, innovation and for economic, social and cultural progress. It allowed farmers to use their plant varieties to produce their own seeds for their own use, and not for commercial purposes.

Institutionally, two public universities were identified as having IPR policies which included Sokoine University of Agriculture (SUA) and the University of Dar es salaam. All respondents reported that these IPRs were effective in protecting innovation and inventions in those particular universities.

Overall, all respondents acknowledged that these IPRs were not effective to protect agricultural IK such as genetic resources and expressions of traditional culture in the local communities. These IPR did not recognise the communal ownership of IK, instead they emphasized the protection of individual rights over IK which was derived from western cultures. Typical responses were:

"…IPR are weak in protecting IK, and some of these IPRs such as patent law do not even recognise IK".

".....it is difficult to protect IK because it is communally owned. There are no legal structures in the communities to protect their own knowledge in the country".

IPR were weak in protecting agricultural IK due to various reasons as stipulated in the following text:

- There was poor recognition of IK and genetic resources in the current IPR such as plant breeders' rights (PBR), and patent act. According to one respondent, PBR safeguarded the outcome of the innovation, and thus it did not protect knowledge that comes with the innovation. On the other hand, the patent act required the invention to be novel, and to show inventive steps and industrial application to be of practical use. The condition of novelty (must be new), which was required by patent law, was difficult for farmers to meet. Farmers' innovation could not be new, since it was related to experiences, accumulated knowledge and collective ownership. That is why, one respondent suggested that, "farmers should raise their concerns and challenge the government, since the existing IPRs do not protect their knowledge and resources especially the plant variety act". However, according to the plant breeder registrar, the Ministry of Food and Agriculture had drafted a bill for controlling the access and benefit sharing of genetic resources, preceding the time of the survey. This bill will control the management of resources taken from the communities. This bill will not directly protect IK, but it will help to protect genetic resources;

- There were contradictions between IPR instruments which contributed to the failure of IPR to protect IK. For instance, the patent act prohibited the registration of plant varieties under section seven, while the plant breeders' rights recognised the registration of plant varieties. However, the patent registrar at BRELA reported that there was an ongoing process to review the industrial property rights which may incorporate IK issues and resolve the contradictions between IPR laws;

- Lack of funds to facilitate the promotion of folklore limited the implementation of IPR laws in the country. For instance, the National Art Council and COSOTA had a team to coordinate, promote and protect the cultural expressions and folklore issues against illicit

misappropriation in terms of exhibitions. However, the exhibitions were carried out without the involvement of local people due to the lack of funds to facilitate them;

- IK issues were inadequately covered by IPR. For instance, the copyright and neighbouring act recognised only cultural expressions and folklore, instead of all IK issues;

- The registration and evaluation process of plant varieties was time demanding and thus most innovators were discouraged from registering their plant varieties. For instance, the respondents stated that, "the registration process of plants varieties starts with the application made by the breeder to the registrar, then the process of conducting research follows afterwards in order to evaluate the invention. The research process can take up to two years. Once the plant varieties are registered, the registrar is able to control the commercialization process of the variety". For instance, the plant breeders' registrar department managed to register only four new plants varieties for the first time in 2006 since its establishment in 2002. Thirteen plant varieties were expected to be registered preceding the time of the survey;

- Most of the international IPRs do not protect IK, and thus it was a challenge for the individual countries to recognise and protect their IK;

- There was no correspondence between the national and global IPR instruments. For example, one respondent reported that the patent law does not correspond with international law. The respondents suggested a need to review this law so that it complies with the international law;

- There was lack of political will to formulate IK policy within the country. For example, the government was not interested in instituting IK policies within the country despite the efforts that had been done to sensitize them. Actually, the government allocated little funding for IPR activities;

- Lack of awareness on the part of the government, researchers and local communities had limited the institutionalization of IK policy within the country. For instance, one respondent indicated that, "there is poor perception that PBR is against farmers' rights due to lack of understanding on the part of the communities";

- Collective ownership of IK had inhibited the protection of IK through the current IPR instruments. One respondent suggested that, "There is a need to enhance the existing system to recognise the communal ownership of IK in order to protect IK against biopiracy"; and

- Most of the local communities were not willing to share their knowledge and practices to the public domain. For instance, one respondent reported that it was a challenge to motivate farmers to promote their innovations through exhibitions. Traditionally, IK was protected in secrecy, and thus the conventional ways of disclosing it were a challenge. One respondent reported that, "some local people such as traditional healers do not like to disclose their knowledge. They are scared of losing their market since other people would easily enter into their business".

In the absence of effective IPR, other people (both local and international) had misappropriated indigenous knowledge under the auspices of intellectual property. For instance, one respondent reported that, "in 2007, the plant *usambara* was patented in UK as a garden plant due to the weak plant breeders' rights in Tanzania. *Usambara* is a well known plant in Tanzania which is used for healing purposes. However, nothing has been done by the government to claim the ownership of that particular plant". Another respondent reported that, "farmers from Ifakara district in Morogoro region filed the complaints to the COSOTA offices that an organisation from Sweden was collecting a lot of plant varieties in their communities. However, nothing was done by the government to protect these genetic resources because these issues were not specified in the plant varieties act". Thus, the respondents suggested that the government should act on these issues because court cases had been helpful against biopiracy in other developing countries. For example, court cases commissioned by India and South Africa had proved a success with regard to the hoodia cactus plant of San in South Africa, and the misappropriation of IK in India.

5.5.1.3 Concern raised by local communities about protecting their indigenous knowledge

An inquiry into whether the communities had shown interest in protecting their knowledge indicated that few communities had expressed their concerns with regard to the protection of their agricultural IK to the IPR related offices. For example, one respondent indicated that SIDA sponsored a team from Sweden to conduct research in Bagamoyo district (Coast district). However, the team paid the communities very little money to compensate them for their

knowledge and resources. Thus, the communities petitioned to district commissioner regarding the misappropriation of their knowledge, who forwarded their grievances to COSOTA.

Another example was about a traditional song owned by the Haya tribe in Kagera region which was abused by another singer. The traditional song was called *indega inaondoka* (aircraft is taking off) which was later sung by the African Band. Thus, the Haya community filed complaints about the infringement of that particular song to COSOTA. According to tradition, the song was supposed to be sung in the evening when the bride was taken to her husband's house and not through radio broadcasts. Thus, the broadcasting of the song was stopped although the damage had already been done. Another example was about a farmer from Mwanza Urban district in Mwanza region who wanted to patent his knowledge on termite control. The farmer consulted the TIPSAC office (Tanzania Intellectual Property Service Advisory and Information Centre), and he was required to fill in forms which would disclose his knowledge on termites' control. However, the farmer refused to disclose his knowledge because he thought that he would lose his market once his knowledge was made public. However, the disclosure of this IK would have helped the responsible office to determine if the innovation could be patented.

The major reason that limited farmers to raise their concerns was related to a lack of awareness on the importance of IPR and policies in IK issues. For example, the plant breeder registrar reported that none of the farmers had ever applied for the registration of the plant varieties. However, not only farmers, but also researchers were not aware about the existence of IPR laws. Few researchers had actually applied for the registration of their plant varieties. Further, farmers did not inquire about IPR issues due to difficult conditions that one needs to attain in order to complete the application. For instance, the condition of novelty (must be new) was difficult to be met by farmers, because their knowledge was related to experiences, accumulated efforts and collective ownership. Lack of trust and willingness to share their knowledge were other problems that limited farmers' efforts to protect their knowledge. The local communities were used to protect their IK through secrecy which had enabled them to safeguard their knowledge over the generations. Thus, the conventional ways of disclosing and protecting that knowledge were a

challenge. However, the respondents suggested that it was important to protect IK and find ways to enable the local communities to protect their knowledge and innovations.

Various factors were proposed by policy makers for the improvement of existing IPR and policies. The respondents suggested a need to assess the existing laws in order to establish the strength and weaknesses and to formulate policies which will address those gaps. The policies should specify the bodies that will be responsible for all IK issues, and how the communities would benefit from their knowledge. Further, there should be an awareness created on IK issues to enable farmers to raise their concerns regarding the importance of formulating policies and IPR that recognise and protect IK. Lastly, the existing IPR framework should incorporate sui generis concept for effective protection of IK in the country.

5.5.2 Relevance of the legal frameworks for the protection of agricultural indigenous knowledge in Tanzania: data from local communities

The study sought to establish the extent to which local communities were aware of IPR and if there was a need to establish IK policy. Ten (5.5%) respondents were aware of intellectual property rights, while 171 (94.5%) were not. The respondents were asked if it was important to have a specific policy on IK within the country. More than half of the respondents indicated that it was important to have a specific policy that would address IK issues within the country, with a score of 52 (28.7%) and 45 (24.9%) respondents in the very important and important categories. Other respondents indicated that it was probably important to have IK policy, accounting for 38 (21%) of the respondents, while eight (4.4%) respondents considered that it was less important to have such a policy. The major reasons for establishing IK policy were to preserve agricultural indigenous knowledge and practices for future generations, with a score of 34 (18.8%) respondents (Figure 5.11).
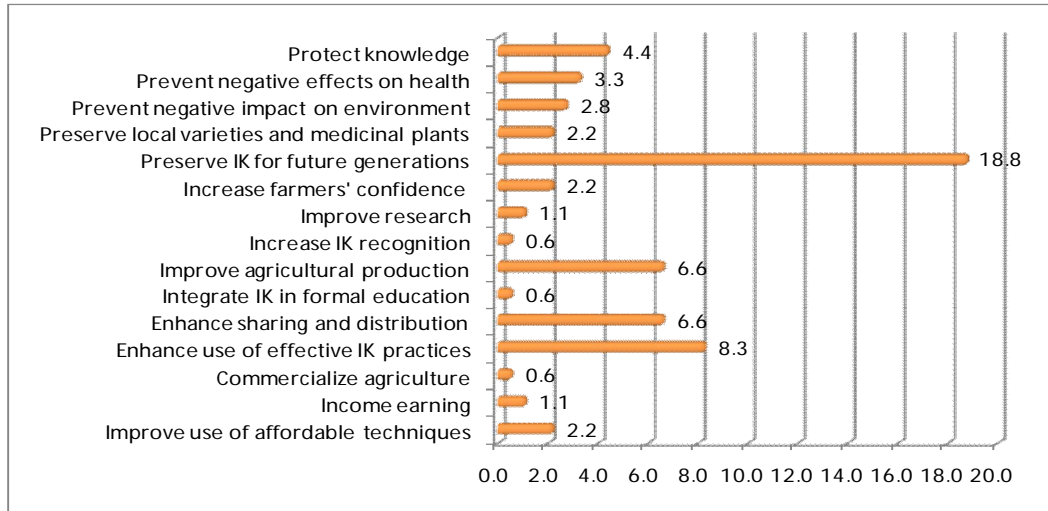
Figure 5.11: Reasons for establishing policy on indigenous knowledge (N = 181)

5.5.3 Relevance of the legal frameworks for the protection of agricultural indigenous knowledge in Tanzania: data from knowledge intermediaries

The study sought to establish the extent to which knowledge intermediaries were aware of IPR and if there was a need to establish IK policy. Most respondents 22 (88%) were not aware of the existence of IPR that addressed IK issues in the local communities, and three (12%) respondents were aware of IPR. On whether it was important to have a policy on IK issues, the majority of respondents indicated that it was important to have a specific policy on indigenous knowledge within the country, with a score of 15 (60%) and two (8%) respondents in the very important and important categories. Other respondents indicated that it was probably important, one (4%) to have IK policy, while one (4%) respondent considered that it was less important to have IK policy, and the remaining six (24%) respondents had no opinion. The major reasons for establishing IK policy were to preserve IK for future generations, and to protect IK from misappropriation. Other major reasons were to improve dissemination of IK, improve agricultural yield, increase use of IK techniques because they are cheap, safe and environmentally friendly, and to improve the evaluation process of IK through research, and to raise IK profile. An inquiry into what an IK policy should address when established showed that IK policy should mainly focus on providing guidelines for disseminating effective indigenous knowledge and practices. Other suggestions, arranged in the order of importance were to preserve IK and local varieties, conduct research to improve IK, protect IK and local varieties. Few knowledge intermediaries proposed that an IK policy should recognise the use of ICT to

disseminate IK, and improve use of vernacular languages in order to prevent the disappearance of these languages.

5.6 Access to agricultural exogenous knowledge in the local communities

The fifth study objective sought to establish the current state of accessing agricultural exogenous knowledge in the local communities. Both local communities and knowledge intermediaries were interviewed.

5.6.1 Access to agricultural exogenous knowledge: data from local communities

The local communities were asked to indicate tacit and explicit sources of exogenous knowledge in the local communities, the frequency of accessing exogenous knowledge, the types of knowledge obtained from tacit and explicit sources, and the application of agricultural exogenous knowledge on their farms. Both interviews and focus groups were conducted.

5.6.1.1 Tacit and explicit sources of agricultural exogenous knowledge

The respondents were asked to indicate their main tacit and explicit sources of agricultural exogenous knowledge. Their multiple responses are shown in Table 5.20. Neighbours/friends were the main sources of agricultural exogenous knowledge in the local communities, with a score of 132 (72.9%) respondents, followed by public extension officers 130 (71.8%) and parents/family 103 (56.9%). Agricultural input suppliers, cooperative unions, village meetings, farmer groups, and NGOs were important sources of agricultural exogenous knowledge. Most of the printed materials were less considered by farmers as important sources of knowledge.

Further, the tacit and explicit sources of knowledge varied across the districts as depicted in Table 5.20. For instance, public extension officers were main sources of agricultural exogenous knowledge in Songea Rural 28 (15.5%), Mpwapwa 27 (14.9%) and Moshi Rural 26 (14.4%). Cooperative union were important sources of knowledge in Kasulu 21 (11.6%), Songea Rural 19 (10.5%) and Moshi Rural 16 (8.8%). Agricultural input suppliers were important sources of knowledge in Moshi Rural 23 (12.7%) and Kasulu 21 (11.6%), while farmer groups and NGOs were significant in Songea Rural and Moshi Rural.

Figure 5.12 shows that the percentages of males recorded as formal sources of knowledge were higher than that of females, which included public extension officers 85 (75.9%), cooperative union 49 (43.8%), and agricultural input suppliers 50 (44.6%). Males also dominated explicit sources of knowledge, while women dominated NGOs and local sources of knowledge.
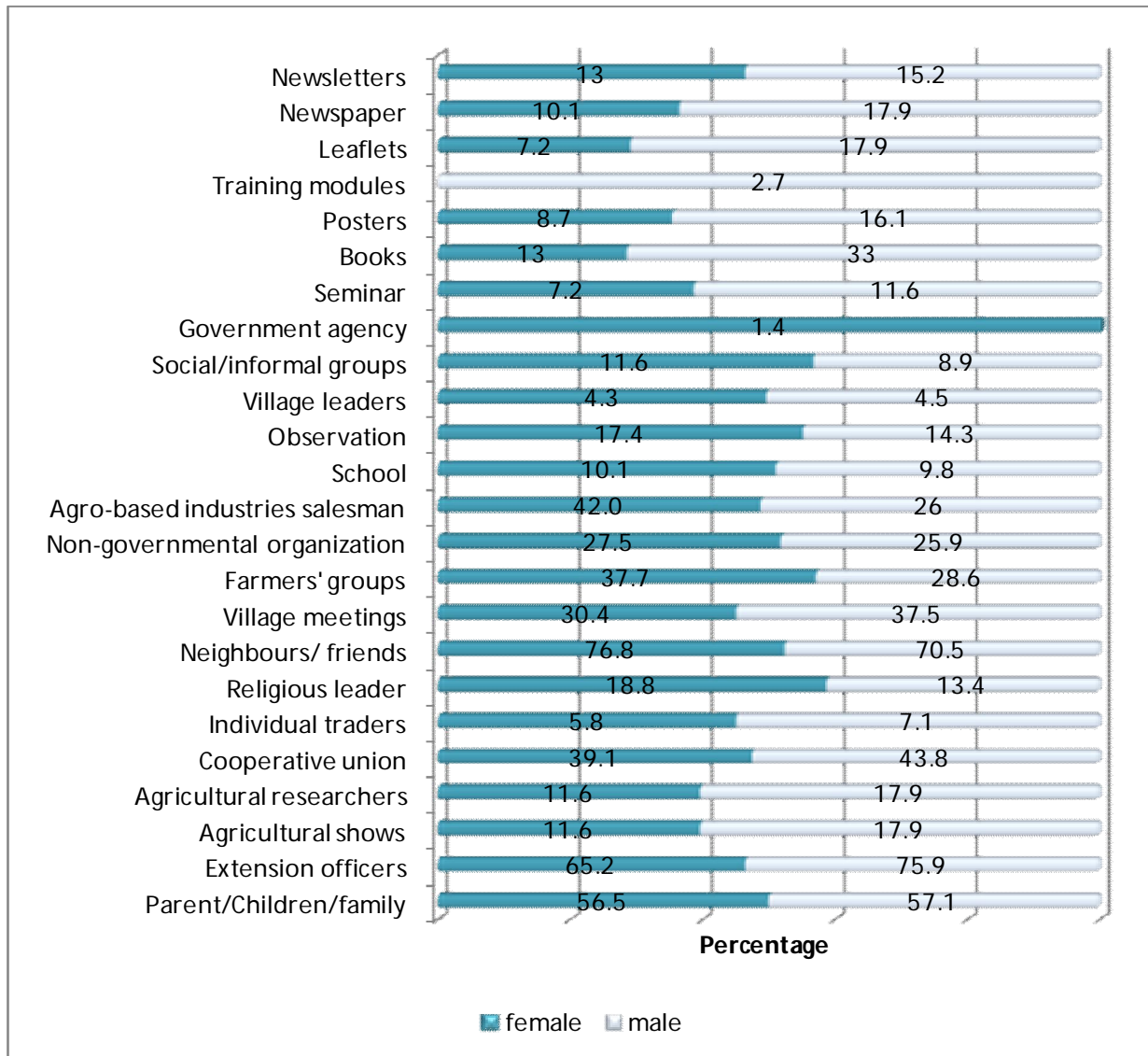
Figure 5.12: Tacit and explicit sources of agricultural exogenous knowledge by gender (N=181) (Multiple responses were possible)

Table 5.20: Tacit and explicit sources of agricultural exogenous knowledge by districts (N=181)

Sources of exogenous knowledge	Mpwapwa		Karagwe		Kasulu		Moshi Rural		Kilosa		Songea Rural		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Parent/Children/family	14	7.7	27	14.9	8	4.4	16	8.8	24	13.3	14	7.7	103	56.9
Extension officers	27	14.9	12	6.6	17	9.4	26	14.4	20	11.0	28	15.5	130	71.8
Agricultural shows	7	3.9	3	1.7	2	1.1	7	3.9	5	2.8	4	2.2	28	15.5
Agricultural researchers	7	3.9	1	0.6	3	1.7	9	5.0	5	2.8	3	1.7	28	15.5
Cooperative unions	3	1.7	17	9.4	21	11.6	16	8.8	-	-	19	10.5	76	42.0
Individual traders	1	0.6	-	-	1	0.6	2	1.1	6	3.3	2	1.1	12	6.6
Religious leaders	4	2.2	4	2.2	1	0.6	16	8.8	3	1.7	-	-	28	15.5
Neighbours/ friends	12	6.6	27	14.9	23	12.7	28	15.5	25	13.8	17	9.4	132	72.9
Village meetings	13	7.2	7	3.9	2	1.1	15	8.3	11	6.1	15	8.3	63	34.8
Farmer groups	6	3.3	3	1.7	8	4.4	11	6.1	8	4.4	22	12.2	58	32.0
NGOs	3	1.7	6	3.3	7	3.9	9	5.0	6	3.3	17	9.4	48	26.5
Input suppliers	1	0.6	-	-	21	11.6	23	12.7	17	9.4	17	9.4	79	43.6
Schools	1	0.6	9	5.0	2	1.1	3	1.7	2	1.1	1	0.6	18	9.9
Observation					1	0.6	20	11	1	0.6	6	3.3	28	15.5
Village leaders	1	0.6	-	-	-	-	6	3.3	1	0.6	-	-	8	4.4
Social gatherings	1	0.6	-	-	-	-	14	7.7	-	-	3	1.7	18	9.9
Government agency	-	-	-	-	-	-	1	0.6	-	-	-	-	1	0.6
Seminars	3	1.7	5	2.8			2	1.1	-	-	8	4.4	18	9.9
Books	7	3.9	14	7.7	7	3.9	4	2.2	8	4.4	6	3.3	46	25.4
Posters	5	2.8	3	1.7	2	1.1	4	2.2	4	2.2	6	3.3	24	13.3
Training modules	1	0.6	1	0.6	-	-	-	-	-	-	1	0.6	3	1.7
Leaflets	7	3.9	3	1.7	1	0.6	4	2.2	7	3.9	3	1.7	25	13.8
Newspapers	8	4.4	9	5.0	2	1.1	2	1.1	3	1.7	3	1.7	27	14.9
Newsletters	5	2.8	6	3.3	2	1.1	11	6.1	-	-	2	1.1	26	14.4

(Multiple responses were possible)

The information mapping and linkage diagrams confirmed that local and informal contacts of parent/family, personal experience and neighbours / friends were the dominant sources of knowledge in the local communities, followed by public extension officers (Figure 5.13). Village leaders, livestock headers, agricultural shops, NGOs, cooperative unions, farmer groups, religious bodies, and middle men were important sources of knowledge in some local communities. Explicit sources of knowledge were less considered as important sources of knowledge in the communities.
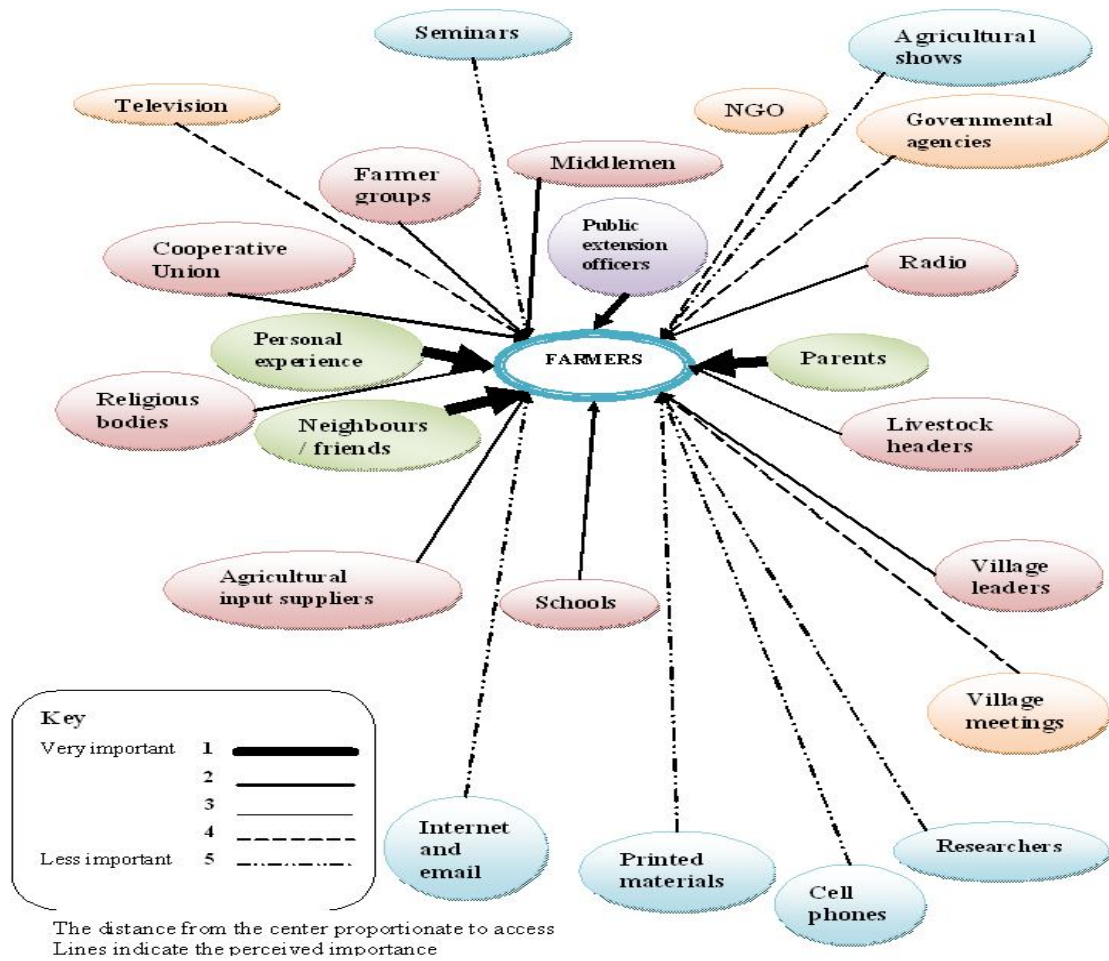
Figure 5.13: The consolidated information maps of the surveyed districts

5.6.1.2 Types of agricultural exogenous knowledge received from tacit and explicit sources of knowledge

The respondents were asked to indicate the types of agricultural exogenous knowledge they obtained from tacit and explicit sources of knowledge in their communities. Appendix 16 indicates that the majority of the respondents obtained knowledge on new varieties and

techniques from various sources of knowledge, which included public extension officers 79 (43.9%), neighbours/friends 66 (36.5%), agricultural input supplier 30 (16.6%), NGOs 28 (15.5%), farmer groups 23 (12.7%), and observation 20 (11%). Other major types of knowledge received from tacit and explicit sources of knowledge were knowledge on crop husbandry and control of animal diseases. Few farmers accessed knowledge on agricultural tools from tacit and explicit sources.

5.6.1.3 The frequency of accessing sources of agricultural exogenous knowledge

For each exogenous knowledge source, respondents were asked how frequent (if at all) they accessed agricultural exogenous knowledge from the sources that they had identified. Their multiple responses are given in Table 5.21. More than half of the respondents ranked parents/family, and friends/neighbours as the most frequently accessed sources of exogenous knowledge in the communities in the "very often" category, accounting for 55 (43.7%) and 53 (55.8%) of the respondents respectively. The next most frequently accessed sources of knowledge in the "often" category were neighbours 50 (39.7%), farmer groups 36 (76.6%), public extension officers 33 (27%), cooperative unions 27 (45.8%), parents/children/family 25 (26.3%), agricultural input suppliers 25 (44.6%), and NGOs 20 (45.5%). Despite the fact that the ranking for extension officers in the "very often" and "often" categories was high, many respondents rarely consulted these officers, with a score of 25 (20.5%) and 17 (13.9%) in the "seldom" and "very seldom" categories. Other less consulted sources were village meetings 12 (20.7%), researchers 7 (36.8%), leaflets 7 (36.8%), and agricultural shows 6 (27.3%) in the "seldom" category.

The focus group discussions confirmed that farmers were in frequent contact with parents/family, and neighbours/friends. The next most frequently accessed sources of knowledge were extension officers, agricultural shops and NGOs. However, extension officers were not available most of the time and thus they were less consulted in some of the communities such as Kilosa (Twatwatwa and Kasiki Village), Karagwe (Katwe and Iteera Village) and Moshi Rural (Mshiri Village). NGOs were less consulted in Songea Rural (Materereka Village), Kasulu (Nyansha Village) and Mpwapwa (Mazae and Vinghawe). Explicit sources of knowledge

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including newspapers, books and newsletters were not available in most of the communities and thus they were less used.

Table 5.21: Tacit and explicit sources of agricultural exogenous knowledge and the frequency of access (N=181)

Sources of exogenous knowledge	Very often		Often		Neither often nor seldom		Seldom		Very seldom	
	No	%	No	%	No	%	No	%	No	%
Parent/Children/family (n=95)	53	55.8	25	26.3	10	10.5	4	4.2	3	3.2
Neighbours/ friends (n=126)	55	43.7	50	39.7	15	11.9	5	4	1	0.8
Extension officers (n=122)	29	23.8	33	27	18	14.8	25	20.5	17	13.9
Village meetings (n=58)	2	3.4	22	37.9	14	24.1	12	20.7	8	13.8
Agricultural shows (n=22)	3	13.6	4	18.2	3	13.6	6	27.3	6	27.3
Farmers' groups (n=47)	8	17	36	76.6	1	2.1	1	2.1	1	2.1
Agricultural researchers (n=19)	2	10.5	6	31.6	3	15.8	7	36.8	1	5.3
NGOs (n=44)	5	11.4	20	45.5	10	22.7	6	13.6	3	6.8
Cooperative unions (n=59)	4	6.8	27	45.8	24	40.7	4	6.8	-	-
Input suppliers (n=56)	8	14.3	25	44.6	11	19.6	5	8.9	7	12.5
Individual traders (n=5)	-	-	2	40	2	40	1	20	-	-
School teachers (n=10)	1	10	3	30	2	20	2	20	2	20
Religious leaders (n=22)	1	4.5	8	36.4	8	36.4	3	13.6	2	9.1
Newspapers (n=20)	2	10	5	25	6	30	5	25	2	10
Books (n=37)	6	16.2	16	43.2	12	32.4	3	8.1	-	-
Leaflets (n=23)	3	13	8	34.8	5	21.7	7	30.4	-	-
Newsletters (n=23)	1	4.3	11	47.8	8	34.8	3	13	-	-
Training modules (n=2)	-	-	-	-	1	50	1	50	-	-
Seminars (n=18)	-	-	5	27.8	10	55.6	3	16.7	-	-
Posters (n=11)	1	9.1	2	18.2	5	45.5	3	27.3	-	-
Observation (n=19)	-	-	16	84.2	3	15.8	-	-	-	-
Village leaders (n=8)	-	-	-	-	7	87.5	1	12.5	-	-
Social/informal groups (n=10)	-	-	6	60	4	40	-	-	-	-
Government agency (n=1)	-	-	-	-	-	-	-	-	1	100
Seminars (n=3)	-	-	1	33.3	1	33.3	1	33.3	-	-

(Multiple responses were possible)

5.6.1.4 The application of exogenous knowledge and technologies in farming systems

The study sought to determine the use of exogenous knowledge in the farming systems. The respondents were asked to indicate if they had applied exogenous knowledge and technologies obtained from tacit and explicit sources of knowledge in their farming activities. Most farmers

141 (77.9% of 181 respondents) indicated that they had applied conventional knowledge and techniques to their farming activities. An inquiry into which exogenous knowledge and technologies were applied in their farming activities indicated that knowledge on crop husbandry was the most applied technology, with a score of 87 (61.7%) respondents, followed by new varieties and techniques 50 (35.5%) (Figure 5.14). The least applied techniques were value added 9 (6.4%) and environmental conservation 8 (5.7%).
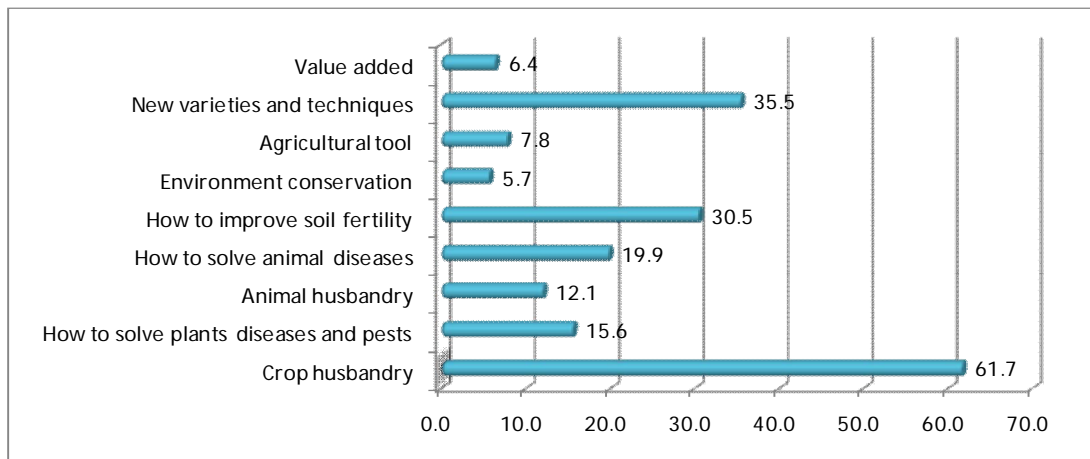
Figure 5.14: The application of exogenous knowledge and technologies in farming systems (N=141)

The focus group discussions confirmed that knowledge on crop husbandry and new techniques and varieties were the most adopted exogenous technologies in the communities. Other techniques, arranged in descending order were: improvement of soil fertility, control of plant pests and diseases, environmental conservation, control of animal diseases, livestock husbandry, value added techniques, and agricultural tools.

Those 141 (77.9%) respondents who reported that they had applied exogenous techniques into their farming systems were asked to indicate the reasons for adopting those methods. Improved agricultural production was the major reason for applying exogenous technologies, especially on crop husbandry, control of plant and animal diseases, soil fertility, new varieties and techniques, agricultural tools, and value added techniques, accounting for 133 (94.3%) respondents. Other major reasons were effectiveness of conventional techniques 65 (46.1%), simplified field

operations 12 (8.5%), source of income 11 (7.8%), to prevent soil erosion 5 (3.5%), to ensure food security 4 (2.8%), and no other alternative technology 2 (1.4%). The least cited reasons were to improve quality of crop produce, lack of access to local inputs, an instructions from village leaders (such as to plant trees), and to reduce crop loss, with a score of 1 (0.7%) respondent each.

The focus group discussions confirmed that improved agricultural production was the major reason for applying exogenous technologies on crop husbandry, new varieties and techniques, and improvement of soil fertility. Another major reason was the effectiveness of exogenous technologies, such as crop husbandry practices, and control of animal and plant diseases. Other reasons, arranged in descending order of importance were as follows: boosted crop and animal growth; validated conventional techniques such as chemical pesticides; increased income; improved soil moisture and fertility; early maturity due to the use of improved crop varieties and seeds; simplified field operations; and assurance of food security due to the use of improved value added techniques such as pesticides.

5.6.1.5 The non-application of agricultural exogenous knowledge and technologies

The respondents were asked to indicate if they had not applied the exogenous knowledge and technologies obtained from tacit and explicit sources of knowledge in their communities. Few farmers 54 (29.8% of 181 respondents) indicated that they had not applied conventional knowledge and techniques to their farming activities. Those 54 (29.8%) were asked to provide details of those technologies. Control of plant diseases and pests was the main technique that was not applied by farmers onto their farms, with a score of 31 (57.4%) respondents, followed by improvement of soil fertility 19 (35.2%), new varieties and techniques 15 (27.8%), livestock husbandry 5 (9.3%), control of animal diseases 5 (9.3%), and agricultural tools 5 (9.3%). The least cited non-applied techniques were crop husbandry and value added, with a score of three (5.6%) respondents each.

Despite the fact that interviews showed that control of plant diseases was the most non-applied technique, the focus group discussions established that knowledge on soil fertility was the most non-applied technique in the local communities. Other major non-applied techniques were

knowledge on crop husbandry, control of plant diseases, livestock husbandry, agricultural tools, and new crop varieties and techniques. Value added was the least cited technique.

Figure 5.15 indicates that high cost of agricultural inputs was the major reason that limited farmers from adopting exogenous knowledge and technologies, such as new techniques and varieties, agricultural tools, pesticides, animal special supplements and fertilizers, accounting for 42 (77.8%) respondents. Other major reasons were toxicity and hazardous effects of conventional inputs (such as pesticides) on human health 18 (33.3%), and conventional techniques were labour intensive 9 (16.7%). Other reasons were dissemination of inappropriate technologies to farmers' agro-ecological conditions, high incidences of pests, land scarcity, low agricultural production, increased consumers' interest in organic products that are produced with local inputs, and some crop varieties matured early and rotted, accounting for one (1.9%) respondent each.
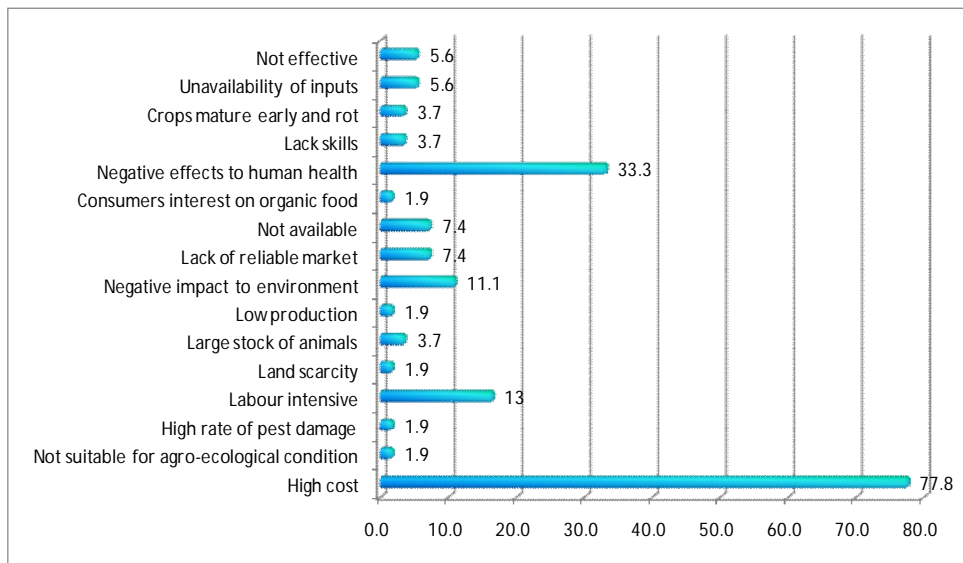
Figure 5.15: Reasons for the non-application of agricultural exogenous knowledge obtained from tacit and explicit sources of knowledge (n=54)

The focus groups confirmed that high cost of inputs, tools and conventional techniques was the main reason which limited farmers in applying exogenous technologies on agricultural tools, new crop varieties and livestock husbandry, improvement of soil fertility, and control of plant diseases. Unavailability of inputs was another reason which limited farmers from applying conventional techniques such as, crop husbandry techniques, soil fertility, control of plant

diseases and value added. Other reasons, arranged in descending order of importance were: lack of skills in conventional farming techniques; some conventional techniques were labour intensive such as row spacing; toxicity and hazardous effects of conventional inputs, such as pesticides and chemical fertilizers; lack of reliable markets; lack of electricity and facilities to apply value added techniques; and some farmers stated that their soil was fertile and thus there was no need to apply any techniques to improve their soil quality as reported by Vinghawe Village's focus group in Mpwapwa.

5.6.2 The access to agricultural exogenous knowledge in the local communities: data from knowledge intermediaries

The study sought to establish the role of knowledge intermediaries in disseminating agricultural exogenous knowledge in the local communities. The knowledge intermediaries were also asked to give details on the strategies used to disseminate exogenous knowledge, effectiveness of those strategies, and approaches used to assess the adoption of exogenous knowledge in the farming activities in the local communities.

More than half of the respondents 15 (60%) acknowledged that they used various means to disseminate agricultural knowledge to farmers (Figure 5.16). Most intermediaries used personal visits and leaflets to disseminate exogenous knowledge to farmers, with a score of 12 (80%) respondents each, followed by training 10 (66.7%). Few intermediaries used farmer field days, flip charts and books to disseminate agricultural exogenous knowledge in the local communities.

The respondents were asked to indicate if the print materials were effective in disseminating agricultural technologies. More than half of the respondents ranked printed material as an effective means to disseminate agricultural exogenous knowledge, with a score of 10 (40%) and six (24%) respondents in the very effective and effective categories. One (5.9%) respondent indicated that printed materials were probably effective, while eight (32%) did not respond.

When asked if they had a follow up mechanism, nine (36%) respondents replied affirmatively that they had a follow up mechanism in their rural knowledge and information provision strategies, while 16 (64%) had not. Personal visits were the predominant approaches used by

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knowledge intermediaries to monitor the adoption of agricultural technologies, followed by farmer groups and farmer field schools.
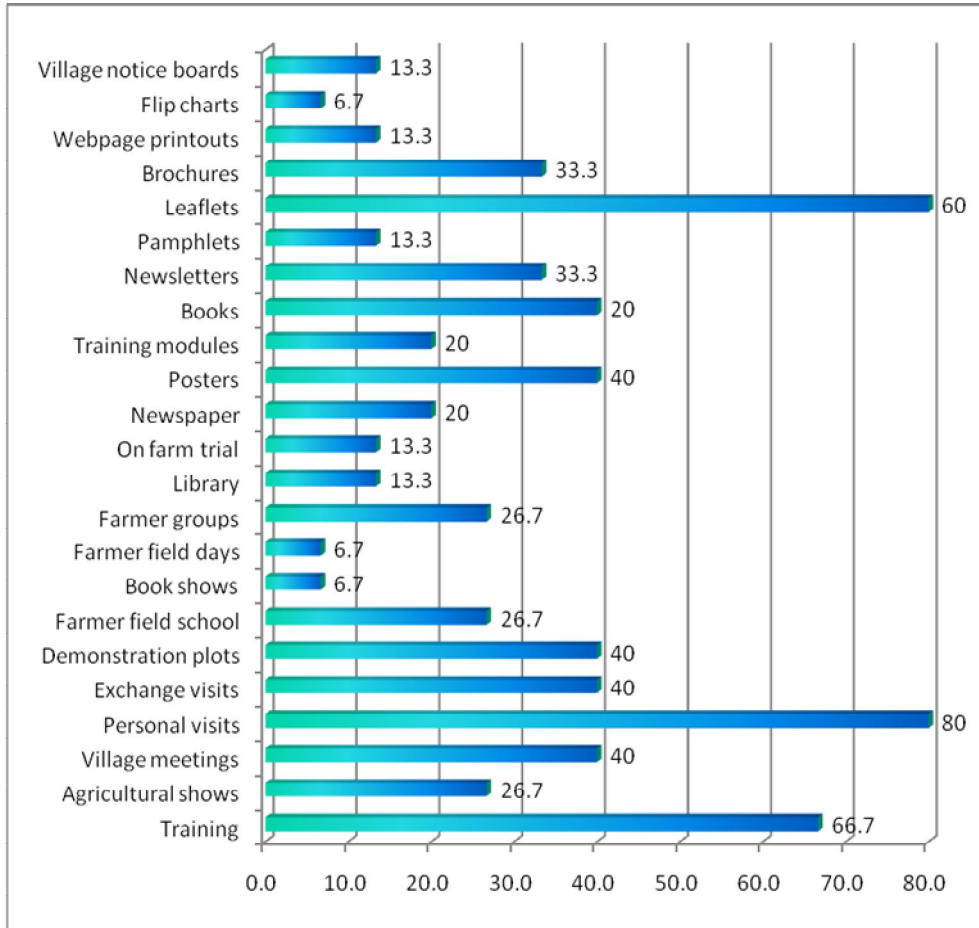
Figure 5.16: Methods used by knowledge providers to disseminate agricultural exogenous knowledge in the communities (N=15)

5.7 The integration of agricultural exogenous and indigenous knowledge in the local communities

The seventh objective on the integration of agricultural indigenous and exogenous knowledge was established by assessing whether rural knowledge intermediaries identified and prioritized agricultural IK and farmers' knowledge needs in their rural knowledge strategies. Both local communities and knowledge intermediaries were interviewed.

5.7.1 The integration of agricultural exogenous and indigenous knowledge: data from local communities

The respondents were asked to provide details if they were satisfied with the agricultural IK that existed in their communities, their willingness to share their IK for agricultural development purpose, and if rural knowledge providers identified and prioritized their agricultural IK.

5.7.1.1 The need to integrate agricultural exogenous and indigenous knowledge in the local community

The respondents were asked if the existing agricultural IK in the local community was sufficient to meet their farming requirements. One hundred and thirteen (62.4%) respondents reported that IK was not sufficient to solve their farming problems, while 60 (33.1%) were satisfied with the IK that existed in their communities, and eight (4.4%) respondents did not have any opinion. Most farmers indicated that IK was not sufficient to solve their farming activities due to the following reasons, which are arranged in descending order of importance:

- Low agricultural production: The respondents reported that they experienced low agricultural production due to the use of IK. For example, one farmer in Kilosa reported that, "I get only five litres of milk per ten cattle, which is very low". Thus, farmers suggested a need to have access to external knowledge in order to improve their knowledge base and agricultural productivity;

- Lack of researched and validated indigenous knowledge: IK was not validated and thus its effectiveness for agricultural activities was low. Farmers suggested a need to integrate IK with exogenous knowledge so that it could be improved;

- Ineffectiveness of indigenous techniques: Some of the indigenous skills and practices were not effective to solve farming problems such as crop and animal husbandry practices, animal and plant diseases control, soil fertility, marketing, and credits. For instance, one farmer at Twatwatwa Village in Kilosa indicated that, "…cutting of cattle ears and use of local herbs have not been effective to treat anaplasmosis (*ndigana*) disease in cattle, instead cattle die at a high rate";

- Lack of IK records: IK was neither recorded nor equally shared in the communities, and thus it was not accessible. Despite the fact that farmers depended on oral communication, it was difficult to identify IK holders because not everybody in the community possessed IK;

- Poor recognition of IK in rural knowledge provision strategies: Most of the extension services focused on conventional techniques and cash crops as compared to indigenous farming. Typical response from Kilosa (Kasiki Village) was that, "extension officers are not available to help us to improve our knowledge system. They tend to focus on cash crops for commercial purposes, and not on food crops which we mostly depend on";

- Disappearance of indigenous resources: Some of the local resources such as seed varieties had disappeared which limited the use of IK for farming purpose. For instance, farmers in Kasulu reported that building materials for crop storage structures (granaries) had disappeared and thus it was difficult to construct granaries in order to preserve their crops;

- Local inputs were time demanding: Most of the local herbs and practices required a lot of time to be prepared which discouraged some farmers from using them for their farming activities. Such techniques included local herbs for treating plants and animal diseases, and manure for improving soil quality; and

- Poverty: Levels of poverty were still high despite the fact that IK had been used for centuries to improve agricultural productivity. Thus, farmers were eager to improve their knowledge system in order to increase their income levels and agricultural production.

This study further sought to establish farmers' willingness to share their knowledge to the development agencies for improved farming practices. On whether farmers were willing to share their knowledge for developmental purposes showed that the majority of the respondents 150 (82.9%) were willing to share their knowledge, while 24 (13.3%) were not willing, and the remaining seven (3.9%) did not respond.

5.7.1.2 Identification of indigenous knowledge in the rural areas

The respondents were asked to indicate if they were involved by knowledge providers in an effort to identify their IK when developing and disseminating agricultural technologies in their communities, and the methods used by knowledge providers to identify their knowledge.

Fifty two (28.7%) respondents indicated that rural information and knowledge providers had involved them in an effort to identify their IK when developing and disseminating agricultural technologies, while the remaining 129 (71.3%) had not. Those 52 (28.7%) respondents were

asked to provide details of those rural information providers who had involved them when developing and disseminating agricultural technologies in their communities. The majority of the respondents 44 (84.6%) ranked public extension officers as the main knowledge providers who had involved them in knowledge development and dissemination in an effort to identify their IK, followed by NGOs 11 (17.3%), and researchers 6 (11.5%).

The 52 (28.7%) respondents were asked to indicate the methods used by the knowledge providers to identify their knowledge. Personal visits were the most dominant approaches used by knowledge intermediaries to identify IK, which included 30 (56.6%) extension officers, four (57.1%) researchers, and three (16.7%) NGOs (Figure 5.17). The least cited methods for identifying IK in the communities were village meetings and farmer research groups, accounting for two (3.8%) of extension officers, and two (28.6%) of researchers. IK was identified through personal visits when farmers sought knowledge regarding their farming problems from intermediaries, or when the intermediaries visited individual farmers especially the public extension officers. Most NGOs did not have their own extension officers, and most times they depended on the public extension officer to conduct their extension services.

Figure 5.17 indicates that participatory approaches which are effective in identifying and prioritizing IK were already introduced in the surveyed rural areas across the districts. These approaches included the following:

- The concept of *shamba darasa* or Farmer Field School (FFS) was already introduced by the extension officers in three districts (Kilosa, Mpwapwa and Kasulu). These FFS focused on crop farming, such as cassava and maize enterprises;
- Farmers' research groups were found in Moshi Rural, which were established by the Tanzania Coffee Research Institute (TACRI). These farmer groups were used to identify and integrate IK on coffee and banana farming;
- Farmer groups were established by NGOs in Moshi Rural, Kilosa and Songea Rural. The extension officers also facilitated the establishment of these groups in all districts. Farmer groups played a great role in the identification of farmers' knowledge through demonstration

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plots, training and exchange visits. For instance, one farmer in Songea Rural reported that, "we agreed with the extension officer to use traditional ridges to prevent soil erosion"; and

- Demonstration plots were also used to identify and prioritize IK on crop farming through farmer groups which were facilitated by extension officers and NGO in Moshi Rural, Kasulu, Kilosa and Songea Rural. For instance, one farmer in Moshi Rural reported that, "we did an experiment with the extension agent on how to use fertilizer in three different plots. In the first plot, we used UREA, while manure was used in the second plot, and ammonium sulphate was used in the third plot. Two plots survived, while one plot with ammonium sulphate failed. Thus, UREA and manure were the best fertilizers".

Despite the fact that the knowledge intermediaries have become so responsive to farmers demands, the public extension services were characterised by inadequate funds and fewer researchers and extension agents were available to engage in participatory research with smallholder farmers.
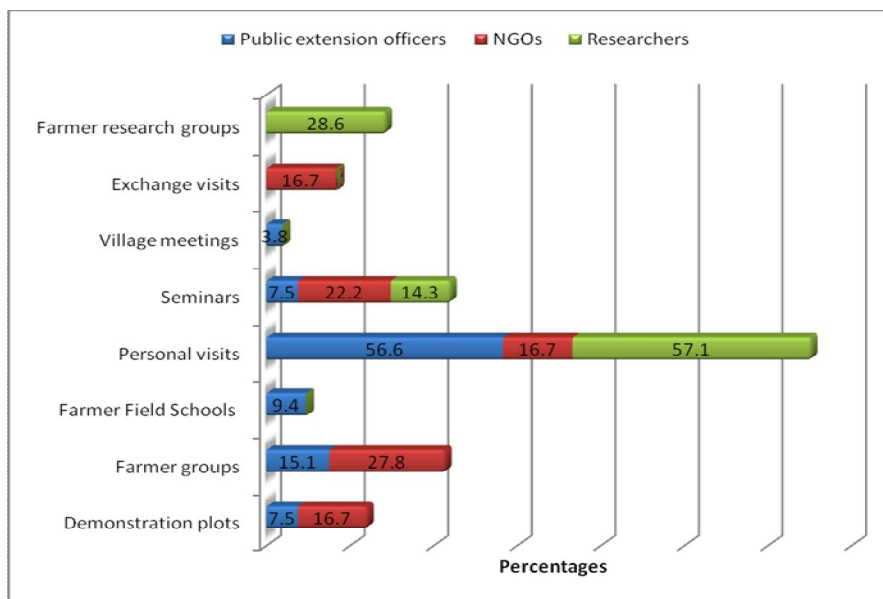
Figure 5.17: Identification of indigenous knowledge in the rural areas (N=52)

5.7.1.3 Prioritization of indigenous knowledge in the rural areas

When asked if information and knowledge providers prioritized IK in their rural knowledge and information provision strategies, forty two (23.2%) respondents indicated that the knowledge

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providers prioritized their IK, while the remaining 139 (76.8%) respondents gave a "no" response.

The extension officers were the main knowledge providers that prioritized farmers' knowledge in their rural knowledge and information provision strategies, followed by NGOs and researchers. Extension officers mainly used personal visits to prioritize farmer's knowledge, followed by farmer groups, demonstration plots, village meetings, and seminars. In personal visits, extension officers prioritized IK on the use of herbs to treat animal and plant diseases, crop husbandry practices, seed varieties, soil fertility, and animal housing in Kilosa, Moshi Rural, Mpwapwa, and Songea Rural. In farmer groups, extension officers prioritized IK in the areas of animal diseases control, livestock keeping, crop husbandry practices, and environmental conservation in Kasulu, Moshi Rural and Songea Rural. Demonstration plots were used in Moshi Rural and Songea Rural to prioritize indigenous technologies on crop husbandry practices. Village meetings were used to prioritize farmers' knowledge on crop production in Karagwe and Mpwapwa. Lastly, farmer field schools were carried out in Kasulu, while seminars were conducted in Karagwe to prioritize farmers' knowledge on crop production.

NGOs prioritized farmers' knowledge through farmer groups on various aspects of crop production in Kilosa, Moshi Rural, and Songea Rural. For instance in Moshi Rural, one farmer reported that "we were educated by FLORESTA NGO through our Mwamko farmer groups to cultivate a plant nursery on various types of indigenous medicinal plants". On the other hand, researchers used farmer research groups to prioritize farmers' knowledge on coffee production and animal breeding in Moshi Rural. For example, one farmer reported that, "TACRI researchers advised us to use animal manure on our farms to improve soil quality".

5.7.1.4 Identification of knowledge and information needs in the rural areas

The respondents were asked to indicate if the rural knowledge providers determined their knowledge and information needs. Fifty six (30.9% of 181 respondents) indicated that knowledge providers determined their information needs. Public extension officers were the major knowledge providers that determined farmers' needs, followed by NGOs and researchers. The public extension officers used personal visits to determine farmer's needs in four districts

(Moshi Rural, Songea Rural, Kilosa, and Mpwapwa). Other methods used by extension officers to determine farmer's needs were farmer groups (Moshi Rural, Kasulu and Songea Rural), demonstration plots and farmer groups (Songea Rural), and village meetings (Mpwapwa).

NGOs were the next most important knowledge providers that identified farmers' needs. These providers used farmer groups (Kilosa, Moshi Rural and Songea Rural), demonstration plots (Songea Rural) and personal visits (Kilosa) to determine farmers' needs. The major focus was put on improving farmers' knowledge through the dissemination of conventional approaches to solve farmers' needs. For instance, one farmer in Kilosa reported that, "these knowledge providers ask us what we want especially knowledge on conventional livestock keeping".

Agricultural researchers were the least cited intermediaries in the identification of farmers' needs in Moshi Rural, Kilosa and Mpwapwa. Most farmers reported that these providers determined their needs when they wanted to introduce new technologies by personally visiting selected farmers and farmer groups. For instance, one farmer in Moshi Rural reported that, "the researchers from TACRI observed my farm and collected problems that I face in coffee and animal farming. These knowledge providers did this when they wanted to bring new coffee variety that grows for six months".

5.7.1.5 Prioritization of information needs in the rural areas

When asked to indicate if the rural knowledge providers prioritized farmers' knowledge and information needs, fifty one (28.2%) respondents replied affirmatively that knowledge providers prioritized their needs. One hundred and twelve (61.9%) gave a "no" response, while 18 (9.9%) did not respond. The public extension officers were the main knowledge providers that prioritized farmers' knowledge needs, followed by NGO, researchers, and agricultural input suppliers. The public extension officers used the following approaches, which are arranged in descending order of importance:

- Personal visits were used to prioritize farmers needs in Kilosa, Moshi Rural, Mpwapwa, and Songea Rural. They focused on crop husbandry, animal and plant disease control, improvement of soil quality, and animal feeds;

- Farmer groups were used to disseminate knowledge on organic farming in Moshi Rural, while Kasulu and Songea Rural farmer groups' were used to educate farmers on conventional techniques for crop production. Further, all farmer groups focused on issues related to markets and access to credit;

- Seminars organised by extension officers and NGO in Mpwapwa, and Moshi Rural were used to disseminate knowledge on various issues such as crop and animal production and environmental conservation;

- Demonstration plots were used to disseminate knowledge on crop production such as coffee and maize production in Songea Rural, while they were used to educate farmers on organic farming in Moshi Rural; and

- Village meetings were used to prioritize farmers' needs on new varieties and technologies, and crop and animal husbandry, and to inform farmers in case of disease or pest outbreak in Mpwapwa.

NGOs mainly used farmer groups and demonstration plots to prioritize farmers' needs in Moshi Rural and Songea Rural. NGOs prioritized farmers' needs by disseminating exogenous knowledge in Songea Rural, while the Moshi Rural NGO's disseminated knowledge on organic farming. Researchers used seminars and personal visits to meet farmers' needs in coffee, banana and animal farming in Moshi Rural. Lastly, agricultural input suppliers visited farmers to market their inputs in Kilosa.

5.7.2 The integration of agricultural exogenous and indigenous knowledge: data from knowledge intermediaries

The study sought to establish the role of knowledge intermediaries in integrating agricultural indigenous and exogenous knowledge. The respondents were asked to provide details on the involvement of farmers in agricultural technology development and dissemination, and the identification and prioritization of farmer's knowledge and needs.

The respondents were asked to indicate if they involved farmers when developing and disseminating agricultural technologies. More than half of the respondents involved farmers when developing agricultural technologies 14 (56% of 25 respondents), while almost half of the

respondents 12 (48%) involved farmers when disseminating agricultural technologies. In agricultural technology development, the knowledge providers mainly used demonstration plots and farmer groups, accounting for four (28.6%) respondents each. Other methods were farmer field schools, three (21.4%), seminars, three (21.4%), on farm trials, two (14.3%), personal visits, two (14.3%), and farmer forums, one (7.1%).

An inquiry to the involvement of farmers in the dissemination of agricultural technologies established that demonstration plots, and farmer-to-farmer promotion were the main methods used by knowledge providers to involve farmers in technology dissemination, with a score of four (33.3%) respondents each. Other methods of importance were farmer field schools, three (25%), farmer groups, two (16.7%), and training, two (16.7%). The least used methods were radio, agricultural shows, farmer field days, village meetings, personal visits, and study visits, accounting for one (8.3%) respondent each.

The respondents were asked to indicate if they prioritized farmers' knowledge in their rural knowledge provision strategies. Almost half of the respondents 11 (44%) replied affirmatively that they prioritized IK into their rural information and knowledge dissemination strategies, while 14 (56%) did not. Most intermediaries used demonstration plots to prioritize IK in the local communities, accounting for six (54.5%) respondents. Other major methods were seminars, four (36.4%), research, four (36.4%), farmer groups, four (36.4%), and farmer field schools, three (27.3%). Other methods were farmer forums, when farmers approached intermediaries for advice, on farm trials, personal visits, and radio, accounting for one (9.1%) respondent each.

An investigation into whether knowledge intermediaries determined farmers' needs indicated that the majority of the respondents determined farmers' information and knowledge needs 19 (76%), while six (24%) did not. Figure 5.18 depicts that most intermediaries used personal interviews 13 (72.2%) to determine farmers' needs in the local communities, followed by farmer groups, four (22.2%), and training needs assessment, four (22.2%). The least used methods were research survey, stakeholder meetings at the research institutes, radio, personal experience, observation, on-farm trials, collaborative projects, and demonstration plots, accounting for one (5.6%) respondent each.

Most of the respondents 18 (72%) indicated that it was important to seek farmers' needs when carrying out their extension services, while seven (28%) did not. When asked if their institutions satisfied their users' needs, half of the respondents 13 (52%) acknowledged that they satisfied their users' needs, while 12 (48%) did not. The 12 (48%) respondents failed to satisfy their users' needs due to the following: lack of agricultural programmes in community radio such as Radio Jamii in Kilosa (Kilosa district); inadequate extension and research officers, facilities and funds; and poor infrastructure.

An inquiry into whether knowledge intermediaries prioritized farmers' needs in their rural provision strategies indicated that more than half of the respondents prioritized farmers' information and knowledge needs in their rural provision strategies, accounting for 14 (56%) respondents, while 11 (44%) did not.
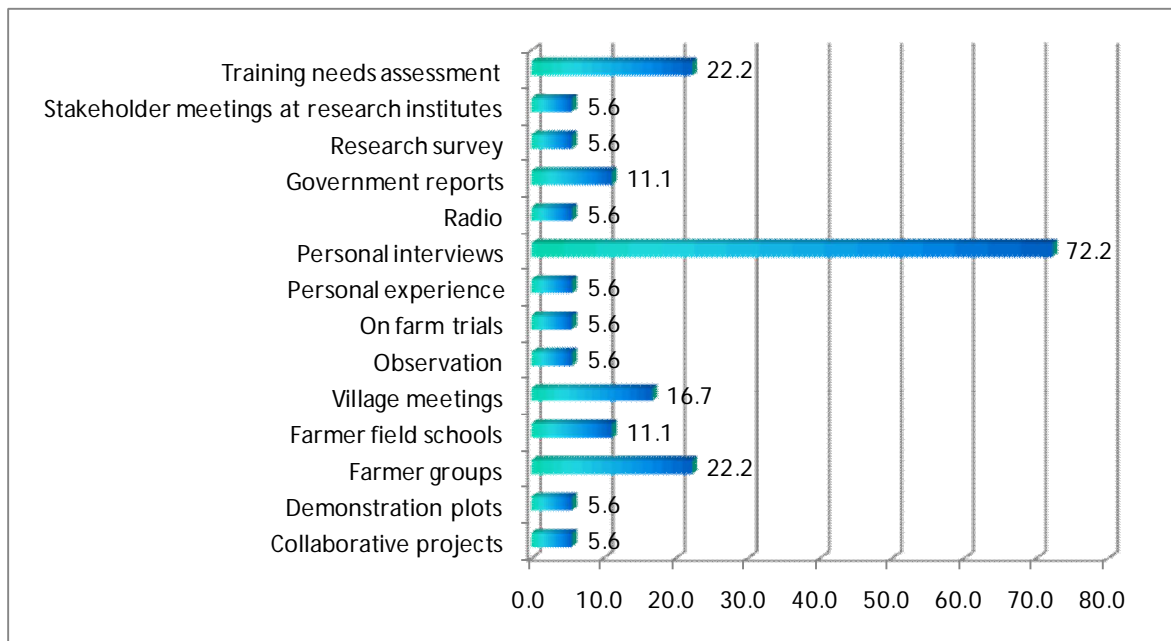
Figure 5.18: Methods used by rural knowledge providers to determine farmers' information and knowledge needs (N=18)

5.8 The role of ICTs in managing agricultural indigenous knowledge

The fourth study objective sought to establish the role of ICTs in managing agricultural IK by assessing the way farmers and knowledge intermediaries used ICTs to manage IK in the local communities. Both local communities and knowledge intermediaries were interviewed.

5.8.1 The management of agricultural indigenous knowledge through ICTs: data from local communities

The study sought to establish the role of ICT in managing agricultural IK by assessing the way farmers used ICTs to acquire, share, preserve and use agricultural IK, frequency of using ICTs to acquire agricultural IK, and types of agricultural IK obtained from ICTs.

5.8.1.1 The acquisition of agricultural indigenous knowledge through ICTs

The respondents were asked to indicate if they had used ICTs to acquire agricultural IK. Eighty two (45.3%) respondents replied affirmatively that they had used ICTs to acquire IK, while 99 (54.7%) had not. The 82 (45.3%) respondents were asked to provide details of those ICTs which they had used to acquire IK. Radio 73 (89%) was the predominant tool used by farmers to acquire IK in the surveyed communities. Other major ICTs were cell phones 39 (47.6%), television 30 (36.6%), audio cassettes 7 (8.5%), email 6 (7.3%) and internet 5 (6.1%). Video cassettes and film shows were less used to acquire IK in the communities, with a score of three (3.7%) respondents each.

Further analysis showed that more men dominated the use of ICTs to acquire agricultural IK than women as depicted in Figure 5.19. The frequencies for males were higher than those of females, which included 30 (55.6%) for cell phones, and 20 (37%) for television.
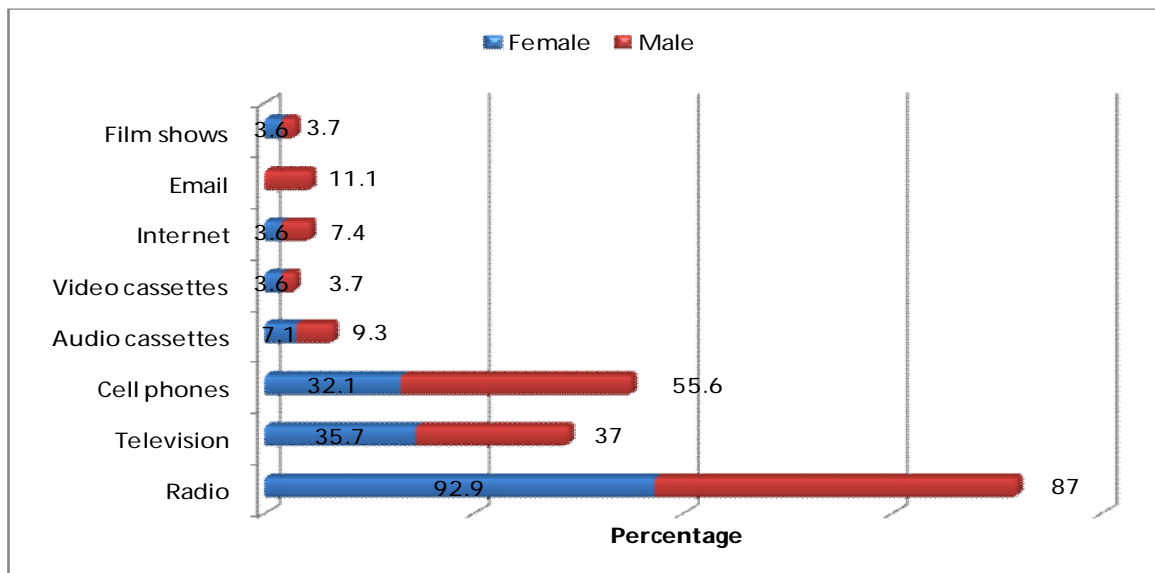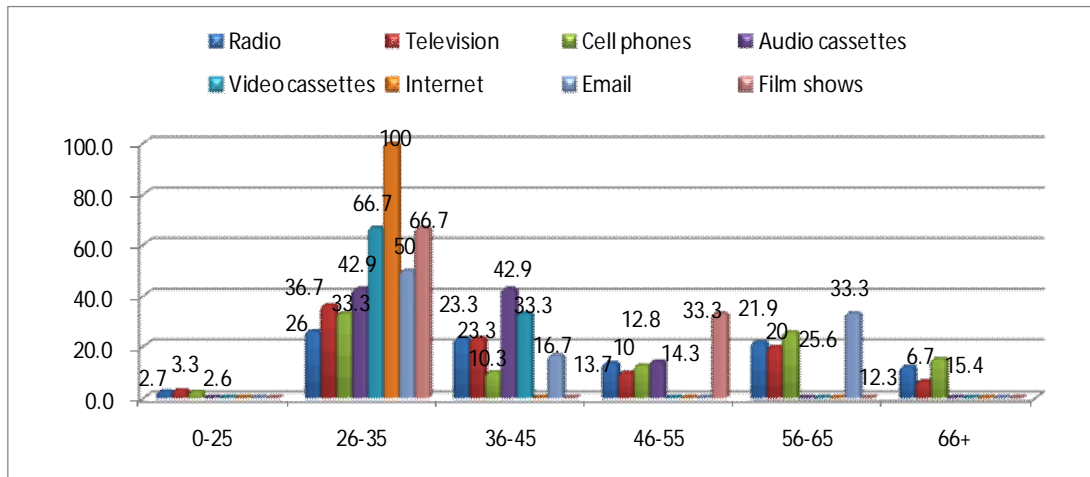
Figure 5.19: Use of ICTs to acquire agricultural IK by gender (N=82)
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Figure 5.20 shows that the percentage of young farmers between the ages of 26-35 was higher in the use of ICTs to access IK than other age categories. The frequencies included 19 (26%) for radio, 11 (36.7%) for television, and 13 (33.3%) for cell phones.



**Figure 5.20: Use of ICTs to acquire agricultural IK by age (N=82)**
*(Multiple responses were possible)*

**5.8.1.2 Frequency of using ICTs to acquire agricultural indigenous knowledge**

When the respondents were asked to indicate how frequently they used ICTs to acquire agricultural IK, radio was the most frequently used ICT to access agricultural IK in the communities, with the score of 46 (63%) respondents, followed by cell phones 16 (41%) as depicted in Table 5.22.

**Table 5.22: ICTs and the frequency of access to agricultural indigenous knowledge (N=82)**

| ICTs | Very often | | Often | | Neither often nor seldom | | Seldom | | Very seldom | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % | No | % |
| Radio (n=73) | 46 | 63 | 11 | 15.1 | 5 | 6.8 | 7 | 9.6 | 4 | 5.5 |
| Television (n=30) | 7 | 23.3 | 12 | 40 | 2 | 6.7 | 5 | 16.7 | 4 | 13.3 |
| Cell phones (n=39) | 16 | 41 | 16 | 41 | 2 | 5.1 | - | - | 5 | 12.8 |
| Audio cassettes (n=7) | 3 | 42.9 | - | - | 2 | 28.6 | 1 | 14.3 | 1 | 14.3 |
| Video cassettes (n=3) | 1 | 33.3 | - | - | 1 | 33.3 | 1 | 33.3 | - | - |
| Film shows (n=3) | 1 | 33.3 | - | - | 1 | 33.3 | 1 | 33.3 | - | - |
| Email (n=6) | 1 | 16.7 | 3 | 50 | - | - | 1 | 16.7 | 1 | 16.7 |
| Internet (n=5) | 1 | 20 | 1 | 20 | - | - | 1 | 20 | 2 | 40 |

*(Multiple responses were allowed)*

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**5.8.1.3 The types of agricultural indigenous knowledge received through ICTs**

The 82 (45.3%) respondents who reported that they used ICTs to acquire IK were asked to indicate the types of agricultural IK that they accessed through ICTs. Table 5.23 indicates that most farmers accessed knowledge on new varieties and techniques, which included radio 27 (32.9%), and television 11 (13.4%). Another major type of IK accessed through ICTs was crop husbandry. Few farmers accessed knowledge on the control of animal and plant diseases. The findings show that radio was mainly used to disseminate IK on new varieties and techniques, and crop husbandry, while cell phones were important sources of knowledge on crop and animal husbandry, and television was the major source of knowledge for new techniques. Advanced ICTs (that is, internet and email) were important to deliver IK on new varieties and techniques.

**Table 5.23: ICTs used to access various types of agricultural indigenous knowledge in the local communities (N=82)**

| ICT | Knowledge types | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | New varieties & techniques | | Crop husbandry | | Animal husbandry | | Plant diseases | | Soil fertility | | Value added | | Animal diseases | |
| | No | % | No | % | No | % | No | % | No | % | No | % | No | % |
| Cell phone | 1 | 1.2 | 10 | 12.2 | 9 | 11 | - | - | - | - | - | - | 2 | 2.4 |
| Email | 3 | 3.7 | - | - | - | - | - | - | - | - | - | - | - | - |
| Internet | 2 | 2.4 | - | - | - | - | - | - | - | - | - | - | - | - |
| Radio | 27 | 32.9 | 11 | 13.4 | 2 | 2.4 | 3 | 3.7 | 9 | 11 | 4 | 4.9 | 1 | 1.2 |
| Audio cassettes | - | - | 1 | 1.2 | - | - | - | - | - | - | - | - | - | - |
| Television | 11 | 13.4 | 4 | 4.9 | 1 | 1.2 | - | - | 1 | 1.2 | - | - | - | - |

In the new varieties and techniques category, radio enabled farmers to access IK on new techniques from various districts with similar agro-ecological conditions. For instance, radio FADECO was used to educate farmers on the use of local herbs to preserve seeds such as *mitoma* tree leaves to control maize seed borers in Karagwe. In Songea Rural, national radio (Tanzania Broadcasting Corporation - TBC) disseminated knowledge on local crop varieties, and techniques such as pests control. Television was used by farmers in Kasulu, Kilosa, Moshi Rural, and Songea Rural to acquire knowledge on various techniques and local varieties that were successful in other districts, and which could be applied in their locations. Through email, WIDA NGO helped farmers to access IK (that is, local techniques for controlling coffee diseases) from TACRI (Tanzania Coffee Reseach Institute). Internet was used by farmers in Moshi Rural and

Kilosa to access knowledge on indigenous farming and pastoralism. For instance, one farmer in Moshi Rural (Lyasongoro Village) reported that, "I always look for websites at FLORESTA NGO newsletter and browse the internet to look for effective indigenous techniques especially on vegetable farming". In Moshi Rural, farmers used cell phones to communicate with FLORESTA NGO to access IK on new varieties and techniques such as local herbs for treating animal and plant diseases.

In crop husbandry techniques, Moshi Rural farmers' used radio (Radio Injili and Radio One stations) to acquire knowledge on effective indigenous farming practices for vegetable production. In Songea Rural, farmers obtained knowledge on local farming practices for maize and coffee production through radio. Cell phones were also used to share knowledge on local seed varieties amongst farmers in Songea Rural.

In the improvement of soil fertility, farmers in Karagwe, Kasulu and Mpwapwa used radio to acquire effective indigenous techniques such as manure. Farmers in Karagwe, Mpwapwa, Songea Rural and Kilosa were able to acquire knowledge on the use of manure through television. For controlling plant and animal diseases and improving soil fertility, farmers in Moshi Rural were educated through radio to use local inputs as compared to pesticides because they had toxicity and hazardous effects on human health and environment.

In animal husbandry and control of animal diseases, farmers in Karagwe, Mpwapwa, Songea Rural and Kilosa were able to acquire knowledge on animal farming practices through television. Cell phones were used by pastoralists in Kilosa (Twatwatwa Village) to communicate with the livestock herders to know the conditions of their animals in the grazing field and advise them incase of any disease outbreak. Cell phones were also used by pastoralists at Twatwatwa Village in Kilosa to contact livestock headers to inquire about a good location for good pasture and safe drinking water for their animals.

In value added techniques, farmers were equipped with knowledge on how to select best seeds for preservation purposes through radio in Kasulu. In Karagwe, farmers were educated through

radio to use local pesticides for preserving their crops. In Moshi Rural, farmers were educated by radio on the use local methods to process and preserve banana. Further, Radio Injili (Evangelist radio) and Kili FM disseminated knowledge on the use of local herbs to control plant and animal diseases in Moshi Rural.

Although interviews showed that new varieties and techniques were the major knowledge types accessed through ICTs, the focus group discussions indicated that animal disease control was the main knowledge type obtained through ICTs, followed by early warning, improvement of soil fertility, crop husbandry, animal husbandry, and control of plant diseases. Most farmers obtained knowledge on animal disease control due to the use of cell phones, which they used to contact livestock/extension officers or their fellow farmers to inquire about the technical solutions for their animal diseases. That is why knowledge on animal disease control was accessed at a high rate from ICTs as indicated in the focus groups.

The knowledge types accessed from ICTs as indicated in the focus group discussion are explained in the following text:

- Animal disease control: Farmers in Songea Rural used cell phones to acquire knowledge on local herbs for controlling animal diseases, such as the use of *mtununga* tree leaves to cure livestock fungal diseases;
- Early warning: Pastoralists in Kilosa (Twatwatwa Village) used cell phones to access information about weather from their fellow farmers. In Moshi Rural, farmers accessed information and knowledge about weather forecasting through radio such as Kili FM. People were allowed to call in during the radio program and explain about weather in their locality and various problems they faced;
- Improvement of soil fertility: Radio was used to disseminate knowledge on the use of manure for coffee production in Moshi Rural and maize production in Mpwapwa (Mazae Village);
- Crop husbandry: Farmers acquired knowledge on how to carry out organic farming on coffee production through radio (Tanzania Broadcasting Corporation) in Moshi Rural (Lyasongoro Village);
- Animal husbandry: Pastoralists in Kilosa (Twatwatwa Village) used cell phones to report to

the radio, police station, and village leaders about the lost animals. Pastoralists in the same district used cell phones to inquire about animal conditions from the livestock headers who usually went very far (that is, between 5 to 110 km) during dry season to look for good pasture and drinking water; and

- Plant diseases control: Radio was used to acquire knowledge on the use of local herbs to control plant diseases in Kilosa, such as neem, and *mchaichai* (*Cymbogon citrates*) plants.

**5.8.1.4 The sharing of agricultural indigenous knowledge through ICTs**
The respondents were asked to indicate if they had used ICTs to share their IK. Thirty four (18.8%) respondents replied affirmatively that they had used ICTs to share their knowledge, while 147 (81.2%) had not. When 34 (18.8%) respondents were asked to describe those ICTs that they had used to share IK, the majority of the respondents 32 (94.1%) had used cell phones to share their IK, while five (14.7%) had used email, and two (5.9%) had used radio.

**5.8.1.5 The preservation of agricultural indigenous knowledge through ICTs**
The respondents were asked to indicate if they had preserved their IK through ICTs. Two (1.1%) respondents acknowledged that they had used ICTs to preserve their IK, while 179 (98.9%) had not. These respondents had used the following ICTs to preserve their knowledge, which were personal computers 2 (40%), cell phone 1 (20%), audio cassettes 1 (20%), and email 1 (20%).

**5.8.1.6 The application of agricultural indigenous knowledge through ICTs**
When asked to indicate if they had applied IK disseminated through ICTs, few farmers 18 (9.9% of 181 respondents) acknowledged that they had applied agricultural IK into their farming systems. Those 18 (9.9%) respondents were asked to mention which indigenous technologies they had applied. The majority of the respondents had applied IK on animal disease control and animal husbandry, accounting for 10 (33.3%) respondents each, followed by new varieties and techniques 5 (16.7%), and soil fertility 5 (16.7%).

The 18 (9.9%) respondents were asked to mention the reasons for adopting these indigenous technologies through ICTs. The increased production and income was the major reason for applying indigenous techniques in the farming systems, accounting for 25 (83.3%) respondents, followed by the availability of inputs, three (10%), and simplicity of indigenous techniques, two

(6.7%). Farmers were able to improve their production and income due to the use of Radio Injili (Evangelist Radio). This radio program equipped them with new knowledge on local herbs such as aloe vera for controlling animal diseases in Moshi Rural. Farmers also improved their crop production due to the use of local seed varieties after they had listened to the radio program in Mpwapwa. Farmers were able to ensure food security and increase their income due to the use of television to access knowledge on local maize seeds in Songea Rural. Cell phones were used to communicate knowledge on local herbs to control animal diseases, such as, *mtununga* tree leaves to treat cattle and pig fungal diseases; or a mixture of chilli pepper and ash to control maize stalk borers in Songea Rural, which improved their productivity. Cell phones were also used by Kilosa pastoralists to make inquiries about their animal conditions in the grazing field, and to inform other pastoralists on the presence of good pasture and safe drinking water, and thus improving their productivity. Radio agricultural programmes equipped farmers with knowledge such as manure which improved their crop production in Mpwapwa, and Karagwe. The simplicity and availability of indigenous technologies that were disseminated through radio such as manure were other reasons for adopting indigenous technologies in Kasulu.

### 5.8.2 The management of agricultural indigenous knowledge through ICTs: data from knowledge intermediaries

The study sought to establish the role of knowledge intermediaries in managing IK through ICTs. The respondents were asked to provide details of ICTs used for acquiring, preserving and disseminating IK in the local communities. Ten (40%) respondents used ICTs to acquire agricultural IK, while 15 (60%) did not. Figure 5.21 shows that six (60%) respondents used cell phones to acquire IK, followed by digital photographs and internet, with a score of five (50%) respondents each. Video and audio cassettes were less used, with a score of one (10%) respondent each.

Ten (40%) respondents who reported the use of ICTs to acquire IK were asked to rank the effectiveness of ICTs in the acquisition of IK. Most respondents ranked ICTs as effective tools for acquiring agricultural IK, accounting for five (50%) and three (30%) respondents in the very effective and effective categories. The remaining respondents indicated that ICTs were probably effective, one (10%), while one (10%) respondent did not have any opinion.

Out of 25 respondents, eight (32%) respondents used ICTs to disseminate agricultural IK in the local communities. Most intermediaries used radio, four (16.7%) to disseminate agricultural IK in the communities. Other major ICTs were land-line phones, internet, email, and television, with a score of three (12.5%) each. The least used ICTs were film shows, cell phones, video cassettes and CDs, accounting for two (8.3%) respondents. Those eight (32%) respondents were asked to rank the effectiveness of ICTs in disseminating agricultural IK. Most respondents ranked ICTs as effective tools for disseminating agricultural IK, accounting for six (75%) and two (25%) respondents in the very effective and effective categories.

Nine (36% of 25 respondents) intermediaries used ICTs to preserve agricultural IK. Personal computers were the main ICTs used to preserve IK, accounting for nine (47.4%) respondents, followed by email, three (15.8%), cell phones, three (15.8%), and CDs, two (10.5%). Few intermediaries used radio, one (5.3%) and video cassettes, one (5.3%) to preserve IK in the local communities. Most respondents ranked ICTs as effective tools for preserving agricultural IK in the very effective, five (55.5%), and effective, four (44.4%) categories.



**Figure 5.21: The use of ICTs to acquire agricultural IK by knowledge intermediaries (N=10)**
*(Multiple responses were possible)*

**5.9 The access to agricultural exogenous knowledge through ICTs in the local communities**
The sixth study objective sought to establish the role of ICTs in disseminating agricultural exogenous knowledge by assessing the way famers accessed and applied exogenous knowledge from ICTs, and the way knowledge intermediaries used ICTs to disseminate exogenous

knowledge in the local communities. Both local communities and knowledge intermediaries were interviewed.

## 5.9.1 The access to agricultural exogenous knowledge through ICTs: data from local communities

The study sought to establish the extent to which the local communities used ICTs to access and apply exogenous knowledge by assessing types of ICTs that farmers used, frequency of accessing knowledge, the types of exogenous knowledge obtained through ICTs, and the use of exogenous knowledge for farming activities.

## 5.9.1.1 The access to agricultural exogenous knowledge through ICTs

One hundred and sixty one (89%) respondents used ICTs to access exogenous knowledge, and the remaining 19 (10.5%) did not. When the 161 (89%) respondents were asked to describe those ICTs, most farmers used radio to access exogenous knowledge on farming systems, with a score of 155 (96.3%) respondents. Other major ICTs were cell phones 71 (44.1%), television 64 (39.8%), email 12 (7.5%), internet 9 (5.6%), and film shows 8 (5%). Few farmers used video cassettes, six (3.7%) to access exogenous knowledge in the surveyed communities. The information mapping confirmed that radio was the principal ICT used by farmers to access knowledge as indicated in Figure 5.13. Television and cell phones were important tools used by farmers to access exogenous knowledge in some locations, while advanced ICTs such as Internet and email were less used to access agricultural exogenous knowledge in the surveyed communities.

Figure 5.22 shows that a higher percentage of males accessed exogenous knowledge through ICTs than female across the surveyed communities, with a score of 104 (98.1%) for radio, 49 (46.2%) for cell phones, and 44 (41.5%) for television.

**Figure 5.22: Access to exogenous knowledge through ICTs by gender (N=161)**

There were age differences in access to exogenous knowledge through ICTs in the rural communities. More young farmers accessed exogenous knowledge from a wide range of ICTs than elderly farmers. Figure 5.23 indicates that young farmers aged between 26-35 years had higher scores on the use of cell phones 16 (22.5%), internet 5 (55.6%), and video cassette 3 (50%) as compared to other age categories. The elderly farmers were more likely to use radio 23 (14.85) and cell phones 12 (16.9%). There were no differences on the use of radio to access exogenous knowledge across various age categories.



**Figure 5.23: Access to exogenous knowledge through ICTs by age (N=161)**

**5.9.1.2 The types of agricultural exogenous knowledge received from ICTs**

The majority of the respondents accessed exogenous knowledge on new varieties and techniques, with a score of 86 (53.4%) radio, 29 (18%) television, 11 (6.8%) cell phones, and 2 (1.2%) film shows (Appendix 17). Other major knowledge types received from ICTs were crop husbandry, livestock husbandry and markerting, while knowledge on credit services was less accessed in the local communities. Radio was mainly used to disseminate knowledge on new varieties and techniques, crop husbandry, soil fertility, livestock husbandry, control of plant diseases, while cell phones were important in sharing knowledge on crop husbandry, marketing, new varieties and techniques, and animal diseases control. Television was mainly used to disseminate knowledge on new varieties and techniques, crop husbandry, and livestock husbandry. Advanced ICTs (internet and email) were important in disseminating knowledge on crop husbandry and marketing. Film shows were mainly used by farmers to access knowledge on new varieties, while video and audio cassettes were used to distribute knowledge on crop husbandry.

In new varieties and techniques, radio and television were used to access knowledge on improved techniques such as irrigation, environmental conservation terraces, seeds, and animal breeds across the districts. Cell phones were used to inquire about new introduced agricultural inputs such as seed varieties, fertilizers, and insecticides from input suppliers and extension officer in Songea Rural and Mpwapwa. Film shows were used to obtain knowledge on new improved seeds varieties through WIDA NGO in Songea Rural.

In plants and animal diseases, radio and television were used to educate farmers on effective methods for controlling animal and plant diseases. Cell phones were used by Kilosa farmers (Twatwatwa Village) to contact other farmers in the regional headquarters to bring animal drugs. Farmers contacted NGOs or extension officers for diagnosis and treatment of animal and plant diseases in Moshi Rural, Songea Rural, Kasulu and Mpwapwa. In Songea Rural, farmers sent their request to WIDA NGO telecentre which used email to forward farmers' queries to TACRI for technical solutions. TACRI in turn sent back the recommended measures, and sent a team of experts to examine the situation and advise farmers, such as technical assistance regarding coffee diseases and pest outbreaks, for example *bungua* pests.

In crop husbandry, radio was used to educate farmers on the effects of bush fires, importance of tree planting, environmental conservation terraces, row spacing and other effective farming practices across the districts. For instance, radio Kwinzela, RFA (Radio Free Africa) and TBC were used by Kasulu farmers to acquire knowledge on timely planting. Television was also used to educate farmers on the effective crop husbandry practices, such as row spacing across the districts. Cell phones were used by farmers to communicate amongst each others in case of emergencies such as natural disaster in Karagwe. Farmers also made telephone calls during the agricultural radio programmes aired by radio FADECO to ask certain questions regarding farming practices in Karagwe. Farmers contacted NGOs or extension officers for advice on crop husbandry practices in Moshi Rural, Songea Rural, Kasulu and Mpwapwa. Cell phones were used by farmers in Moshi Rural to communicate with researchers (TACRI) to access technical details on coffee production in Moshi Rural. Cell phones were used to remind farmers about farmer groups' meetings, training and demonstration plots in Moshi Rural and Songea Rural. Internet was used by farmers to access information and knowledge on natural resource management and agricultural techniques through community or regional telecentres in Moshi Rural, Mpwapwa, Karagwe and Kilosa. Two farmers in Moshi Rural also used cell phones to access the internet in Moshi Rural. Film shows were used to access knowledge on coffee husbandry through WIDA NGO in Songea Rural.

In marketing, cell phones were used to contact community telecentre (FADECO) in Karagwe to access marketing information. Informal contacts were made between farmers and middlemen through cell phones to access information and knowledge on market outlets, and crop and animal prices in Kilosa, Moshi Rural, Kasulu and Songea Rural. Radio was used to access information and knowledge on crop prices and market outlets through radio FADECO in Karagwe. Farmers also accessed marketing information through national radio (Tanzania Broadcasting Cooperation (TBC)) in Kasulu, Moshi Rural and Songea Rural. WIDA NGO telecentre in Songea Rural enabled coffee farmers to negotiate crop prices through email, and market their products to some countries in Europe. In Karagwe, farmers were able to access information on crop prices and markets through email when the FADECO telecentre was still in operation in 2007. Through the internet, one farmer in Moshi Rural was able to secure a market for banana crops. However, it

was not possible to sell crops due to lack of assistance from the government authorities on online marketing. Another farmer in Kilosa was able to secure markets for banana in another district (Tukuyu) through the link learner's online forum. However, it was not possible to sell the products because they were in such small quantity. Farmers acknowledged accessing information and knowledge on market outlets and crop prices from the national TV (Tanzania Broadcasting Cooperation (TBC)) in Songea Rural and Kilosa.

With respect to financial information and knowledge, radio was used to access knowledge on how to form credit and saving groups, and various sources of loans for small scale farming in Mpwapwa, and Kasulu

In value added techniques, radio FADECO in Karagwe was used to access knowledge on the crop processing procedures and the use of pesticides for preserving crops. Through email and internet, farmers accessed information on crop storage through FADECO telecentre in Karagwe when it was in operation in 2007. Cell phones were used to contact extension officers and plowing services for details on how to use ox drawn plows for farming activities in Mpwapwa. On the other hand, radio was used to access knowledge on the use of draught animals for farming purpose in Mpwapwa and Kasulu.

The focus group discussions showed that crop husbandry and new varieties and techniques were the major types of exogenous knowledge obtained through ICTs, followed by knowledge on marketing, plant diseases control, soil fertility, animal diseases control, and early warning. Few farmers accessed exogenous knowledge on value added, animal husbandry and credit services. These knowledge types are explained in detail in the following text, which are arranged in descending order of importance:

- Crop husbandry: Through radio and television, farmers obtained knowledge on the use of conventional crop husbandry practices. Farmers also inquired about the availability of seeds from village leaders, input suppliers, and their fellow farmers through cell phones in Moshi Rural and Songea Rural;
- New varieties and techniques: Radio and television enabled farmers to acquire knowledge and information on new types of crops and inputs;

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- Marketing: Radio has enabled farmers to access information on crop prices and market outlets in Karagwe, Mpwapwa and Songea Rural. Cell phones were used to obtain market information from other farmers, customers, and middle men in Moshi Rural, Kasulu, Kilosa, Mpwapwa and Songea Rural. Emails were used by farmers in Songea Rural to secure buyers from Europe through WIDA NGO;

- Plant diseases control: Radio and television (such as radio FADECO in Karagwe, TBC (National TV and radio), and radio Kwizela in Kasulu) were used by farmers to acquire knowledge on pesticides. Farmers also used cell phones to inquire about the availability of pesticides from input suppliers in Moshi Rural and Songea Rural. Emails were also used by farmers in Songea Rural to access knowledge on control measures for plant pests;

- Soil fertility: Farmers used cell phones to inquire about the availability of fertilizers from village leaders, input suppliers, and their fellow farmers in Moshi Rural and Songea Rural;

- Animal disease control: Farmers used cell phones to contact extension officers for advice on animal disease diagnosis and treatment in Kasulu (Kidyama Village), Moshi Rural and Songea Rural. Farmers in Songea Rural used cell phones to inquire about the availability of pesticides for treating animal diseases from input suppliers. Farmers also used cell phones to report emergencies such as disease outbreaks to the district council in Kilosa (Twatwatwa Village);

- Early warning: Farmers in Kilosa (Kasiki Village) planted drought resistant and short seasoned crops such as vegetables in 2008 once they heard from TBC radio. Cell phones were also used to access weather information from fellow farmers. Television (such as TBC and Independent Television) enabled farmers to access information on weather in Kilosa and Mpwapwa;

- Value added techniques: Radio and television enabled farmers to learn the appropriate use of pesticides for preserving crops;

- Animal husbandry: Cell phones were used by farmers in Kilosa (Twatwatwa Village) to advise each other on livestock keeping issues. Few people had managed to source livestock related information through internet. For example, some pastoralists in Kilosa (Twatwatwa Village) searched the internet and they were able to attend a conference in Spain about livestock keeping; and

- Credit services: Through email, WIDA NGO in Songea Rural had been helping farmers to look for donors to support their agricultural activities such as access to improved crop varieties.

### 5.9.1.3 Frequency of accessing agricultural exogenous knowledge through ICTs

The 161 (89%) respondents were asked to indicate how often they used ICTs to access agricultural exogenous knowledge. Table 5.24 depicts that radio was the most frequently used ICT to access agricultural exogenous knowledge, with the score of 91 (58.7%) and 27 (17.4%) in the very often and often categories. Film shows, and Internet were less used to access exogenous knowledge in agriculture, accounting for three (50%) respondents each.

**Table 5.24: ICTs and the frequency of access to agricultural exogenous knowledge (N=161)**

| ICTs | Very often | | Often | | Neither often nor seldom | | Seldom | | Very seldom | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % | No | % |
| Radio (n=155) | 91 | 58.7 | 27 | 17.4 | 11 | 7.1 | 22 | 14.2 | 4 | 2.6 |
| Television (n=64) | 11 | 17.2 | 25 | 39.1 | 7 | 10.9 | 14 | 21.9 | 7 | 10.9 |
| Cell phones (n=69) | 31 | 44.9 | 21 | 30.4 | 7 | 10.1 | 4 | 5.8 | 6 | 8.7 |
| Audio cassettes (n=9) | 6 | 66.7 | 1 | 11.1 | 1 | 11.1 | - | - | 1 | 11.1 |
| Video cassettes (n=6) | 2 | 33.3 | - | - | 2 | 33.3 | 2 | 33.3 | - | - |
| Film shows (n=6) | 1 | 16.7 | 1 | 16.7 | 1 | 16.7 | - | - | 3 | 50 |
| Email (n=8) | 1 | 12.5 | 4 | 50 | - | - | 1 | 12.5 | 2 | 25 |
| Internet (n=6) | 1 | 16.7 | 1 | 16.7 | - | - | 1 | 16.7 | 3 | 50 |

*(Multiple responses were possible)*

The focus groups discussions confirmed that farmers frequently used radio to access agricultural exogenous knowledge. The next most frequently used ICTs were cell phones, followed by television. However, television was not available in most of the communities' households, and thus farmers in some communities seldom used TV as the source of knowledge. Farmers made little use of internet and email due to lack of awareness and ICT skills.

### 5.9.1.4 The application of agricultural exogenous knowledge through ICTs

When asked to indicate if they had applied exogenous knowledge they accessed through ICTs, the rate of respondents who had adopted exogenous techniques was low, accounting for 64 (35.4%) respondents. The 64 (35.4%) respondents were asked to indicate which techniques they

had adopted. The majority of the respondents had adopted crop husbandry techniques, with a score of 31 (48.4%), followed by new techniques and varieties 21 (32.8%), and soil fertlity 15 (23.4%). Other adopted techniques through ICTs were control of plant diseases and pests 8 (12.5%), and control of animal diseases, seven (10.9%). Few farmers accessed knowledge on agricultural tools, five (7.8%), livestock husbandry, one (10.9%) and value added, one (1.6%).

Those 64 (35.4%) respondents were asked to indicate reasons for adopting those agricultural exogenous technologies and knowledge. Improved crop and animal production was the major reason for adopting exogenous techniques through ICTs, accounting for 63 (98.4%) of the respondents. Other reasons were to control of animal diseases, five (7.8%), simplify field operations, four (6.3%), increase income levels, three (4.7%), control of plant diseases, two (3.1%), ensure food security, two (3.1%), appropriate techniques for farmers' agroecological conditions, one (1.6%), and to conserve environment, one (1.6%). The reasons for adopting agricultural knowledge are explained in detail in the following text, and are arranged in descending order of importance:

- Increased production: Radio enabled farmers to improve their animal and crop production in Songea Rural, Mpwapwa, Kasulu and Moshi Rural. Radio and TV programmes enabled farmers to use improved varieties, synthetic fertilizers, and good crop husbandry practices to enhance their crop yields in Karagwe, Kilosa, Songea Rural and Mpwapwa. For instance, one farmer in Mpwapwa reported that, "I was able to improve my crop yield due to the use of improved seeds (such as short sorghum varieties and sunflower) which I learnt from the radio agricultural programmes". Weather information accessed through TV enabled farmers in Kilosa to plant early and to increase their crop yields. Farmers in Mpwapwa and Songea Rural used cellphones to consult extension officers for advice on crop planting and plant diseases control. Cell phones were also used by farmers to inquire about new agricultural inputs (improved seeds and fertilizers) from suppliers such as Wino Agricultural Marketing Co-operative Society (WAMCS) in Songea Rural and input suppliers in Mpwapwa, which improved their crop production;

- Control of animal diseases: Television and radio agricultural programmes enabled farmers to use sprayers, and a range of drugs such as acaricides to treat animal diseases in Kilosa,

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Songea Rural and Mpwapwa. The breakouts of livestock diseases (such as anaplasmosis and Contagious Bovine Pleuropneumonia (CBPP)) in cattle were reported early by radio programmes which enabled farmers to quickly attend to the matter in Kilosa (Twatwatwa Village). Cell phones were used by farmers to consult livestock officers for disease diagnosis and treatments at their premises in Moshi Rural, Mpwapwa and Songea Rural. The use of cell phones amongst pastoralists enabled them to acquire animal drugs from regional headquarters in Kilosa;

- Simplified field operations: Farmers were able to simplify their field operations and improve their production due to the use of ox drawn plows which they had learnt from the agricultural radio programmes in Mpwapwa (Vinghawe Village);

- Increased income: Farmers in Songea Rural accessed knowledge on new techniques (such as exotic pig breeds, quality seeds, pesticides) through radio programmes which enabled them to increase their income. Radio and TV programmes enabled rural farmers in Mpwapwa (Vinghawe Village) to access knowledge on animal disease control which increased their income and thus intensified their agricultural livelihoods;

- Control of plant diseases: Radio programmes enabled farmers to use conventional drugs to control plant diseases in Kasulu, Songea Rural, Kilosa, and Mpwapwa;

- Food security: Farmers were able to ensure food security after they had learnt how to use pesticides to store maize and bean crops through radio programmes in Karagwe and Kasulu;

- Environmental conservation: Farmers also prevented soil erosion by designing terraces which they had learnt through radio programmes in Moshi Rural. In addition, farmers in Songea Rural abandoned shifting cultivation after they had learnt about its toxicity effects on the environment through a radio programme; and

- Suitable for agro-ecological conditions: Through radio, Kilosa farmers used new maize varieties (such as staha) because they were suitable for their agro-ecological condition.

**5.9.1.5 The non-application of agricultural exogenous knowledge through ICTs**
When asked to indicate if they had not applied any agricultural exogenous techniques which they accessed through ICTs, twenty three (12.7% of 181 respondents) respondents indicated that they had not applied some of the agricultural exogenous techniques they accessed through ICTs. Those 23 (12.7%) respondents were asked to specify what those agricultural technologies were.

Eight (34.8%) respondents had not applied techniques on how to improve soil fertility, followed by new varieties and techniques, with a score of seven (30.4%) respondents. Other major techniques which were not applied in the farming systems were crop husbandry, five (21.7%), livestock husbandry, four (17.4%), control of plant diseases and pests, three (13%), and agricultural tools, one (4.3%).

The 23 (12.7%) respondents were asked to indicate reasons for not applying those agricultural exogenous technologies. Table 5.25 indicates that most farmers 14 (60.9%) did not apply exogenous techniques due to high cost of inputs, followed by inappropriate technologies for agroecological conditions, three (13%).

**Table 5.25: The reasons for the non-application of agricultural exogenous knowledge and technologies disseminated through ICTs (N=23)**

| Reason | Details of the technology |
|---|---|
| High cost of inputs (n=14; 60.9%) | Involved non-use of agricultural tools such as tractors and oxen drawn plow in Mpwapwa. For instance, an oxen drawn plow was rented at 10,000 TShs (10$) or 15,000 TShs (15$) per acre in Mpwapwa. It also involved non-use of new techniques, crop husbandry techniques (such as zero grazing), animal varieties (exotic breeds of cattle and poultry) and inputs such as animal mineral supplements, mineral fertilizers, seed varieties and pesticides in Moshi Rural, Kasulu, Mpwapwa, Kilosa, Mpwapwa and Songea Rural. |
| Irrelevant technologies (n=3; 13%) | Involved non-use of improved seed varieties such as, sugar cane was irrelevant in Karagwe, while cotton and some maize seed varieties (such as SEED CO) were not appropriate for agro-ecological conditions in Kilosa. |
| Unavailability of inputs (n=2; 8.7%) | Involved non–adoption of new inputs, varieties and techniques in Kilosa, Mpwapwa and Karagwe. |
| Labour intensive (n=2; 8.7%) | Involved non-adoption of animal husbandry techniques such as zero-grazing in Kilosa, Mpwapwa and Songea Rural |

| Seed damage (n=2; 8.7%) | Included non-adoption of new varieties. For instance, new maize seeds varieties were abandoned because they used to rot before they germinated in Songea Rural. |
|---|---|
| Hazardous effects on environment (n=2; 8.7%) | Included non-use of pesticides and mineral fertilizers in Karagwe and Kasulu. For instance, one farmer in Karagwe reported that, "I have stopped to use DDMARK pesticides after I learnt about their toxicity effects on environment through email at the FADECO telecentre". |
| Lack of skills (n=1; 4.3%) | Involved lack of adequate skills to apply new techniques such as dairy farming in Kilosa. |
| Land scarcity (n=1; 4.3%) | Farmers could not adopt some of the new techniques and varieties such as flower production due to shortage of land in Moshi Rural. |
| Good changes not observed from other farmers' practices (n=1; 4.3%) | Included non-use of techniques for improving soil and controlling plant diseases. For instance, although they learnt from radio, Mpwapwa farmers' did not use fertilizers and pesticides because they had not seen good changes on crop yields from other farmers who had adopted those technologies. |

## 5.9.2 The role of knowledge intermediaries in disseminating agricultural exogenous knowledge through ICTs

The study sought to establish the role of knowledge intermediaries in disseminating exogenous knowledge through ICTs, by assessing the types of ICTs used for disseminating exogenous knowledge, and the effectiveness of those ICTs in disseminating exogenous knowledge in the local communities.

An inquiry into whether knowledge intermediaries used ICTs to disseminate exogenous knowledge in the communities showed that more than half of the respondents 16 (64%) used ICTs to disseminate agricultural exogenous knowledge, while nine (36%) did not. Out of those 16 (64%) respondents who used ICTs to disseminate agricultural knowledge, internet services, seven (46.7%) and cell phone, six (40%) were the main ICTs used to deliver exogenous knowledge to farmers in the surveyed communities. Other major ICTs were radio, four (26.7%),

CDROM, three (20%), email, three (20%), and television, two (13.3%). Video production, one (6.7%) was less used to disseminate exogenous knowledge in the communities. Further, the majority of the respondents indicated that ICTs were effective in disseminating exogenous knowledge in the communities, with a score of eight (50%) and four (25%) respondents in the very effective and effective categories, while four (25%) respondents did not have any opinion. The use of ICTs by the knowledge intermediaries is explained in detail in the following text, which is arranged in descending order of importance.

Community radio (radio FADECO in Karagwe), and six telecentres used internet to disseminate exogenous knowledge to farmers. The community radio and two Kilosa's telecentres (Kilosa Rural Services and Electronic Communication (KIRSEC) and Ilonga Youth Training Centre) used to download useful agricultural information from the internet, repackage and later disseminate to farmers. For instance, the community radio such as FADECO in Karagwe, used to search the offline resources base (compendia, books, CD-ROM libraries), and internet and download useful web-based agricultural knowledge and disseminate to farmers in response to farmers' queries and their needs. Farmers' queries were delivered to the radio station either physically or through cell phone SMSs. FADECO radio downloaded useful web-based agricultural knowledge and information from the WORLDSPACE radio receiver, Open Knowledge Network, and BBC Swahili service website, and broadcasted the information to farmers. FADECO radio also looked for marketing prices and daily exchange rates on the internet and broadcasted the information to farmers.

KIRSEC (Kilosa Rural Services and Electronic Communication) telecentre and Ilonga Youth Training Centre in Kilosa also downloaded agricultural knowledge from the web, repackaged and disseminated the information to extension officers and farmers. KIRSEC linked farmer groups and extension officers to the online farmers' discussion forum which was called http://www.linkinglearners.net/. Through this online tool, farmers were able to share and access information on natural resource management, market outlets and agricultural production. Four farmer groups were already registered to the linking learners' website by May 2008, which were Usagara women group, Juhudi, Mshikamano and Jiendeleze. The telecentre charged farmers for

translating their messages from Swahili to English, and sending and receiving messages from the linking learners' forum, which was called e-runner service. KIRSEC assisted farmers to advertize their produce by placing their digital photographs on the link learners' website. The telecentre used the internet to assist farmer groups in securing soft loans from NGOs in UK.

There was low use of internet services to access agricultural knowledge in the remaining five telecentres, which were Ilonga Youth Training Centre (Kilosa), Kasulu telecentre (Kasulu), Marangu Village Internet Service and Guerba computer centre (Moshi Rural), and Mpwapwa telecentre (Mpwapwa). The most popular services in these telecentres were access to examination results for secondary schools, distance learning, research, and tourism for telecentres in Moshi Rural.

Cell phones were used by extension/livestock officers in Moshi Rural to communicate with farmers on various farming issues such as plant and livestock diseases control, availability of inputs, and crop husbandry practices such as row spacing. Cell phones were used by stockists to receive orders for inputs from farmers in Mpwapwa. In Songea Rural, WIDA NGO and public extension officers used cell phones to contact farmers in case of a meeting or training. The KIRSEC telecentre's manager also trained farmers on how to use cell phones to access marketing information. Further, the KIRSEC telecentre used cell phones to alert farmers and farmer groups in case of an urgent incoming email, if mobile access was available. In Karagwe, farmers sent SMS or made telephone calls to the FADECO radio station for advice on their farming problems.

The research institute (Ilonga Agricultural Research Institute in Kilosa) and two community radio stations (FADECO Radio in Karagwe, and Radio Jamii in Kilosa) broadcasted agricultural knowledge and information in the local communities. The research institute disseminated agricultural information such as farmer field days through the national radio station (Tanzania Broadcasting Corporation (TBC)), where the coordination of the radio programmes was done by the Ministry of Agriculture and Food Security. Further, seventy percent of the content of FADECO community radio was focused on agriculture, with topics ranging from production,

marketing and value addition. FADECO radio also collaborated with various stakeholders to disseminate agricultural information and knowledge to the communities. These stakeholders included universities (Sokoine University of Agriculture), radio stations (such as TBC, deutschevelle, BBC), agricultural research institutes (SELIAN, MARUKU, UKIRIGURU), and the district extension and veterinary officers. Other collaborating international agencies were Arid Land Information Network East Africa (ALIN-EA), the International Network for the Availability of Scientific Publications (INASP), Technical Centre for Agricultural and Rural Cooperation (CTA), CAB International, Centre for Information on Low External Input and Sustainable Agriculture (ILEIA), and FOODNET. Through FADECO radio, farmers were able to ask questions through live radio programmes, and report missing cattle.

On the other hand, radio Jamii disseminated information on environment and marketing such as crop prices, and business outlets. The radio station used to have an agricultural programme, which was known as, "kilimo chetu". However the programme was last broadcasted in 2007 due to various reasons, which included inadequate support from public extension officers in content generation; inadequate facilities and staff; lack of incentives to pay government officials who would participate on the radio programmes; and lack of ward/village reporters. Most of the programmes of the Radio Jamii were entertainment, with few programmes on news, environment, health and marketing.

Email was used by Wino Development Association (WIDA) in Songea Rural, Radio FADECO (Karagwe) and KIRSEC telecentre (Kilosa) to disseminate agricultural knowledge and information to farmers. WIDA used email for e-business in the area, personal communication, and coffee marketing linkages to buyers abroad. WIDA also communicated with TACRI (Tanzania Coffee Research Institute at Moshi Rural) for technical support on coffee husbandry, and coffee disease diagnosis and treatment. Radio FADECO accessed market information from FOODNET in Uganda and KACE in Kenya via email and printed the information on the notice boards, and broadcast the same information on radio. Through e-runner service, KIRSEC (Kilosa) assisted farmers to register their individual emails, and to send and receive their emails.

The telecentre also helped farmers belonging to farmer groups to send and receive emails from link learners' online forum.

Other ICTs such as CDROM, TV and video were used at a low rate to disseminate agricultural knowledge in the local communities. For instance, CDROM were used by FADECO NGO, KIRSEC telecentre and Mpwapwa telecentre (Mpwapwa) to disseminate agricultural information and knowledge to farmers and extension officers. Television was used by the Ilonga Agricultural Research Institute to disseminate agricultural information such as farmer field days through national television broadcasts (Tanzania Broadcasting Corporation) and SUA (Sokoine University of Agriculture) television. WIDA NGO had a TV room with a satellite dish which was used to educate farmers on agricultural practices before they were taken to the demonstration plots.

## 5.10 Barriers that hinder the management of agricultural indigenous knowledge and access to exogenous knowledge in the local communities

The ninth study objective sought to identify the challenges that faced farmers in the management of agricultural IK, access to exogenous knowledge in the local communities, and use of ICTs in managing agricultural IK and accessing exogenous knowledge in the local communities. Both local communities and knowledge intermediaries were interviewed.

### 5.10.1 Barriers that hinder the management of agricultural indigenous knowledge

The study sought to establish barriers that hindered the management of agricultural IK in the local communities. Both local communities and knowledge intermediaries were interviewed.

### 5.10.1.1 Barriers that hinder the management of agricultural indigenous knowledge: data from local communities

The respondents were asked to indicate challenges that hindered the acquisition, sharing and preservation of agricultural IK in the local communities.

### 5.10.1.1.1 Barriers that inhibit the acquisition of agricultural indigenous knowledge

An inquiry into the barriers that hindered the acquisition of agricultural IK indicated that poor recognition of IK and resistance to change were the most cited barriers in the acquisition of IK in the communities, with a score of 121 (66.9%) each. Other major problems were lack of IK

records 120 (66.3%), poor knowledge sharing culture 116 (64.1%), lack of a resource centre 112 (61.9%), lack of trust 102 (56.4%), socio-economic factors 80 (44.2%), lack of appropriate IPRs 71 (39.2%), disappearance of traditional seeds, plant species and traditional medicine 31 (17.1%), disappearance of culture and practices that are important for KM activities 20 (11%), and difficulties in knowing the knowledge bearers 18 (9.9%). The least cited problem was the exclusion of IK in the formal education system, with a score of 13 (7.2%) respondents. These barriers are explained in the following text.

- Resistance to change: Negative attitudes and lack of awareness, as well as interest in learning from each others inhibited the acquisition of IK in the communities through the existing social structures in the local communities, such as apprenticeships, folklore;

- Poor recognition of IK: The results showed that IK was perceived as an outdated knowledge system by farmers. It was also suspected to be linked to witchcraft and thus it was neglected by most farmers. Most youth were not receptive of IK due to modernization and formal education system which poorly recognised IK. The government also did not recognise IK, since it lacked plans and structures to prioritize, preserve and disseminate IK to the communities;

- Lack of IK records: Most IK was preserved in the human minds and through folklore and thus it was not documented. There were no village journalists to report farmers' issues to the outside world and thus most of the farmers' knowledge was location specific;

- Poor knowledge sharing culture: Little cooperation from knowledgeable farmers limited access to knowledge. Most respondents reported that they did not have a culture of sharing their knowledge, and the village leaders did not encourage them to do so;

- Lack of a knowledge resource centre: Only one village (Kasiki Village in Kilosa) was located near the district library. Other surveyed villages were located very far from district or regional public libraries;

- Lack of trust: Some farmers did not trust the advice they received from their fellow farmers for various reasons such as bad motives, and ineffectiveness of some indigenous techniques to solve farming problems, such as control of plant and animal diseases;

- Social economic factors: Differences in age, gender, social, and economic status limited farmers in acquiring IK from their fellow farmers or village leaders. Most of the elderly

people and women did not want to learn from the present generation, while progressive farmers ignored IK, and did not want to learn or share their knowledge with the poor farmers. Most of the poor farmers relied on their IK due to lack of funds to acquire external inputs, and thus their knowledge was limited to their own circle of families and friends. For instance, one farmer at Kasiki Village in Kilosa reported that, "I am scared to observe other peoples' farms because I will be suspected of having bad motives";

- Lack of appropriate intellectual property rights: Most IK holders felt that their fellow farmers would benefit once their knowledge was made public. Others felt that their knowledge would be used by the pharmaceuticals to manufacture drugs. In actual fact, some IK holders required payments for their services especially knowledge on herbal medicine to control animal and plant diseases in Moshi Rural and Kasulu;

- Disappearance of traditional seeds, plant species and traditional medicine: This included indigenous plants, seeds and medicinal plants that could be used to control plant and animal diseases, and preserve crops and planting materials. Some of those plants had disappeared due to the population pressure, drought and migration from one place to another especially the nomadic pastoral society. For instance, the pastoralists of Kilosa (Twatwatwa Village) acknowledged that they had lost a lot of local herbs used for treating their cattle diseases when they practiced nomadic pastoralism. They have changed from nomadic to transhumance pastorals due to land scarcity, globalization and education issues;

- Disappearance of culture and practices: Most of the traditional cultures had disappeared due to modernization, technology, population pressure and education. The settlement of professionals from different ethnic background and intermarriages had also contributed to the disappearance of traditional cultures. These cultures included team working in the farming activities in Songea Rural and Kilosa, a specific date for a meeting at the village office in order to exchange ideas in Moshi Rural (Lyasongoro Village), and exchange of seed and animals breeds. Folklore was also disappearing at a high rate due to the advancement of technologies such as TV and radio which had replaced local dances, songs and tales. Few people attended folklore performances which limited the acquisition of knowledge in the community. On the other hand, the disappearance of indigenous techniques such as long-term fallowing, granaries and traditional irrigation system had discouraged some farmers from

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acquiring knowledge. Long-term fallowing was disappearing due to a shortage of land and population pressure, while granaries were used at a low rate due to the widespread cases of theft in Songea Rural and Karagwe, and the traditional irrigation system was destroyed by the road construction activities in Moshi Rural. Some of the local herbs were not appropriate to control new plants and animal diseases, and thus farmers were obliged to seek exogenous knowledge;

- Difficulties in knowing IK holders: It was difficult to know IK holders and where these IK holders were located due to lack of established structures to identify them; and

- Exclusion of IK in the formal education system: IK was not included in the curriculum of the formal education system in Tanzania. The Agriculture subject was included in selected secondary and primary schools within the country, and thus it was excluded from the curriculum of most of the basic educational schools in the country. Thus, there was little chance of including agricultural IK in the formal education system.

Other factors that inhibited farmers from acquiring IK in the surveyed communities included the following, which are arranged in descending order of importance:

- Occurrence of conflicts within families inhibited the sharing of knowledge;

- Agricultural indigenous inputs were time demanding such as local herbs which discouraged farmers from acquiring IK;

- Unavailability of extension officers to train farmers on agricultural indigenous techniques;

- Disappearance of vernacular language: Some farmers were inhibited from acquiring IK from other farmers especially youth, because they could not communicate in vernacular languages. In fact, interviews with some elderly people had to be conducted with a translator because they were not familiar with the Swahili or English languages. Vernacular languages were disappearing at a high rate due to the formal education system which had entirely excluded these languages from the curriculum. The settlement of professionals from different ethnic background and intermarriages had contributed to the disappearance of these languages;

- Small-scale farming: Farmers reported that IK was not suitable for large scale farming as compared to contemporary technologies, which limited the acquisition of IK in the communities;

- Traditional structures, customs and taboos: Some of the knowledge (such as, local herbs, blacksmith) was transmitted through inheritance or in specific clans, and thus it was not shared with the whole community (Kasulu, Moshi Rural, Karagwe);

- Illiteracy inhibited some farmers from acquiring agricultural IK from the printed materials; and

- Some indigenous techniques were not effective to solve farmers' problems, and thus many farmers were discouraged from acquiring and using IK. Typical responses included:

  "…..neem tree juice is not effective to treat Newcastle poultry disease, while vaccines are effective in controlling the disease".

  "….I used traditional herbs to treat three cattle and one died, so this knowledge is not effective since I have already experienced a loss".

The problem trees established that poor recognition of IK was the major barrier in the communities that inhibited acquisition of IK in the communities as indicated in Appendices (18 - 23). Other major problems were exclusion of IK in the formal school curriculum and lack of trust. Other challenges, which are arranged in descending order of importance were: poor knowledge sharing culture; difficulties in identifying IK holders; IK was suspected to be linked to witchcraft; agriculture was not an income earning sector; resistance to change and learning from other farmers; and extension officers were more concerned with conventional approaches and thus they were not helpful sources of IK. They inadequately identified, validated and disseminated IK in the local communities.

### 5.10.1.1.2 Barriers that inhibit the sharing of agricultural indigenous knowledge

An inquiry into the barriers that inhibited farmers from sharing their agricultural IK indicated that poor recognition of IK and lack of IK records were the most cited barriers in the communities, accounting for 119 (65.7%) and 118 (65.2%) respondents respectively as shown in Figure 5.24. Other major barriers were poor knowledge sharing culture 116 (64.1%), lack of a knowledge resource centre 111 (61.3%), lack of trust 104 (57.5%), and social-economic status 76 (42%). Other challenges included: selfishness; occurrence of conflicts within families; disappearance of vernacular languages; use of conventional technologies undermined the sharing

and use of indigenous techniques; traditional structures, customs and taboos; some IK holders required to be paid in order to share their knowledge; and illiteracy.



**Figure 5.24: Barriers that hinder sharing of agricultural indigenous knowledge (N=181)**

The problem tree confirmed that poor recognition of IK was the major problem that hindered farmers to share IK with their communities as indicated in Appendices (18 – 23). Other major problems were poor knowledge sharing culture, and selfishness. Other barriers were: some IK was shared within specific clans and through inheritance, and thus it was not accessible to the public; lack of trust and jealousy; IK was suspected to be linked to witchcraft; advancements of technologies such as TV and radio had replaced oral culture; the settlement of professionals from different ethnic backgrounds and intermarriages had contributed to the disappearances of useful cultures that would influence knowledge sharing in the communities; lack of a system to compensate IK holders when they shared their knowledge; and village leaders who did not encourage knowledge sharing activities in the communities; lack of intellectual property rights that recognised IK. Other barriers included: some of the indigenous practices such as local herbs were time demanding and thus farmers were discouraged from sharing their knowledge; IK was not documented and validated, and thus poor prescriptions were given to farmers (such as herbs) which could affect their health; a high level of illiteracy inhibited farmers from seeking ways to

share their knowledge; the dominant use of agricultural exogenous knowledge over IK; a lack of markets for some agricultural produce which was cultivated by using local methods such as organic farming in the communities; and farmers who were exposed to organic farming in Moshi Rural district did not like to teach others because they were not compensated for their time and resources.

**5.10.1.1.3 Barriers that hinder the preservation of agricultural indigenous knowledge**

When asked to indicate if they faced any problems in the preservation of agricultural IK, poor recognition of IK and lack of efforts to preserve IK were the most cited problem, accounting for 117 (64.6%) and 116 (64.1%) of the respondents respectively as indicated in Figure 5.25. Other major barriers were poor knowledge sharing culture, lack of trust, and social status. The least cited problem was the exclusion of IK in the formal education system 13 (7.2%).



**Figure 5.25: Barriers that hinder the preservation of agricultural indigenous knowledge (N = 181)**

Other challenges included the following: most IK was preserved in people's minds; the dominant use of exogenous technologies had undermined the preservation of IK; traditional structures, customs and taboos had inhibited sharing of some indigenous techniques (such as knowledge on indigenous medicines, and blacksmith); and high illiteracy level of the early IK custodians had undermined the preservation of IK.

The problem trees confirmed that lack of national efforts to record IK was the major problem which limited farmers in the preservation of their knowledge as indicated in Appendices (18 – 23). Other major barriers were the disappearance of IK holders, poor recognition of IK by the government, farmers' ignorance, and some of IK holders had migrated to urban areas because agriculture was not an income earning sector. Other problems were lack of professionals to manage IK, and disappearance of an oral culture such as folklore. Further, researchers and NGOs who conducted research on agricultural IK did not disseminate their findings back to farmers.

The problem trees showed that the major effects of the poor management of IK were low agricultural production and increasing rate of unethical conducts by youth (such as theft), followed by food insecurity and loss of IK, culture and values as shown in Appendices (18 – 23). Other effects, arranged in descending order of importance were: failure to utilize IK for farming activities; low income from agricultural practices; increased rate of poverty; dominant use of exogenous knowledge; disappearance of traditional seeds, crop varieties and animal breeds; loss of labour since most farmers had migrated to urban areas; unequal distribution and access to IK; and environmental degradation due to use of ineffective indigenous techniques such as field burning.

### 5.10.1.2 Barriers that hinder the management of agricultural indigenous knowledge: data from knowledge intermediaries

The respondents were asked to indicate various challenges they faced when managing agricultural IK in the local communities. Lack of IK policy 10 (40% of 25 respondents) was the major barrier that inhibited knowledge intermediaries to manage agricultural IK. Other major barriers were lack of facilities 9 (36%), lack of funds 9 (36%), inadequate training on the management of IK 9 (36%), lack of intellectual property rights 8 (32%), poor knowledge sharing culture in the communities 8 (32%), long distances to the communities 7 (28%), inadequate number of staff 2 (8%), and local techniques such as the cultivation of herbs were time demanding 2 (8%). Other barriers were the disappearance of indigenous species, lack of a reading habit, lack of access to researched knowledge on agricultural IK, poor recognition of IK, lack of national efforts to document IK and thus IK was preserved in human minds, the research

and registration process of patents took a lot of time, and a language barrier, since most farmers were not comfortable with the English language.

### 5.10.2 Barriers that hinder access to agricultural exogenous knowledge

The study sought to establish the challenges that inhibited access to agricultural exogenous knowledge in the local communities. Both local communities and knowledge intermediaries were interviewed.

### 5.10.2.1 Barriers that hinder access to agricultural exogenous knowledge: data from local communities

When asked to indicate problems they faced when accessing agricultural exogenous knowledge, poor public extension services were the most cited problems, with a score of 143 (79%) respondents. Other major barriers were a lack of access to information materials 133 (73.5%), lack of a knowledge resource centre 131 (72.4%), and a low level of literacy 118 (65.2%). Poor extension services were characterised with the following, which are arranged in the order of importance: public extension officers were either not available, or they were few, lack of follow up by public extension officers, lack of access to timely agricultural knowledge, and lack of female extension officers to cater for women's information and knowledge needs. For instance, one respondent in Songea Rural (Matetereka Village) reported that, "there are no female extension officers in our village, so the extension officer only contacts my husband. Thus, it would be better if there were female extension officers".

Other problems were related to farmers' groups, where few farmers were involved in the farmer groups across the districts mainly due to wrong perception about farmer groups. Some farmers thought that they will gain some funds once they joined farmer groups, and thus they left the farmer groups when they found out that there were no funds. For instance, one farmer in Kilosa (Twatwatwa village) reported that, "we have just started our farmer groups with a small capital. Thus, many people do not like to join our group because of our small capital although everyone in the village knows about us". Other major reasons were that no good changes were observed from the farming practices that were adopted by other farmers who were involved in farmer groups; lack of awareness on the importance of farmer groups; resistance to join farmer groups due to old age; and lack of encouragement from the village leaders.

Other major problems, which are arranged in the order of importance were: resistance to change; lack of funds to purchase information materials and pay library membership fees in order to borrow books; lack of knowledge sharing culture to share and learn from each others, such as to attend village meetings or join farmer groups; social-economic factors such as age and gender; and selfishness, where farmers who were exposed to agricultural training were too selfish to teach others. Village leaders were also selfish in not sharing useful agricultural knowledge and information to farmers. For instance, one farmer in Kasulu (Kidyama Village) said that, "leaders are selfish to share exogenous knowledge in the community such as sources of credits".

Other problems were: lack of access to irrelevant knowledge; unavailability and/or high cost of inputs; lack of awareness of the available information services; distant location, such as agricultural shows were usually held at the regional and zonal levels which were too far from the villages; lack of a bookshop; and the ineffectiveness of some of the conventional inputs to solve farming problem. For instance, one farmer in Kilosa (Kasiki Village) reported that, "I have tried to vaccinate poultry to prevent them from Newcastle disease by using conventional vaccines, but I have never been successful".

The problem trees confirmed that poor public extension services and inadequate access to printed information materials were the major problems that hindered access to exogenous knowledge in the communities as indicated in Appendices (24 – 29). Other major problems were poor knowledge sharing culture among farmers, and lack of funds to purchase information materials or to pay library membership fees for the villages that were located near to the library. Other barriers which are arranged in descending order of importance, included the following: selfishness; lack of awareness of the importance of farmer groups; inputs and funds for farmer field schools were delivered late by the government; some technologies which were disseminated by extension officers and printed materials such as newspapers were not relevant to farmers' needs and their agro-ecological conditions; and village leaders did not encourage farmers to share their knowledge, and they did not respond to their needs. Typical responses included:

"…Village leaders introduced Tanzanian Social Action Fund (TASAF) to us and they inquired about our problems, but they have never solved our problem although they had promised to do so" (Mshiri Village, Moshi Rural)

"……Village leaders always tell us about the subsidized inputs but they either do not deliver the inputs or they delay to bring those inputs" (Kasiki Village, Kilosa).

Other barriers included the following: illiteracy; lack of agricultural shops in Kilosa (Twatwatwa Village), and Karagwe (Iteera and Katwe Village); agricultural input suppliers were not reliable sources of knowledge because their extension services were market oriented; middlemen used to provide wrong information on market prices in order to buy farmer' produces at low prices; resistance to change; village meetings were not frequently organised; poor recognition of agricultural practices by the government; low awareness on the part of farmers to demand their rights such as adequate access to agricultural knowledge and information; extension officers and researchers did not adequately involve farmers in technology development and dissemination; and the exclusion of agricultural subjects in most of the primary and secondary schools in the country.


When asked to indicate effects of the barriers that hindered access to exogenous knowledge in their communities, the majority of the respondents specified low agricultural production as their major effect, followed by the prevalent use of ineffective agricultural methods as depicted in problem trees (Appendices 24 – 29). Other major effects were: low adoption of agricultural exogenous technologies, failure to cope with frequent changes such as plant and animal diseases, unreliable markets, and lack of access to agricultural inputs and tools. Other effects which are arranged in descending order of importance were: lack of access to credits; crop loss due to lack of post-harvest skills; inadequate animal feeds; loss of labour since most farmers were migrating to urban areas to look for new opportunities; inability to meet household expenses such as health, and education; inability to establish farmer groups; and lack of access to weather information.

### 5.10.2.2 Barriers that hinder access to agricultural exogenous knowledge: data from knowledge intermediaries

The study sought to establish barriers that limited knowledge intermediaries to disseminate exogenous knowledge in the communities. Lack of funds was the main barrier that hindered

knowledge intermediaries to disseminate agricultural exogenous knowledge in the communities, with a score of 19 (76%) respondents. Other major barriers were lack of facilities 16 (64%), inadequate trained personnel 16 (64%), and long distances to the communities 16 (64%). Other barriers were: high illiteracy rate on the part of farmers 9 (36%), difficulties in coordinating farmer groups 4 (16%), late delivery of subsidized inputs 4 (16%), poor cooperation from district officials and other governmental agencies 4 (16%). Other barriers were low rate of adopting new technologies by farmers 2 (8%), lack of access to updated agricultural information 2 (8%), inadequate refresher training courses for the extension officers 1 (4%), poor reading habits on the part of farmers 1 (4%), and unpopularity of the library services due to the introduction of ICTs in the rural areas 1 (4%).

## 5.10.3 Barriers that inhibit the use of ICTs to manage indigenous knowledge and access to exogenous knowledge on farming systems

The study sought to establish barriers that limited farmers in managing their agricultural IK and access exogenous knowledge through ICTs. Both local communities and knowledge intermediaries were interviewed.

## 5.10.3.1 Barriers that inhibit the use of ICTs to manage indigenous knowledge and access to exogenous knowledge on farming systems: data from local communities

The respondents were asked to indicate challenges of managing IK and accessing exogenous knowledge through ICTs. High cost of ICTs was the predominant problem that farmers faced when managing IK and accessing exogenous knowledge through ICTs, accounting for 152 (84%) of the respondents as indicated in Table 5.26. Lack of electricity 129 (71.3%) was the second most cited problem, while lack of a nearby telecentre 83 (45.9%) was the least cited problem.

**Table 5.26: Barriers that hinder the use of ICTs to manage indigenous knowledge and access to exogenous knowledge on farming systems (N=181)**

| Barrier | Explanation |
|---|---|
| High cost of ICT (n=152; 84%) | Most ICTs such as television, cell phones were expensive to most farmers. Costs for maintaining ICTs were also high such as charges for using internet and email from telecentres, airtime for cell phones, recharging power for cell phones, batteries for radio, and electricity power. For instance, it was 500 Tshs (5 $) to recharge a cell phone in Kilosa (Twatwatwa Village), which was very expensive for most farmers. |
| Lack of electricity (n=129; 71.3%) | Most of the interviewed farmers did not have electricity which limited the use of some ICTs such as television. |
| Lack of local and relevant content (n=122; 67.4%) | Included lack of adequate television and radio programmes on agricultural indigenous and exogenous knowledge. Most of the television and radio broadcasts tended to focus on entertainment programmes. Internet also lacked relevant and local content which limited communities to access knowledge. One farmer at Lyasongoro Village in Moshi Rural reported that, "I normally access a lot of information from the internet but I have never managed to access agricultural knowledge that suits my local context". |
| Lack of awareness (n=119; 65.7%) | Most farmers were not aware of the importance of ICTs such as internet to access indigenous and exogenous knowledge for their farming activities |
| ICT illiteracy (n=114; 63%) | Most farmers lacked skills on how to use computers, internet and cell phones to access agricultural knowledge and information. |
| Poor ICT infrastructure (n=104; 57.5%) | Included poor coverage of both television and radio broadcasts, as well as cell phone network |
| Lack of telecentres (n=83; 45.9%) | Some communities were located very far from telecentres such as Kasulu (Kidyama Village), Kilosa (Twatwatwa Village), Mpwapwa (Vinghawe Village), Karagwe (Katwe Village), and Songea Rural (Matetereka Village). |

Other problems which are arranged in the order of importance included:

- Language barrier: Some farmers preferred radio programmes to be aired in their vernacular language because they did not understand Swahili language, which is a national language.

Further, most of the content in the internet and language used in cell phone and computer software was in the English language, which was difficult for most farmers to understand;

- Poor timing of radio and television broadcasts: Some of the agricultural television and radio programmes were aired at the inappropriate time when farmers were busy with their agricultural activities;

- Socio-economic status: Factors such as age, gender, social and economic class limited farmers who did not own ICTs to use their neighbours' ICTs (such as radio, TV or cell phones) to access knowledge;

- Television and radio programmes were not practically oriented: Farmers preferred information and knowledge to be delivered in participatory approaches and printed format for future reference. It was difficult for farmers to understand, memorize and implement what they had learnt from radio or TV broadcasts. For instance, one farmer in Kilosa (Kasiki Village) reported that, "I heard about the use of fertilizer from the radio. However, it was difficult for me to apply the technique because I could not remember";

- Low priority was accorded to ICTs: Most farmers placed high value to their farming activities as compared to ICT because they were not aware of the importance of ICTs. For instance, one farmer at Vinghawe Village in Mpwapwa said that, "I would rather spend my money for farming activities than ICTs, since my income depends on agricultural activities";

- Lack of follow up from professionals: There was no follow up on the implementation of technologies that were disseminated through radio and TV broadcasts;

- Widespread cases of theft limited farmers to acquire ICTs; and

- Lack of assistance on the use of ICTs to market farmers' produce: For instance, one farmer in Moshi Rural was able to secure a buyer for her banana crops through internet. However, it was not possible to sell those produce due to lack of government assistance on online marketing.

Although interview results showed that high cost of ICTs was the major barrier, the problem trees indicated that inadequate access to local content through ICTs and lack of electricity were the major problems that hindered farmers to access knowledge through ICTs as indicated in Appendices (30 – 35). Other major barriers were high cost of ICTs, and lack of awareness on

ICTs. Despite the discrepancies, major pattern can be drawn that high cost of ICTs, inadequate access to local content through ICTs and lack of electricity were the major problems that inhibited farmers in using ICTs to manage IK and access exogenous knowledge in the local communities.

Other problems as shown in the problem trees (see Appendices 30 – 35) included the following which are arranged in descending order of importance: poor telecommunication infrastructure; access to inaccurate information, such as middlemen used cell phones to deliver incorrect market prices to farmers in order to gain cheap offers; ICT illiteracy in the communities; and poor delivery of radio and television broadcasts, which included poor timing of broadcasts, lack of practical training on the radio programmes, agricultural broadcasts were not consistent, short periods of time were allocated to the agricultural programmes, lack of follow up on the adoption of agricultural technologies which were disseminated through radio and television programmes, and poor sound and picture quality of programmes.

Other problems were lack of a nearby telecentres; lack of access to cheap power sources such as solar power; some cultures and customs limited farmers from accessing knowledge through ICTs. For instance, the Kilosa problem tree showed that livestock herders were not allowed to listen to the radio when they were grazing animals to prevent animal loss; and lack of ICT services that cater for community needs, such as community radio. For instance, rural radio stations were found only in two districts, which were Kilosa (Radio Jamii) and Karagwe (Radio FADECO).

When asked to indicate effects of the barriers that hindered the use of ICTs to manage IK and access to exogenous knowledge, the majority of the respondents specified low agricultural production as their major effect as depicted in the problem trees (Appendices 30 – 35). Other major effects were unreliable markets, over-dependence on local sources of knowledge within their villages which were not enough to improve their agricultural activities, and low adoption of improved technologies. Other effects which are arranged in descending order of importance were: lack of access to improved technologies; failure to cope with changes in agricultural

activities such as plants and animal diseases; food insecurity; lack of inputs; low income; use of ineffective and unimproved techniques; and loss of labour.

### 5.10.3.2 Barriers regarding the management of IK, dissemination of exogenous knowledge and the role of ICTs: data from knowledge intermediaries

The respondents were asked to indicate various challenges that inhibited them in managing agricultural IK and disseminating exogenous knowledge through ICTs in the local communities. Lack of funds was the major barrier that inhibited knowledge intermediaries managing IK and disseminating exogenous knowledge in the local communities, accounting for 18 (72%) respondents. Other major barriers included the following: inadequate ICT expertise 16 (64%), high level of ICT illiteracy on the part of farmers 14 (56%), lack of awareness on ICTs on the part of farmers 13 (52%), high cost of ICT facilities 9 (36%), poor ICT infrastructure 9 (36%), lack of institutional ICT policy 7 (28%), inadequate efforts to generate local and relevant content 7 (28%), unreliable electricity 6 (24%), and low use of telecentres by farmers 5 (20%).

Other barriers included: high user fees for internet services in the telecentres 4 (16%), lack of public and private partnership in the rural ICT investments 4 (16%), difficult to change farmers' mindset 2 (8%), communities were located too far which inhibited the rural radio stations to involve farmers in the production of agricultural radio programmes 2 (8%), and difficulty in keeping pace with the technology advancements 2 (8%). Other barriers were difficult regulations by TCRA (Tanzania Communication Regulatory Authority) in establishing community radio; lack of research on the development of ICTs; lack of subsidy from the government on rural ICT investments; lack of trust between macro and micro companies involved in rural ICTs; poor recognition of agriculture as an income earning sector; the predominant small-scale agriculture had limited farmers to market their produce online; and telecentres may become unpopular due to the advancements of ICTs such as internet access through cell phones, accounting for one (4%) respondent each.

**5.11 Summary of findings**

This chapter dealt with the analysis and presentation of the findings from data obtained in interviews, focus groups, non-participant observation, and participatory rural appraisal (information maps, and problem trees). Some of the major findings were:

**5.11.1 Identification of types of agricultural indigenous knowledge, and the integration of indigenous and exogenous knowledge in the farming systems**

- Farmers possessed an extensive base of knowledge on soil fertility, assessment of arable land, cropping system, weed control, preservation of planting materials and crops, plant diseases and pests control, animal breeding and disease control;

- Knowledge on plants that repel insects, and medicinal plants for controlling plant and animal diseases and for preserving crops was generally low;

- There was high use of IK in the acquisition of planting materials, soil fertility, cropping systems, crop planting system, weeding control, irrigation, control of predators, and animal feeding as compared to conventional inputs;

- The majority of the farmers did not generally use measures to control plant diseases and pests. However, when the use of local herbs and conventional inputs was compared in the control of plant diseases and pests, the latter was more commonly used than the former.

- Indigenous practices were also the dominant methods for controlling plant pests;

- There was high use of exogenous knowledge and techniques in the preservation of planting materials and crops, and control of animal diseases, and animal husbandry, as compared to local inputs; and

- Although more than half of the respondents indicated that there were no differences on the roles of men and women in the farming activities, the analysis of farming roles carried out by men and women indicated that women were more involved in the farming activities than men.

**5.11.2 The management of agricultural indigenous knowledge in the local communities**

Some of the major findings under the research objectives two and three which were analyzed in the relation to the KM processes include the following:

**5.11.2.1 Information and knowledge needs and information seeking patterns**

- The majority of the respondents needed information and knowledge on the control of plant diseases and pests, marketing, credit and loan facilities, and control of animal diseases;

- Knowledge and information needs were location specific. There were slight variations in the information and knowledge needs across gender categories;

- Half of the respondents had tried to look for ways to solve their knowledge and information problems in the local communities;

- Farmers largely sought information from friends/neighbours, while extension officers, agricultural input suppliers and family/parents were important sources of knowledge in which farmers consulted to fulfill their knowledge needs; and

- Poor extension services, lack of awareness, location, low response from the authorities, and poor knowledge sharing culture were the major problems that hindered farmers from seeking information in their communities.

**5.11.2.2 Knowledge acquisition**

- Sources of agricultural IK were predominantly local, including parents and/or family, personal experience, and neighbours and/or friends;

- There were variations of the access to indigenous knowledge from formal sources of knowledge across the districts. However, there were slight differences in access to IK across gender categories in the surveyed communities; and

- The majority of the respondents obtained IK on crop husbandry, new varieties and techniques, and value added techniques from tacit and explicit sources of knowledge.

**5.11.2.3 Knowledge development**

- Farmers' knowledge was constructed within the social and scientific paradigms;

- Knowledge was mainly created within the social paradigm more than the scientific paradigm in the surveyed communities; and

- Farmers developed new knowledge by carrying out local experiments driven by personal curiosity, seeking solutions, and as an adaptation to new knowledge in the social paradigm.

### 5.11.2.4 Knowledge sharing

- Traditional culture, such as apprenticeships, folklore and initiation rites influenced sharing agricultural IK although they were practiced at a low rate;
- Access to agricultural indigenous knowledge was influenced by the culture, status, trust, and context and space in the local communities; and
- Few farmers were involved in farmer groups. These groups were less used to share IK.

### 5.11.2.5 Knowledge preservation

- Most of agricultural IK was preserved in human minds; and
- Explicit sources of knowledge and artifacts were less used to preserve IK.

### 5.11.2.6 Knowledge application

- The majority of the respondents had applied IK obtained from explicit and tacit sources of knowledge in their farming systems; and
- Few farmers had not applied agricultural indigenous techniques obtained from explicit and tacit sources of knowledge in their communities.

### 5.11.2.7 The role of knowledge intermediaries in managing indigenous knowledge in the local communities

- Majority of knowledge intermediaries captured IK from the local communities, while few knowledge intermediaries preserved IK in printed formats; and
- Many knowledge intermediaries used oral communication channels to disseminate IK in the communities.

### 5.11.3 Legal framework relevant for the protection of agricultural indigenous knowledge in Tanzania

- All policy makers acknowledged that IPRs were not effective to protect agricultural IK such as genetic resources and agricultural knowledge;
- The policy makers indicated that few communities had expressed their concerns with regard to the protection of their agricultural IK to the IPR related offices;
- More than half of the farmers indicated that it was important to have a specific policy that would address IK issues within the country; and

- Most knowledge intermediaries and all policy makers indicated that it was important to have a specific policy on indigenous knowledge within the country.

### 5.11.4 Access to agricultural exogenous knowledge in the local communities

- There were variations of tacit and explicit sources of agricultural exogenous knowledge within the districts and within gender categories that existed within them;

- Neighbours/friends were the main sources of agricultural exogenous knowledge, followed by public extension officers and parents/family;

- Agricultural input suppliers, village meetings, farmer groups, cooperative union, and NGOs were important sources of agricultural exogenous knowledge in some districts;

- Explicit sources of exogenous knowledge were less considered by farmers as important sources of agricultural exogenous knowledge;

- The majority of the respondents obtained exogenous knowledge on new varieties and techniques, crop husbandry and control of animal diseases from tacit and explicit sources of knowledge;

- More than half of the respondents indicated that they had applied exogenous knowledge received from tacit and explicit sources of knowledge;

- Few respondents indicated that they had not applied exogenous knowledge and techniques received from tacit and explicit sources of knowledge;

- More than half of the knowledge intermediaries disseminated agricultural exogenous knowledge in the local communities; and

- Few knowledge intermediaries had a follow mechanism in their rural information and knowledge provision strategies.

### 5.11.5 The integration of agricultural exogenous and indigenous knowledge in the local communities

- Most farmers indicated that IK was not sufficient to solve their farming problems;

- Most farmers were willing to share their knowledge to the development agencies for improved farming activities;

- Few farmers indicated that rural information and knowledge intermediaries involved them in knowledge development and dissemination in an effort to identify and prioritize their knowledge and their needs;

- More than half of the knowledge intermediaries involved farmers when developing agricultural technologies;

- Almost half of the knowledge intermediaries involved farmers when disseminating agricultural technologies;

- Almost half of the knowledge intermediaries prioritized IK into their rural dissemination strategies; and

- Most knowledge intermediaries determined farmers' information and knowledge needs; and

- More than half of the knowledge intermediaries prioritized farmers information and knowledge needs in their rural knowledge provision strategies.

## 5.11.6 The role of ICT in managing agricultural indigenous knowledge

- Almost half of the farmers had used ICTs to acquire IK;

- Radio was the predominant tool used by farmers to acquire IK in the surveyed communities, followed by cell phones and television;

- Men dominated the use of ICTs to acquire agricultural IK more than women;

- Most users who acquired IK through ICTs in the areas under investigation were generally young, with ages between 26-35;

- Farmers mainly acquired IK on new varieties and techniques, crop husbandry, and soil fertility from ICTs in the local communities;

- Few farmers had used ICTs to share and preserve agricultural IK. Cell phones were the dominant tools used by farmers to share agricultural IK;

- There was a low rate of respondents who had applied agricultural IK obtained from ICTs;

- Few knowledge intermediaries used ICTs to capture, preserve and disseminate agricultural IK in the communities;

- Cell phones were the major ICTs used by knowledge intermediaries to capture IK in the communities, while radio was mainly used for disseminating agricultural IK; and

- Personal computers were the main ICT used by knowledge intermediaries to preserve agricultural IK.

### 5.11.7 Access to agricultural exogenous knowledge through ICT in the local communities

- Most farmers used ICTs to access agricultural exogenous knowledge;
- Radio was the dominant ICT used by farmers to access exogenous knowledge on farming systems;
- More males accessed exogenous knowledge through ICTs than females;
- There were age differences in access to exogenous knowledge through ICTs in the rural communities;
- The rate of respondents who had applied exogenous techniques obtained through ICTs was low;
- Few farmers indicated that they had not applied some of the agricultural exogenous techniques they accessed through ICTs;
- More than half of the knowledge intermediaries had used ICTs to disseminate agricultural exogenous knowledge; and
- Internet services and cell phones were the main ICTs used by the knowledge intermediaries to disseminate agricultural exogenous knowledge to farmers.

### 5.11.8 Barriers that hinder the management of agricultural indigenous knowledge and access to exogenous knowledge in the local communities

- Poor recognition of IK, resistance to change, lack of IK records, and poor knowledge sharing culture were the major barriers that limited farmers in acquiring IK in the local communities;
- Poor recognition of IK, lack of IK records, poor knowledge sharing culture, lack of a knowledge resource centre, lack of trust, and social-economic status were the major barriers which inhibited farmers from sharing their agricultural IK in the local communities;
- Lack of efforts to preserve IK, poor recognition of IK, poor knowledge sharing culture, lack of trust, and social status were the major constraints that inhibited farmers from preserving their agricultural IK;

- Lack of IK policy, facilities, funds and training on the management of IK were the major barriers which inhibited knowledge intermediaries from managing agricultural IK in the local communities;

- Poor extension services, lack of access to information materials, lack of a knowledge resource centre, and illiteracy were the major challenges that limited farmers in accessing agricultural exogenous knowledge in the local communities;

- Lack of funds, facilities and trained staff, and long distances were the major barriers which inhibited knowledge intermediaries from disseminating agricultural exogenous knowledge in the communities;

- High cost of ICTs, lack of electricity, lack of local and relevant content, lack of awareness, poor telecommunication infrastructure, and ICT illiteracy were the predominant problems that inhibited farmers from managing IK and accessing exogenous knowledge through ICTs; and

- Lack of funds and ICT skills were the major barriers that inhibited knowledge intermediaries in the use of ICTs to manage IK and disseminate exogenous knowledge in the local communities.

**5.12 Summary**

Chapter Five presented the research findings, in accordance with the research objectives. The key themes which emerged from the findings were that farmers possessed an extensive base of IK on various farm tasks. There was high use of indigenous knowledge and techniques in the acquisition of planting materials, improvement of soil fertility, cropping systems, crop planting systems, weeding control, irrigation, control of predators, and plant pests. On the other hand, there was high use of exogenous knowledge and techniques in the preservation of planting materials and crops, control of animal and plant diseases and pests, and animal husbandry. The existing policies and intellectual property rights inadequately protected agricultural IK. Despite its importance for agricultural activities, IK was not enough to solve all farming problems such as new animal and plant diseases and plant pests. Thus, it was important to integrate IK with exogenous knowledge for improved agricultural activities. However, rural information and knowledge providers inadequately identified and prioritized indigenous knowledge and farmers' information and knowledge needs in their rural knowledge provision strategies. For their information and knowledge needs, farmers mainly depended on the informal network of friends,

neighbours and families, and formal sources such as extension officers, and agricultural input suppliers. There were variations on access to agricultural indigenous and exogenous knowledge across the surveyed districts and within gender categories that existed within them. Access to agricultural IK was influenced by the culture, power, status, trust, context and space in the local communities. ICTs were important tools to manage agricultural IK and disseminate exogenous knowledge in the local communities. However, there were gender and age differences in access to ICTs. Various factors inhibited the management of IK and access to exogenous knowledge in the local communities. The data provided in this chapter formed the basis for the data interpretation presented in Chapter Six.

# CHAPTER SIX: INTERPRETATION OF THE RESULTS

## 6.1 Introduction

Chapter Six provides an interpretation of the research findings presented in Chapter Five. The research findings were interpreted in accordance with existing knowledge management (KM) models. The relevant literature and the extent to which the current research findings presented a common view, and what made them distinctive from previous KM research of a similar nature were also presented. The findings are presented according to the theoretical framework (see section 3.3.2 of Chapter Three) and specific objectives of the study outlined in section 1.5 of Chapter One, with the exception of the last specific objective, namely to propose a KM model for managing agricultural indigenous and exogenous knowledge in the local communities. This objective is covered in Chapter Seven. Further, the discussion starts with background information about the respondents which was not part of the specific objectives but which is relevant for informing the interpretation of the results.

## 6.2 Characteristics of respondents

The findings on the characteristics of respondents are provided in section 5.2. This subsection discusses the findings on the characteristics of respondents and implications of the findings for KM and the use of ICTs as tools to manage IK and providing access to exogenous knowledge for improved agricultural activities. This subsection discusses the extent to which the characteristics of the respondents involved in this study facilitated or hindered their ability to manage IK, accessing exogenous knowledge, and their use of ICTs to manage their knowledge for effective KM activities and improved farming activities in the local communities.

## 6.2.1 Age

Age is one of the factors that may influence the management of IK in the local communities (Fairhead and Leach 1994; Sillitoe, Dixon and Barr 2005:3). The mean age of the respondents in this study was 48 years, where the majority of the respondents 135 (74.6%) were between the age of 29 and 68 years. These findings are not surprising given the fact that more than 54% of Tanzanians are between the ages of 15 and 64 years, where the majority can expect to reach

52.45 years, statistically (CIA 2009). The findings of this study are similar to the profile of the IK holders in most parts of developing countries including Africa, in terms of age. Tikai and Kama (2004) reported that the most (63% of 30 respondents) farmers were around the age of 30 to 50 years and they were well experienced and knowledgeable in the local Samoan method of farming. Mugisha-Kamatenesi *et al.,* (2008) reported that active farmers 63 (53%) in Uganda were mostly between the ages of 31 and 50 years. The demographic characteristics of this study are also similar to the profile of the rural farmers in other studies on ICTs in terms of age.  In a study to analyze the use of radio for farming activities in Ghana, Chapman *et al.,* (2003) noted that the average age of the farmers was 47 years (the range was 25 to 70 years for 60 respondents). The present study sought to include respondents who were actively involved in farming activities, and thus most of the respondents were relatively middle aged or elderly. However, these results do not mean that IK is mainly possessed by elderly people as compared to young farmers in the areas under investigation as already suggested in the literature (Dube and Musi 2002; Fairhead and Leach 1994; Onyango 2002:250; Sillitoe, Dixon and Barr 2005:3). These findings indicate a need to assess the extent to which farmers possess IK across different age groups in the local communities.

**6.2.2 Gender**

Both sexes may have different knowledge about agricultural activities, various ways of organising knowledge, and different ways of preserving and transferring knowledge (Niamir-Fuller 1994). Gender is thus an important factor in influencing KM processes in the local communities. The findings from the present study showed that the majority 112 (61.9%) of the farmers were males in the surveyed communities, while the remaining farmers 69 (38.1%) were females. The characteristics of the respondents in this study were also similar to the profiles in other studies on agricultural KM and ICTs in the rural areas in Tanzania in particular, and developing countries in general. A study of IK and its role for sustainable agriculture in Samoa showed that 77% of the respondents were male, while 23% were female (Tikai and Kama 2004). In Tanzania, a study to analyze the use of ICTs by rural farmers noted that more men 134 (67%) were involved in the study than women 66 (33%) (Mwakaje, Mwakipesile and Nyakisinda

2009). The gendered nature of the social, culture, economic and policy systems may have limited women farmers from participating in the study.

### 6.2.3 Literacy and education level of the respondents

The literacy level in terms of the ability of the respondents to read and write in the national language (Swahili) was quite high at all research sites. The study findings revealed that 152 (84%) of the respondents had some level of formal schooling, and about 163 (91.2%) could read and understand simple instructions. The profile of the respondents in this study was also similar to the distribution of respondents in other studies in terms of literacy levels. For instance, a study carried out in Samoa showed that there was high percentage of farmers who had attended formal education (99%) (Tikai and Kama 2004). In their study of agricultural knowledge and information systems in the Vietnam Uplands, Castella *et al.,* (2006) reported that household heads had a relatively high level of education, at least secondary school. Similarly, a study involving 117 farmers in Uganda indicated that over 80% of the respondents interviewed, had attained some formal education (that is, primary and secondary levels) (Mugisha-Kamatenesi *et al.,* 2008). In Tanzania, Mwakaje, Mwakipesile and Nyakisinda (2009) noted that most of the rural farmers (99% of 200 respondents) had attended formal education at Rungwe district in Mbeya region. The findings of the present study indicate that most farmers can use a wide range of oral and explicit sources of knowledge (such as print formats and ICTs) to manage their IK and access exogenous knowledge in the local communities.

The study findings further noted that male farmers dominated the highest education category as compared to female farmers. The apparent preponderance of males in the higher education category is not surprising considering the cultural and historical gender imbalances in education in the country (Mbilinyi *et al.,* 1991). It is worth noticing that the difference in literacy between men and women is large countrywide in Tanzania, where males constitute 77.5% of the literate population and females comprise 62.2%, statistically (URT 2002b). The findings of the present study regarding the level of education between gender categories are similar to the findings of an earlier study by Kiondo (1998), who reported that about 41.4% of 773 of rural female farmers had completed primary schools, and only 1.81% had attained secondary education in Tanga

region, Tanzania. Banmeke and Olowu (2005) also reported that almost half of the women farmers (47.8% of 347 respondents) did not have formal education, while 28% had attained primary education in Nigeria. Olatokun and Ayanbode (2008) also found that a high percentage of the rural women could neither read nor write, 166 (72.8% of 250 respondents) in Nigeria. The findings of the present study indicate that there is a low level of higher education among farmers and more often than not women farmers are disadvantaged in terms of access to formal education in the surveyed sample.

## 6.2.4 Occupation

The study mainly involved smallholder farmers, with the average farm size of 4.9, where nearly two thirds of the crop farmers 104 (61.9%) had farm sizes below 4.9 acres (See Section 5.2.1.1). These findings are not surprising given the fact that most of Tanzania's farmers generally cultivate an average farm size of between 0.2 to 2 hectares (or 0.49 to 4.94 acres) (URT 2001b). These findings of the present investigation are in accordance with a study by Olatokun and Ayanbode (2008) who reported that the majority of the respondents in their study (72%) were subsistence farmers who owned between 0.164 to 2.025 hectares (or 4.052 to 5.009 acres) of land in Nigeria. Chapman *et al.,* (2003) also reported that in their study the majority (85%) cultivated less than four hectares of land for their household needs in Ghana.

The findings of the present study showed that the majority of the respondents were involved with crop farming, 168 (92.9%), as compared to livestock production, 146 (80.2%). Among those crop farmers and livestock keepers, 133 (73.5%) respondents were engaged in mixed farming. Similar observations were made by Sabo (2007), who reported that women farmers carried arable crop farming and, to a lesser extent, practiced animal husbandry in Nigeria. Kolawole (2004) suggested that the more active involvement of people in farming activities than any other job indicates that IKS practices may have found common use amongst the local people. Indications from the current study are that small-scale farmers in the sample of the study possess an extensive base of IK on crop farming as compared to livestock production.

The present study's findings showed that farmers mainly relied on family labour, 92 (50.8%) to carry out their farming activities, followed by hired labour, 67 (37%), and both family and hired labour, 22 (12.2%). Another study on the integration of conventional and farmers' knowledge in Ghana found that most farmers 415 (92%) used external labour in addition to family labour for their farming activities, while the remaining 36 (8%) depended solely on the family labour (Kudadjie 2006). Chapman *et al.,* (2003) also noted that most of the farmers (71% of 60 respondents) relied on family labour for cultivation, and the remaining 29% used a combination of extended household and family labour in Ghana. It is apparent from the present findings that most farming activities were carried out within the family which shows that most farmers possessed indigenous knowledge since they were extensively involved in all stages of farming activities but without formal training.

However, there was a difference in the distribution of labour and responsibility between the sexes and age groups in the farmers' families. Although nearly two-thirds of the respondents were men, and more than half of the respondents indicated that there were no differences between the roles of men and women regarding farming activities, the analysis of farming roles carried by both men and women indicated that women were more involved in the farming activities than men. These findings are not surprising given the fact that women constitute 80% of agricultural labour resource and produce 60% of food requirements in Tanzania, statistically (AFDF 2008). Other studies carried out in India (Singh and Sureja 2006), Nigeria (Nathaniel-Imeh 2004) and Tanzania (Mattee 1998) came to the same conclusion that women constituted the main part of the agricultural labour force when compared with men. The different agricultural roles between men and women are mainly defined by the culture of a certain locality (Kaiza-Boshe 2003; Wall 2006). These roles may have an effect on the patterns of access, use, and control, and results in different perceptions and priorities for the innovation and use of IK (Hart and Mouton 2005; Kaiza-Boshe 2003; Pidatala and Khan 2003; Wall 2006). It is thus important to equally involve men and women in KM activities since both genders may have different levels of knowledge due to dissimilar patterns in their farming roles, and access and use of knowledge in the local communities.

## 6.2.5 ICT ownership and use

The findings of the current study showed that majority of the farmers in the sample owned ICTs. Radio was the predominant ICT tool owned by the rural farmers, followed by cell phones and television. This finding is similar to an earlier finding by Chilimo (2008) who reported that most farmers owned radio and cell phones in four rural districts of Tanzania. A study at the Rungwe District in Tanzania also revealed that most farmers owned radio and cell phones, while the ownership of TV was very low, and no one used internet services (Mwakaje, Mwakipesile and Nyakisinda 2009). A survey of six countries in Africa and India indicated that the ownership of radio was high in Uganda, Tanzania, Botswana and Mozambique, while TV ownership was high in South Africa and India (Batchelor, Scott and Eastwick 2005). The ownership of radio was high due to its low cost, and its lack of dependence on electricity. On the other hand, there was low level of ownership of other ICTs such as cell phones and television probably due to lack of electricity, high cost of ICTs and a lack of relevant content. A study by Batchelor, Scott and Eastwick (2005) in six countries of Africa and India showed that as the poor get wealthier and have access to basic infrastructure such as electricity and good national broadcast signals, they migrate to television even with the current limits on programming (that is, limited local language and local cultural content). It is thus important to improve the electricity supply in the local communities, since it is a major prerequisite for the ownership of ICTs, especially television.

The findings of the present study, however, are not in complete agreement with the findings of other studies in Africa which have shown that the ownership of ICTs in the rural areas is very low. Kari (2007) reported that few rural people owned radio, and even fewer owned television and telephones in Bayelsa State in Nigeria. In a sample of 188 rural farmers in Zambia, Kalusopa (2005) found that the majority of the farmers (80.9%) did not own television, and few (11.2%) did not have radio. The reasons for this inconsistency appear to be varied levels of economic development, literacy and ICT expertise, infrastructure, and the legal and regulatory framework for the expanding markets in the rural areas. These findings suggest that digital divide is still prevalent in the rural communities of various African countries.

The present study also established that even if there is limited ownership of certain ICTs such as cell phones and television, there are various communal and neighbourly ways and means of accessing these devices. The findings showed that farmers mainly accessed television from their neighbours' homes or social clubs, while cell phones were accessed from neighbours, friends, families, or telephone operators. These findings correspond with those of Kari (2007) in Nigeria, which established that the majority of farmers who did not own ICTs accessed radio and television from their relatives/friends homes and a few accessed telephones from GSM operators. Similar observations were made in four rural districts in Tanzania (Chilimo 2008). It is apparent from the findings of the current study that lack of ICTs does not appear to constitute a barrier to accessing ICTs in the rural communities. However, issues related to social status limited some farmers in accessing ICTs (that is, television, radio and cell phone) from their neighbours/friends homes (see Section 5.10.3.1). On the other hand, issues related to ICT literacy, awareness, high cost and cultural barriers limited farmers in using telecentres to access email and internet in the surveyed communities (see Section 5.10.3.1).

It was evident from the study findings that there were no major differences across gender in terms of ICT ownership. However, there were variations in ICT ownership by age. ICTs such as radio, cell phones and TV were owned by young farmers aged between 26 and 36 years to a greater extent than by middle aged and elderly farmers. Similarly, a study in Tanzania found that majority of the farmers between 21 and 60 years owned at least one type of ICT compared to other age categories (Mwakaje, Mwakipesile and Nyakisinda 2009). The study's findings suggest that most owners and users of ICTs in the surveyed rural areas were younger rather than elderly farmers.

## 6.3 Identification of types of agricultural indigenous knowledge and the role of indigenous and exogenous knowledge in the farming systems in the local communities

The first objective of the study focuses on the identification of agricultural IK and the role of the indigenous and exogenous knowledge in the farming systems. Although KM involves a number of processes that move back and forth between different phases, a review of KM models which guided the present study showed that knowledge identification can form an entry point to the KM processes (Probst, Raub, and Romhardt 2000). The study was based on the assumption that

the communities have an extensive base in IK which needs to be identified for KM practices and sustainable agricultural activities to be effective. This section discusses the findings of the study in relation to the identification of agricultural IK types and use of IK for agricultural activities, based on data presented in section 5.3 and the summary of result in section 5.12.1, and in relation to Probst, Raub, and Romhardt's (2000) KM model. The processes of identifying knowledge gaps and how farmers locate the knowledge they need are discussed in section 6.4.1.

### 6.3.1 Types of agricultural indigenous knowledge

One of the KM process as shown in the Probst, Raub, and Romhardt's (2000) KM model was the importance of identifying organization's knowledge environment for effective KM activities, hence the focus on the identification of types of agricultural IK in this research. The identification of the company's knowledge environment is important to help the knowledge workers to locate the knowledge they need for effective KM practices (Probst, Raub, and Romhardt 2000). Based on the study findings, it was evident that the local communities had an extensive base of IK and understanding of their environment, and they were able to put appropriate managerial skills and adaptive strategies to crop and animal farming and forage resource management. The findings of the present study also showed that IK was location specific. This finding supports Grenier's (1998) views that IK is unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a specific location.

The study findings established that farmers possessed IK on various farm tasks such as soil fertility, assessment of arable land, cropping system, weed control, preservation of planting materials and crops, plant diseases and pests control, animal breeding and disease control. A similar observation was made by Eyong (2007), who reported that local people in Central Africa possessed an enormous wealth of IK that covered clearing the land, tilling, selecting seed varieties for planting, planting, harvesting and storage. Related observations were made by various studies in developing countries, such as Bangladesh (Miah *et al.,* 2005), Laos (Saito *et al.,* 2006), Nepal (Walker *et al.,* 1999), and Peru (Rhoades 1989). These findings also correspond with the observations made by various studies in African countries, which include Burkina Faso

(Gray and Morant 2003), Cameroon (Lambi 2004), Nigeria (Ajibade and Shokemi 2003; Akpabio and Akankpo 2003; Gana 2003; Ogen 2006; Osbahra and Allan 2003), South Africa (Luseba and Van Der Merwe 2006; Magoro and Masoga 2005), Tanzania (Hill 2003; Kamwenda 2002; Minja 2001; Mollel 1991; Mshana 1992), Uganda (Hart and Mouton 2005), and Zambia (Sikana 1994).

The study findings established that farmers had a broad base of knowledge on the assessment of the quality of soil fertility. Apart from low crop yield and poor growth of crops and weeds, farmers determined changes of soil fertility by using crop characteristics (that is, changes of crop colour, layers of rotten grasses, and appearance of certain plant species), soil characteristics such as presence of compact soil, and common sense, prior experience and trial and error to evaluate soil fertility. The findings of this study were also similar to other studies which showed that soil and crop characteristics were major factors used by farmers to determine changes of soil fertility in Jamaica (Bailey 2003), the Philippines (Price 2007), and Uganda (Akullo *et al*., 2007).

In the preservation of planting materials, centuries of practical experience have given local farmers a unique decision-making role and knowledge about what to conserve and how to store the planting materials. While conventional inputs were important for preserving planting materials in the surveyed regions, the present findings also showed that farmers had an extensive base of knowledge on local herbs, cultural practices, and traditional facilities which they used for preserving these materials. However, the application of local herbs, indigenous practices and traditional facilities varied considerably across the surveyed regions probably due to differences in culture and the agro-ecological conditions as shown in Section 5.3.2.2.

Further, the study found that similar local inputs (such as chilli pepper, neem and ash) were applied in various regions to preserve the same planting materials. This finding agree with what other studies had found that local knowledge can effectively be applied outside the spatial locales in which it was developed (Briggs 2005; Briggs and Sharpe 2004; Warren 1991:2). However, it is argued that a local innovation is developed to fit a particular biophysical and socio-economic setting and usually cannot be transferred "as is" to other settings (Waters-Bayer and van

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Veldhuizen 2005). Other authors have argued that IK should not be up-scaled because it becomes decontextualized and ineffective when separated from its environment (Agrawal 1995; Klees 2008). Nevertheless, the documentation and sharing of local innovations can provide ideas and inspiration for others to try out and adapt new ideas to their own setting (Waters-Bayer *et al.,* 2006; Waters-Bayer and van Veldhuizen 2005). Since IK is site-specific, it can therefore seldom be scaled up without adaptation, however it can be used to stimulate experimentation and innovation in other communities.

With regard to the preservation of crops, the findings showed that farmers had wide-ranging knowledge on the use of local herbs, practices and traditional facilities for preserving crops although they mainly used conventional inputs and facilities. The application of these local herbs, practices and traditional facilities varied across the regions probably due to cultural and agro-ecological factors. For traditional facilities, clay pots and granaries that were located outside or within farmers' houses or over the hearth were mainly used to preserve crops. Another study conducted by Agea *et al.,* (2008) in Uganda found that majority of the households in Mukungwe sub-county stored their food in granaries (80%), and locally made sacks, on kitchen shelves, in pots and baskets (42%). The high use of granaries was also found in Nigeria (Ogundele 2006). However, the present study found that the use of granaries which were located outside farmers' houses were no longer common due to cases of rampant theft.

Further, farmers used similar plant parts of particular species such as leaves, roots, bark, and husks to preserve their crops. Most farmers used chilli pepper (*capsicum annum*) in combination with other plant parts to preserve their crops. It was apparent from the findings that a wide range of cultural inputs and practices were used to preserve crops, such as anthill soils, and sliced cassava which was boiled with salt, dried and preserved (see Section 5.3.4). It was also very clear from the literature that this technique for preserving cassava was also a common practice in the surveyed communities in Uganda (Akullo *et al.,* 2007). The present findings showed that similar local inputs (such as chilli pepper, and ash) were found to be applied in various regions to preserve the same crops. These findings show that the same technique can be adapted in different localities with similar agro-ecological conditions.

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The study findings showed that farmers had broad base of knowledge regarding the diagnosis of plant diseases, where more than half of the respondents 105 (62.5% of 168 crop producers) identified twenty plant diseases. Although interview results established that chemical inputs were the main methods used to control plant diseases, the focus group discussions showed that local herbs and practices were the major methods used by farmers to control plant diseases, followed by conventional inputs and practices. Despite the discrepancies from interview and focus group findings, broad patterns can be drawn, namely that conventional inputs were the major techniques used to control plant diseases due to the limited ways to share IK in the surveyed communities as revealed from the non-participant observation. IK was location specific, where various plant parts (bark, roots, leaves) were used alone, or in combination with other ingredients such as cattle urine, kitchen ash and other inputs as shown in Section 5.3.5.1.

On the control of plant pests, the findings showed that the majority of the respondents 149 (88.7% of 168 crop producers) identified various pests and measures used to control plant pests. Farmers used a wide range of indigenous practices and local herbs to control plant pests in the communities, although the application of these inputs varied across the regions. Farmers either used various parts of plant (roots, bark, leaves) alone, or in combination with other inputs to control various plant pests, such as kitchen ash (see Section 5.3.5.2). Mugisha-Kamatenesi *et al.,* (2008) also reported similar findings in their study of IK on the field insect pests in Uganda. The present findings also showed that similar local inputs (such as ash) were applied in various regions to control the same plant pests. This finding shows that the same technique can be adapted in different local communities with similar agro-ecological conditions.

Farmers specified various criteria for selecting male and female animals (that is, cattle, goats, sheep, poultry, donkeys and pigs) for breeding purposes. Farmers mainly used body size, appearance, temperament and history of ancestors to select male animals, while they used body size, temperament, milk production, appearance, history of ancestors, and prolific criteria to select female animals. Similar criteria for selecting male animals were identified in the Maasai community in Tanzania (Kilongozi, Kengera and Leshongo 2005). These findings suggest that

farmers had a broad base of knowledge about animal breeding where criteria for selecting animal for breeding purposes were based on the physical appearance, behaviour and performance.

Farmers had an extensive knowledge of the diseases afflicting their livestock and remedies. The study findings showed that the majority of the respondents 133 (91.1% of 146 livestock keepers) identified animal diseases and measures for controlling these diseases. Although farmers mainly used external inputs to control animal diseases, they had developed fairly extensive methods for controlling their animal diseases, which included local herbs and indigenous practices. The application of these local herbs and indigenous inputs varied across the regions (see Section 5.3.8.1 and 5.3.8.2). Neem and chilli pepper were the most used herbs by farmers for controlling animal diseases. These findings suggest that farmers have been able to control and prevent animal diseases by using methods which are easy to use and locally available.

On the whole, knowledge on farming activities may seem to be determined solely by the physical properties, unique qualities, behaviour and performance of either crops or animals. The identification of IK types was important to determine and understand what the communities knew and how that knowledge could be located in order to add value to the agricultural activities as was suggested by Probst, Raub, and Romhardt's (2000) KM model. IK identified in the present study forms the basis for local-level decision making in various issues such as food security, animal and crop husbandry, natural resource management and other related agricultural activities in the rural areas. It is thus important to understand, and facilitate the identification, acquisition, sharing, preservation and use of this knowledge as well as integrating it with conventional knowledge for improved agricultural activities.

### 6.3.2 The role of indigenous and exogenous knowledge in the farming systems

The research findings on the role of indigenous and exogenous knowledge in the farming systems were in line with the KM process of identifying knowledge and how it adds value to the organisation for effective KM practices as indicated in Noeth's (2006) and Probst, Raub, and Romhardt's (2000) KM models. The study did identify farmers' knowledge and the value it adds to the rural communities. The study findings showed that farmers possessed

an extensive base of knowledge which they used to ensure food security and increase agricultural productivity in the surveyed communities. The study findings illustrated that farmers employed various indigenous techniques and practices in crop production more than in livestock management. Similar observations were made in a study to assess the role of agricultural IK in Uganda (Akullo *et al.,* 2007). The high cost of livestock management and lack of skills may have limited most farmers' involvement in animal husbandry. The present findings indicated that farmers mainly relied on the indigenous knowledge and techniques to improve soil fertility, acquisition of planting materials, cropping systems, crop planting systems, weed control, irrigation, and control of predators and plant pests. On the other hand, there was high use of exogenous knowledge and techniques in the preservation of planting materials and crops, control of animal and plant diseases and animal husbandry.

### 6.3.2.1 Soil fertility

The study findings indicated that the majority of the respondents used indigenous techniques and inputs to improve the quality of their soil, which included application of crop rotation techniques 73 (44.5%), and local inputs such as manure 95 (57.9%), crop residues 58 (35.4%), and organic materials 52 (31.7%). The high use of organic manure was also established in other African countries such as Nigeria (Kolawole 2004; Ogundele 2006), Samoa (Tikai and Kama 2004), South Africa (Magoro and Masoga 2005), and Uganda (Agea *et al.,* 2008). The present findings showed that there was low use of conventional inputs, such as mineral fertilizers 38 (23.2%) and nitrogen-fixing crops 14 (8.5%) due to the following: lack of skills, unavailability of these inputs, lack of financial ability to purchase them, and adverse negative effects to human health. These findings are in consistent with the research findings of Eyong (2007) who reported that farmers in Central Africa used local inputs (such as ash or manure) on their farms due to their having few adverse effects on the food chain compared to chemical fertilizers. On the other hand, the present study found that not all indigenous methods (such as long-term fallowing) had high use in the surveyed communities. Long-term fallowing was practiced at a low rate due to population pressure and the demand for land for other purposes, such as investment in large scale farming or tourism.

**6.3.2.2 Crop husbandry**

The study findings showed that farmers mainly used intercropping systems (which is inherent to indigenous farming) as compared to mono-cropping systems and both mono-cropping and inter-cropping systems. It was also very clear from the literature that an intercropping system was a common practice in the surveyed communities in Uganda (Hart 2007). The shortage of land, lack of funds to purchase extra land, or to hire land, inherited practice and plant diversification were the major reasons for practicing inter-cropping system in their farms in the areas under investigation.

Further, the present findings also indicated that the random planting technique which is inherent in indigenous farming was the dominant method practiced in the surveyed communities as compared to row planting. Both row and random planting, and row transplanting were the least used methods in the surveyed communities. The predominant use of indigenous techniques was contributed by the lack of funds to purchase ropes or hire labour for row spacing, existence of inherited crops which were randomly planted in the field such as bananas and coffee, and lack of access to knowledge on improved techniques such as row spacing.

Consequently, the use of indigenous techniques on weed control was also high. The findings showed that the majority of the respondents 152 (90.5%) used selective weeding, crop rotation 76 (45.2%), intercropping 53 (31.5%), dry leaves 36 (21.4%), short-term fallow 26 (15.5%), and organic matter 26 (15.5%) to control weeds. These findings correspond with those of Tikai and Kama (2004) in Samoa who reported that the majority of farmers between 60% and 70% practiced the indigenous method of "pull and burn" and "fallowing" to control weeds among *taro*, yam and *taamu*. In the present study, conventional inputs such as herbicides were less used due to their unavailability, high cost, lack of awareness about them and their negative effects on human health.

In addition, the study findings indicated that few farmers practiced irrigation 45 (26.8%), such as furrows to irrigate rice and maize crops. Few farmers irrigated their crops due to lack of skills and resources. Indications are that it is important to ensure adequate access to relevant

agricultural knowledge and resources to enable farmers to adopt improved farming practices in order to increase their farm outputs.

## 6.3.2.3 Plant predators

A clear trend on the use of indigenous techniques emerged in the control of predators in the local communities. The findings indicated that local herbs and indigenous techniques were the major methods used to control predators, which included, monkeys 53 (89.8 %) and wild pigs seven (11.9%) as compared to conventional inputs (see Section 5.3.5.3) in the surveyed communities. The high use of local inputs and techniques was because of their simplicity, affordability, safety and availability.

## 6.3.2.4 Plant diseases and pests

Despite the fact that the majority of farmers did not use any measure to control plant diseases, chemical pesticides were commonly used by farmers to control their plant diseases, as compared to local herbs, indigenous practices, and both conventional and local inputs. The study findings also showed that a large number of farmers used chemical pesticides, and indigenous practices to control plant pests. Few farmers used local herbs, and a combination of local and conventional inputs to control plant diseases and pests. The use of indigenous practices to control plant pests was supplemented by the application of traps, scaring, guarding, applying poisons and mechanical methods for controlling rodents and birds. This finding is in accordance with the results of a study carried out in South Africa which showed that chemical inputs were the predominant method used to control plant pests in the area. However, at least 50% of the farmers were aware of indigenous pest control methods (Odeyemi, Masika and Afolayan 2006). Indications are that chemical pesticides were commonly used to control plant diseases and pests probably due to the lack of access to indigenous knowledge and techniques. The use of indigenous techniques was also supplemented by the availability, simplicity, and affordability of local inputs in the surveyed communities.

The findings further indicated that the majority of the respondents preferred to use exogenous techniques 69 (41.1%) to control plant diseases and pests, followed by indigenous techniques 56

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(33.3%), and a mixture of exogenous and indigenous techniques 9 (5.4%). Farmers mainly preferred to use exogenous inputs due to their effectiveness, availability and proven scientific procedural explanations. Overall, the findings of the current study indicate that farmers relied on conventional inputs to control plant pests and diseases despite their negative effects. Indications are that farmers could use local inputs if they were aware of their effectiveness, and if they were readily available in the communities. This calls for a need to promote sharing and use of IK before it disappears all together.

### 6.3.2.5 Value added practices

The study findings showed that the planting materials were mainly selected and saved seeds and germplasms from the previous seasons. Other major methods of acquiring planting materials in the surveyed communities were through purchase, the farmers' own suckers, and borrowing from other farmers. Planting materials were either bought from local markets or input suppliers. This finding is consistent with the research findings of Kudadjie (2006), who found that most sorghum farmers, tended to use their own seed, followed by sourced seeds from the market, more than from other farmers, or the Ministry of Food and Agriculture, or Bewda, a non-governmental organisation in Ghana. A study by Nathaniels and Mwijage (2000) revealed that home-saved seeds and neighbours were the predominant seed sources, followed by markets, extension officers and local village shops for farmers at Nachingwea District in Tanzania. It is clear from the findings of the present study that farmers mainly rely on indigenous and local planting materials more than conventional materials in the sample under investigation.

Despite the fact that most farmers relied on the indigenous and local planting materials, there was high use of conventional facilities and synthetic insecticides for preserving planting materials as compared to local herbs, practices and traditional facilities. Few farmers used both indigenous and conventional techniques and facilities to preserve planting materials in the surveyed communities. In Ghana, Kudadjie (2006) found that the most common form of storage was to keep seeds in the unthreshed state and stored in a mud silo (63%), while clay pots were less used. Most sorghum farmers (63%) also did not treat their seeds before storing them while the rest used chemicals, followed by wood ash and neem extract. It is apparent from the present

findings that farmers have adequate knowledge of the preservation of planting materials, though some loss of IK in this practice is evident. Vorster, Stevens and Steyn (2008) studied the production system of traditional leafy vegetables in South Africa and came to the same conclusion that indigenous practices for preserving local seed varieties were becoming extinct. It is clear from the findings of the present study and other literature that it is important to find ways to manage IK to prevent further loss of crop species and knowledge.

The findings further indicated interest in the use of indigenous practices and inputs for preserving planting materials. In this study, farmers preferred to use indigenous methods for preserving their planting materials 70 (41.7%), followed by conventional techniques 66 (39.3%), and both indigenous and conventional methods 16 (9.5%). The majority of the farmers in the surveyed area were poor and few could afford to purchase conventional inputs. Thus, most of them tended to use most cost effective alternatives.

In the preservation of crops, the study findings indicated that conventional facilities and synthetic insecticides were the dominant methods used by farmers to preserve their crops, as compared to local herbs, practices and facilities. However, there is an increasing interest in the use of indigenous practices and inputs for preserving crops in African countries. For instance, Gana (2003) found that small-scale farmers in the three villages in Nigeria had developed interest in the use of indigenous planting materials to protect food crops because these materials were effective, safe and cheap. Thus, the need for promoting sharing and use of local practices for preserving crops cannot be over-emphasized.

### 6.3.2.6 Animal husbandry

Despite the fact that most farmers used conventional techniques to keep their animals (such as zero grazing), there was low use of other important techniques for feeding their livestock such as domesticated livestock fodder and special supplements. The study findings showed that few farmers grew livestock fodder, 31 (21.2%), and almost half of the respondents, 64 (43.8%) provided special feeds to their livestock. These findings show that knowledge on improved

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animal farming is still inadequate, although farmers were willing to learn new techniques in order to improve their animal husbandry practices.

### 6.3.2.7 Animal diseases

The study findings showed that exogenous inputs and practices were the dominant methods used by farmers to control animal diseases, as compared to local herbs and practices, and both exogenous inputs and local herbs. Farmers mainly applied exogenous inputs to treat cattle and pigs, while local inputs were used to control diseases in cattle and poultry. Both exogenous inputs and local herbs were used on cattle and poultry, while most farmers did not apply any medication to treat poultry diseases because poultry were sold at a cheaper price than other animals. IK was not used to control pig diseases because a piggery was a relatively new enterprise in most households. A study by Akullo *et al.,* (2007) also observed that there was low use of IK for controlling pig diseases in Uganda. The findings of the present study also established that exogenous inputs 75 (70.8%) were the dominant approach used to prevent animal diseases, followed by local herbs and cultural practices 22 (20.2%), and both exogenous inputs and local herbs 9 (8.5%). The study findings further indicated that the majority of the respondents, 103 (70.5%) preferred to use exogenous techniques, as compared to indigenous techniques, and both indigenous and exogenous inputs.

On the whole, the prevalent use of conventional veterinary medicine indicates that IK is not commonly used to control animal diseases because it is not equally shared in the local communities. It is clear that farmers tended to ignore other knowledge modes such as IK due to the acquisition of exogenous knowledge on veterinary medicine in the surveyed communities. Similarly, Jacob, Farah and Ekaya (2004) studied the Maasai ethno-veterinary diagnostic skills in Kenya and came to the same conclusion that knowledge on ethno-veterinary was disappearing in association with an increase in the dependency on conventional animal drugs among the Maasai ethnic group in Kenya. In the present study, low use of local herbs and practices for controlling animal diseases was due to many factors, such as lack of scientific procedural explanations, ineffectiveness of some local herbs, low level of awareness of the effective herbs and related practices, a poor knowledge sharing culture, resistance to accepting IK especially in the present

generation, and animals being purchased at a high cost. Thus, it was better to use exogenous inputs more than ineffective local inputs (see Section 6.6.3). However, some farmers indicated that neither local remedies nor conventional treatment proved to be as effective as they desired. This fact is probably due to high cost of inputs, and thus farmers managed to buy small amounts of the inputs which they used incorrectly in an attempt to extend their use.

### 6.3.2.8 Medicinal plants

The low use of local herbs for preserving crops and controlling plant and animal diseases can be justified by the fact that there was low level of knowledge and use of the medicinal plants for preserving crops and controlling animal and plant diseases. The study findings indicated that few farmers domesticated medicinal plants that repel insects, 24 (14.3%), and for controlling plant, 8 (4.4%), and animal diseases, 36 (24.7%). Further, the study findings indicated that few farmers used wild medicinal plants for preserving crops, 33 (18.2%), and for controlling plant diseases, ten (5.5%), and animal diseases, 39 (21.5%). This knowledge on medicinal plants was location specific. For instance, farmers in Moshi Rural possessed more knowledge on domesticated medicinal plants for controlling plant diseases and pests, and animal diseases, and wild medicinal plants for controlling animal diseases than farmers in other regions. The major reason for this fact was due to the existence of both FLORESTA NGO and Tanzania Coffee Research Institute (TACRI) in the Moshi Rural region which promoted the use of organic farming. On the other hand, farmers in Karagwe and Kasulu regions had extensive knowledge on wild medicinal plants for controlling plant diseases and pests, and Kasulu farmers possessed more knowledge on wild medicinal plants for preserving crops than farmers in other surveyed districts. The variations of knowledge on medicinal plants were probably due to the cultural and agro-ecological conditions differences.

### 6.3.2.9 Knowledge loss in the indigenous farming systems

Sources in the literature have argued that the growth of knowledge may be linked to growth of ignorance since as people acquire more knowledge, they tend to designate former knowledge as ignorance (Evers and Menkhoff 2005:145; Jashapara 2004; Lehaney *et al.,* 2004). In this study, the extensive use of exogenous knowledge and inputs in some farming aspects, and high use of IK in other farming activities was linked to ignorance because as farmers acquired more

exogenous knowledge, they tended to ignore other knowledge modes. On one hand, the study findings showed that local inputs were mainly used in the improvement of soil fertility, acquisition of planting materials, crop husbandry, and control of plant predators as compared to conventional inputs (see Section 6.3.2.1, 6.3.2.2, 6.3.2.3). On the other hand, the study noted that there was high use of exogenous inputs in the preservation of planting materials and crops, animal husbandry, and control of animal and plant diseases as compared to local inputs and practices (see Section 6.3.2.4, 6.3.2.5, 6.3.2.6, 6.3.2.7).

The findings of the present study agree with those of Mudege (2005) in Zimbabwe who reported that although scientific knowledge was efficient, it had made farmers more dependent on agri-business as opposed to the more autonomous space they had enjoyed when all the resources were locally available. Wall's study carried out in rural Uzbekistan noted that whilst the Soviet period introduced a considerable amount of new agricultural knowledge, which was adapted to local conditions and thus made 'local', there was also a considerable growth of real ignorance (Wall 2006). Indications are that farmers tend to rely on conventional knowledge systems for some farming aspects, and ignore their own knowledge system, which leads to the disappearance of some indigenous practices and inputs. Wall (2006) concluded that knowledge loss is a feature of the local knowledge system, with a great deal of knowledge being simply destroyed and not replaced. However, this lost knowledge could play a significant role in improving agricultural livelihoods of the local people. It is thus important to strike a balance between unhealthy and healthy ignorance concerning the use of new knowledge, and between a stimulating and an overwhelming flow of information in the local communities as suggested by Probst, Raub and Romhardt (2000).

## 6.4 The management of agricultural indigenous knowledge

This section discusses study findings of the research objectives two and three in relation to KM processes as deduced from the reviewed KM models (see Section 3.3.2.1 of Chapter Three), and data presented in Section 5.4 of Chapter Five. The former focuses on the current state of managing agricultural IK in Tanzania, while the later deals with the identification of farmers' information and knowledge needs. Despite the fact that various KM models (Bouthillier and

Shearer 2002; Nonaka, Toyama and Konno 2000; McAdam and McCreedy 1999; Probst, Raub, and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) use different labels to identify KM processes, the following KM processes were found relevant for the current study and they are discussed in relation to the study findings: knowledge identification, acquisition, development, sharing, preservation and application (see Section 3.3.2 of Chapter Three). The study findings indicated that both tacit and explicit knowledge contribute to each of the KM process as shown in the Rowley's (2001) KM model. Thus, the following sections discuss the identification of agricultural information and knowledge needs, and both tacit and explicit indigenous knowledge as they contribute to the KM processes in the local communities. Further, the role of knowledge intermediaries in facilitating KM activities in the local communities is also discussed.

### 6.4.1 Identification of agricultural information and knowledge needs

The findings in this section are discussed in relation to objective three of the study which sought to identify farmers' information and knowledge needs in the local communities of Tanzania. The study findings were in line with the KM process of knowledge identification which emphasizes the importance of identifying internal and external knowledge to guarantee transparency, and to help individual and groups to locate what they need for effective KM practices as indicated in various KM models (Earl 2001; Noeth 2006; Probst, Raub, and Romhardt 2000). This knowledge identification process addresses the oft-quoted phrase, "if only we knew what we know". Despite the fact that there are theories to better understand knowledge identification processes in the KM context (Holsapple and Joshi 1999; Kraaijenbrink and Wijnhoven 2006; Noeth 2006; Probst, Raub and Romhardt 2000:72), the information needs and information seeking behaviour is the relevant theory for this process. The study assessed the information needs of the rural farmers as a requirement that drove farmers to seek information and knowledge in an attempt to fulfil their information and knowledge gaps, and to improve their agricultural livelihoods. In this section, the study findings are discussed according to farmers' knowledge and information needs, information seeking patterns, and the role of intervening variables. The results of this objective are presented in section 5.4 of Chapter Five.

**6.4.1.1 Farmers' knowledge and information needs**

The study findings in section 5.4.1.1.1 showed that there was a huge knowledge gap, despite the fact that the communities possessed an extensive base of IK. The major knowledge gaps identified in this study included control of plant diseases and pests 120 (66.3%), marketing 107 (59.1%), credit and loan facilities 106 (58.6%), and control of animal diseases 99 (54.7%). It is obvious that farmers were concerned with subjects that directly affected their farming activities. Further, the findings of the present study indicated that knowledge and information needs varied across the surveyed communities. The knowledge and information needs were location specific due slight variations in agricultural activities and agro-ecological conditions, as well as state of development per village and the presence of active knowledge intermediaries such as extension officers and NGOs in some districts in the surveyed communities. These findings were similar to other studies on agricultural information needs in Eritrea (Garforth 2001), Kenya and South Africa (Wafula-Kwake and Ocholla 2007), Lesotho (Lesaoana-Tshabalala 2003), Manipur (Meitei and Devi 2009), and Tanzania (Matovelo, Msuya, and de Smet 2006).

The study findings showed that there were slight variations in information needs according to gender. Female farmers ranked first knowledge of the value added techniques, crop planting, and irrigation, while male farmers needed knowledge on agricultural marketing, and soil fertility. These findings correspond with the earlier results in Section 6.2.4 which showed that there were differences of gender roles in farming activities and that is why both male and female had dissimilar agricultural knowledge and information needs. Although the study findings showed that there were slight variations in the information needs of farmers by gender, other studies carried out in other African countries reported that there was a definite gender split in the information needs of farmers, such as Eritrea (Garforth 2001), and Nigeria (Adomi, Ogbomo and Inoni 2003). It is thus important for the rural KM initiatives to primarily focus on various knowledge and information needs per location and between persons or groups and their gender aspects for effective KM practices.

**6.4.1.2 Information-seeking patterns**

The present findings showed that slightly more than half of the respondents 93 (51.4%) had tried to look for ways to solve their knowledge and information problems, while 88 (48.6%) had not.

Although the study findings indicated that slightly more than half of the respondents had tried to look for ways to solve their knowledge problems, a study by Chilimo (2008) reported a higher percentage, 106 (93% of 114 respondents) of rural people who had attempted to find information to fulfil their needs in the rural areas of Tanzania. In the present study, the findings showed that out of those 93 (51.4%) respondents who had tried to find ways to solve their knowledge and information problems, more than half of the respondents 53 (57%) had managed to solve part of their knowledge problems. Although more than half of the respondents in this study had managed to solve part of their knowledge problems, a study by Ikoja-Odongo (2001) indicated a higher percentage of the informal entrepreneurs (87.5%) who were able to find the information they wanted in Uganda. The findings of the present study and from the previous studies show that farmers had various means of identifying and locating knowledge to fulfil their knowledge needs. These findings also mean that there is a need to create a culture that would encourage farmers to seek knowledge in order to fulfill their needs and improve their farming activities.

It was evident from the findings of the present study that farmers largely sought information and knowledge from friends/neighbours, 40 (43%), extension officers, 33 (35.5%), agricultural inputs suppliers, 16 (17.2%) and family/parents, 16 (17.2%). The focus group discussions also indicated that extension officers, village leaders, neighbours and district authorities were important sources of knowledge and information in which farmers consulted. Farmers made little use of printed materials, and ICTs such as television. These results were also similar to other information seeking studies of rural farmers in Zambia (Kalusopa 2005), rural women in Botswana (Mooko 2005), and Nigerian fishermen (Njoku 2004), which showed that friends, relatives, neighbours were the major sources of information in rural areas. The findings of the present study also support Aina's (2004) information-seeking model which shows that rural people mainly seek knowledge and information from informal sources as compared to formal sources. The findings also suggest that farmers mainly depended on person-to-person communication rather than explicit sources of knowledge when seeking knowledge and information in the surveyed communities. These findings were in line with Earl's (2001) KM model which shows that conversation and contacts are key ways in identifying knowledge sources in an organisation rather than knowledge databases which not only may contain

inadequate knowledge, but also have answers to too precise questions that may not fulfill the knowledge gaps of the knowledge seeker.

These findings also indicate that farmers identified both indigenous and exogenous knowledge from within and outside the community to fulfil their knowledge gaps. The identification of both local and external sources is important for effective KM activities as indicated in various KM models (Earl 2001; Probst, Raub, and Romhardt 2000). This fact also underscores Bouthillier and Shearer's (2002) KM model which shows that the discovery process involves only locating internal knowledge within the organisation. According to Probst, Raub, and Romhardt's (2000) KM model, the visibility of knowledge sources exposes existing gaps and helps the individuals and organisations to decide between acquiring knowledge and developing it themselves.

### 6.4.1.3 Role of intervening variables

Major reasons that inhibited respondents from seeking information and knowledge were related to the unavailability of the extension officers, lack of awareness, distant location, poor response from the government and village leaders, personal barriers (that is, age, gender, resistance to change, and selfishness), and poor knowledge sharing culture (see Section 5.4.1.1.3). These barriers correspond with Ikoja-Odongo and Mostert's (2006) categories of internal (personal) and external or environmental factors which inhibited Ugandan informal entrepreneurs from seeking information. In Tanzania, Chilimo (2008) reported that local communities did not tackle their problems because of ignorance, low social status, and the unavailability of the extension officers. Similarly, illiteracy and language barriers limited rural dwellers from seeking information in Nigeria (Momodu 2002). Similar findings were reported in the information seeking studies of Nigerian fishermen (Njoku 2004), and South African peri-urban dwellers (Zaverdinos-Kockott 2004). These findings indicate that farmers did not have a culture of sharing and learning from others due to many factors including personal, social and resource based factors, and thus they tended to ignore new knowledge. According to Probst, Raub and Romhardt (2000:73), the knowledge gaps are mainly contributed by the lack of a way to identify particular kinds of knowledge, both internal and external. Thus, valuable knowledge assets may go unnoticed and unused, and managers may not know that the company has internal experts on a given subject.

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**6.4.2 The acquisition of agricultural indigenous knowledge**

The findings are discussed in relation to tacit and explicit sources of agricultural IK and the types of IK obtained from tacit and explicit sources of knowledge, based on data presented in Section 5.4.1.2.

**6.4.2.1 Tacit and explicit sources of agricultural indigenous knowledge in the local communities**

The study findings as in line with the KM process that deals with knowledge acquisition as indicated in KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub, and Romhardt 2000) showed that farmers acquired knowledge from within and outside their communities. The acquisition of knowledge involves the importation of substantial amounts of knowledge from the internal and external sources of the organisation (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub, and Romhardt 2000). However, the research findings of the present study showed that farmers mainly relied on the local sources of knowledge to acquire IK, as compared to external and formal sources of knowledge. In this study, IK was mainly acquired through local sources such as family or parents 170 (93.9%) and neighbours or friends 156 (86.2%) in the surveyed rural areas. Other common sources of knowledge were personal experience 154 (85%), social group gatherings 66 (36.5%), demonstration and observation 57 (31.5%), and farmer groups 44 (24.3%). Farmers rarely used formal sources of knowledge (public and private extension services) and printed materials to acquire IK.

These findings were supported by the results of other studies in developing countries, such as USA (Kroma 2006), and Uzbekistan (Wall 2006) that local sources were the major sources of agricultural IK as compared to formal sources of knowledge. Similar observation were made in other African countries such as Ethiopia (Dixon 2002), Nigeria (Nathaniel-Imeh 2004; Olatokun and Ayanbode 2008), Tanzania (Nathaniels and Mwijage 2000), and Uganda (Akullo *et al.,* 2007), that informal sources were the dominant sources of agricultural IK as compared to formal sources of knowledge. These findings are also supported by various authors who contended that face-to-face communication is the major mechanism for acquiring knowledge in the organisations (Earl's KM model) and local communities (Meyer and Boon's merger model) (Earl 2001; Meyer and Boon 2003). The study findings were in line with the Boisot's (1987) KM

model which references diffusion and codification of knowledge in terms of personal knowledge (see section 3.3.2 of Chapter Three). The study findings indicated that most farmers depended on their personal knowledge to carry out their farming activities. According to Boisot's (1987) KM model, personal knowledge can neither be codified nor shared to the public in the organisation.

There were also differences in people's acquisition of IK from formal sources of knowledge in various locations. However, there were slight differences in access to IK across gender categories in the surveyed communities. Males had access to a much larger set of formal sources of knowledge, including seminars 8 (7.1%), agricultural shows 8 (7.1%), and newspapers 8 (7.1%), as compared to females. Women relied on NGOs 8 (11.6%), and local sources of knowledge, which included personal experience 60 (87%), parents/family 67 (97.1%) and neighbours/friends 60 (87%). The research findings support Hart and Mouton's (2005) observations that IK about a specific topic, such as agriculture was not equally shared among farmers and labourers, males and females, and across all age groups within the farming system and household structures in Uganda. The findings from the present study show that rural KM initiatives do not prioritize IK and its equal accessibility in various locations and the gender categories that exist within them in the rural areas. These findings also indicate the dominance of exogenous knowledge system over IK as was suggested by the previous literature (Ngulube 2002).

### 6.4.2.2 Types of indigenous knowledge received from tacit and explicit sources of knowledge

In the present study, it was necessary to determine the topics for which IK was frequently sought. The goal here was partly to reconfirm the knowledge and information needs of farmers involved in the study. The findings indicated that the majority of respondents obtained knowledge on crop husbandry, followed by knowledge on new varieties and techniques, value added techniques, livestock husbandry, animal diseases, plant diseases, soil fertility and agricultural tools. The findings show that there was limited access to knowledge on animal and plant diseases, markets and credits from tacit and explicit sources of IK, and that was why they were amongst the major knowledge and information needs of farmers. It is apparent from the findings there is a need to

integrate IK with exogenous knowledge to strengthen the local knowledge system. Probst, Raub and Romhardt's (2000:102) KM model emphasized that once a company has recognised the gaps in its own knowledge and skills, it knows where to make a start on acquiring and developing knowledge. Thus, the knowledge identification and acquisition steps may form an entry point for the development and integration of knowledge in the local communities in order to improve their agricultural livelihoods.

### 6.4.3 Knowledge development in the local communities

The study findings were in line with the KM process of knowledge development as identified by KM models (McAdam and McCreedy 1999; 2000; Probst, Raub, and Romhardt 2000:130; Rowley 2001). Knowledge development is an important building block in KM models, since it focuses on the development of new skills, new products, better ideas and more efficient processes (Probst, Raub, and Romhardt 2000:130). The research findings illustrated what various KM models (McAdam and McCreedy 1999; 2000; Nonaka and Takeuchi 1995; Probst, Raub, and Romhardt 2000:130; Rowley 2001) had suggested that internal knowledge may be combined with other internal or external knowledge to create new knowledge. The research findings in section 5.4.1.3 of Chapter Five were in line with various KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub and Romhardt 2000; Rowley 2001) which show that knowledge can be constructed within various social and scientific paradigms. The social paradigm of various KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub and Romhardt 2000; Rowley 2001) is also similar to the socialization sub-process (that is, transferring tacit to tacit knowledge) of the knowledge creation model of Nonaka and Takeuchi (1995).

The findings showed that farmers created new knowledge through socialization processes such as face-to-face interactions, group interactions (that is, social gatherings and farmer groups meetings), and cultural roles such as apprenticeships, initiation rites during adolescent age, and age-set systems (see Section 5.4.1.4). The socialization process enabled farmers to combine their knowledge with that of others to carry out their own experiments out of curiosity, to solve problems, and as an adaptation of knowledge in their own environment (see Section 5.4.1.3). The

study results corroborate findings from a study of Andean farmers on the cultivation of potatoes, which found that farmers carried out three kinds of local experiment which were motivated by: curiosity, problem solving and adaptation to experiments (Rhoades and Bebbington 1988). Similar observations were made in Ethiopia (Dixon 2002), Tanzania (Kajembe and Kessy 1999), and Zimbabwe (Mudege 2005).

Apart from socialization process, the findings showed that other sub-processes in Nonaka and Takeuchi's (1995) knowledge creation model were partially fulfilled in the current study, which included externalization, combination and internalization. These findings are similar to an earlier finding by Ha, Okigbo, and Igboaka (2008) who found that Nonaka's (1994) model was partially fulfilled in that farmers were able to create knowledge through socialization and combination processes, while externalization and internalization processes were not quite successful at Anambra State in Nigeria.

In the externalization process, the present findings showed that farmers externalized their tacit knowledge into explicit knowledge although it was practiced at a very low rate. The present findings showed that few 24 (13.3%) farmers converted their indigenous tacit knowledge into explicit forms, which included written formats, carvings, and still pictures as explained in section 6.4.5. The findings also showed that the most knowledge intermediaries, 18 (72%) externalized IK by transferring farmers' tacit knowledge into explicit form (see 6.4.8).

As for the combination process, the study findings showed that farmers created new knowledge through the use of multiple bodies of explicit indigenous and exogenous knowledge, although they were used at a low rate as discussed in section 6.4.2.1 and 6.6.1. These printed materials included books, newspapers, newsletters and posters. There was low use of ICTs to combine and create new knowledge in the communities as discussed in section 6.8.1 and 6.9.1. Farmers mainly depended on the oral media such as radio and television, while advanced ICTs such as email and internet were used at a low rate.

In the internalization process, the present findings showed that the created explicit knowledge was shared with farmers through learning by doing, which included extension services, farmer groups, seminars, and demonstration and observation (see Section 6.4.2.1 and 6.6.1). However, farmers mainly acquired exogenous knowledge as compared to IK from formal and explicit sources of knowledge in the surveyed local communities. The following trend emerged in the application of both indigenous and exogenous knowledge to create knowledge through internalization process in the surveyed communities:

- The majority of the respondents 157 (86.7%) applied IK received from tacit and explicit sources of knowledge more than exogenous knowledge 141 (77.9%) received from the same sources in the farming systems (see Section 6.4.6 and 6.6.3);

- Most respondents applied IK 157 (86.7%) received from tacit and explicit sources of knowledge in the farming systems, as compared to the IK received from ICTs 18 (9.9%) (see Section 6.4.6 and 6.8.5);

- The majority of the respondents applied exogenous knowledge 141 (77.9%) received from tacit and explicit sources of knowledge in the farming systems, as compared to the exogenous knowledge received from ICTs 64 (35.4%) (see Section 6.6.3 and 6.9.3); and

- Most respondents applied exogenous knowledge 64 (35.4%) received from ICTs in the farming systems, as compared to the IK received from the same sources 18 (9.9%) (see Section 6.9.3 and 6.8.5).

These findings indicate that farmers trusted their own knowledge, and ignored other forms of knowledge. The findings also suggest that face-to-face communication is very important for enabling the knowledge creation processes in the communities as compared to other communication channels such as print formats and ICTs.

With reference to the scientific paradigm as indicated by KM models (Earl 2001; McAdam and McCreedy's 1999; 2000; Probst, Raub and Romhardt 2000; Rowley 2001), the study findings showed that farmers created knowledge within scientific paradigm when they were involved with research and extension officers in the agricultural technology development. However, the findings indicated that few farmers were involved in the participatory research activities in the

surveyed communities to generate knowledge (see Section 6.7). Thus, these findings indicate that knowledge was mainly created within the social paradigm more than the scientific paradigm in the surveyed communities.

### 6.4.4 Sharing and distribution of agricultural indigenous knowledge in the local communities

The findings of the present study as in line with the KM process that deals with knowledge sharing as indicated by KM models (Bouthillier and Shearer 2002; Probst, Raub and Romhardt 2000; Rowley 2001) showed that knowledge can be shared by either a centrally directed process of distributing knowledge among a particular group of farmers, or it can be transferred between individuals, or within group of farmers. In this section, the sharing and distribution of agricultural IK is discussed in relation to two categories, which include indigenous practices that enable sharing and distribution of IK in the local communities (such as folklore practices, farmer groups, apprenticeships, and initiation rites during adolescent age), and the right conditions for knowledge sharing and distribution as suggested by Probst, Raub and Romhardt's (2000) KM model which include culture, trust, status and context and space. This section discusses knowledge sharing activities in the local communities, based on data presented in section 5.4.1.4 and the summary of results in section 5.11.2.4.

### 6.4.4.1 Indigenous practices for sharing and distribution of agricultural indigenous knowledge in the local communities

In the organisational context, there are various instruments to support the sharing and distribution of organisational knowledge which cover all physical, technical and organisational aspects of individual and group working context (Probst, Raub and Romhardt 2000:168). However, the findings showed that there were no pre-defined structures and instruments in the surveyed communities to enable knowledge sharing and distribution. The study findings confirmed what previous studies (Owuor 2007) had found that IK was commonly shared and distributed among individuals and within the communities through events such as folklore, initiation rites, apprenticeships and inheritance of specialized knowledge such as indigenous medicine. Thus, the

sharing of IK in relation to folklore activities, initiation rites during adolescence age, apprenticeships, and farmer groups is discussed more in detail in the following sections.

### 6.4.4.1.1 Folklore activities

The findings indicated that the folklore activities were important for sharing agricultural IK in the surveyed communities, although they were practiced at a low rate. The results revealed that 79 (43.6%) respondents replied affirmatively that folklore activities were still practiced in their communities, while 102 (56.4%) did not. The study established that songs, 69 (87.3%) were the major forms of folklore practiced across the districts, followed by dance, 56 (70.9%), and storytelling, 45 (57%). Other types of folklore activities were less practiced, which include drama, puppet shows, plays, debates and poetry. The findings also indicated that there were variations of the folklore activities across the regions. Each of the 24 ethnic groups in the surveyed communities had a store of folklore activities including folk tales, songs, dances, riddles, proverbs, drama, puppet shows, poetry and sayings that embodied their culture and tradition.

In the present study, folklore activities was less practiced due to the ignorance of the present generation about such practices and the advancements in ICTs such as radio and television broadcasts which had replaced the traditional dances and storytelling. Eyong, Mufuaya and Foy (2004) noted that the mass media posed a great threat to folklore activities as families spend time watching pop music and soap operas on television, rather than telling folk tales, or singing folk songs, which are powerful vehicles for transmitting IK. The present study also noted that formal education had contributed to the disappearance of folklore activities, since students had to read after schools, and thus little time was allocated for storytelling or songs as was suggested by Chisenga (2002). If strengthened and recognised, folklore could play a great role in managing IK, and integrating IK with other knowledge systems.

Although folklore activities were practiced at a low rate in the present study, previous research in other developing countries have indicated that folklore activities play a key role in sharing and preserving indigenous knowledge and culture. A study carried out by Olatokun and Ayanbode

(2008) in Nigeria revealed that traditional festivals were celebrated frequently in the rural areas and most women 174 (76.3% of 250 respondents) played a key role in singing folk songs, dancing and cooking which helped to promote, transfer and preserve culture. A survey of agricultural knowledge and information systems of the Udaipur and Trichy villages of India revealed that puppet shows were a popular medium, but only in the Udaipur village (Conroy *et al.,* 2004). Chapman *et al.,* (2003) found that the use of drama performed by local actors with corresponding thematic discussions improved the sharing of agricultural knowledge and information amongst farmers listening to agricultural extension radio programmes in Ghana. These findings are confirmed by Meyer and Boon (2003) who found that the use of indigenous communication mechanisms (such as storytelling, dancing, and drama) applicable to the local context, enabled the development agents to integrate indigenous and exogenous knowledge in the rural communities at Phokoane in South Africa. These findings indicate that folklore activities alone or in combination with other media such as radio can improve the sharing of agricultural IK and introduce the relevant exogenous knowledge in the local communities.

The present findings showed that the major purpose of performing folklore activities was for cultural issues, followed by agricultural, social, political, discipline, and histioral issues. An inquiry to which events represented the folklore activities practiced showed that folklore activities were practiced for agricultural and political events, although the socio-cultural events were the main events in which they were performed. These findings were similar to those results in Mudege's (2005) study of knowledge production and dissemination in Zimbabwe which indicated that although songs and drama were performed for agricultural education and entertainment, the messages conveyed were also highly political in content. These findings indicate that folklore activities played a key role in sharing and distributing agricultural knowledge in the surveyed communities, although they were also used for other purposes as well (such as socio-cultural and political purposes).

The open sharing of knowledge heralds the way forward to an empowered knowledge society which can efficiently manage the development change process (Nath 2000). In this study, although there were few cases were the attendance at the folklore activities was restricted to

selected members of the communities, almost everybody was allowed to attend the folklore activities, and thus they were able to access and share their agricultural knowledge. Certain folklore activities (such as dances and songs) which were performed for socio-cultural issues were restricted to invited people or elders in the local communities. Despite the fact that the attendance at most of the folklore activities was not restricted, it emerged that the attendance at these activities was very low due to people's negligence and the advancements of ICTs such as television and radio which have replaced the folk media. These findings indicate the need to promote folklore practices in the communities to improve sharing of agricultural knowledge in the local communities.

Almost everybody was allowed to perform all types of folklore activities. There were also special entertainment groups in Moshi Rural, Kilosa, Karagwe and Mpwapwa which were used to perform songs and traditional dances, and to a lesser extent to perform drama, puppet shows and poetry. These results suggest that every farmer had an opportunity to take part in the folklore activities, and thus they were able to share their IK. Similar findings were made by Mudege (2005) in Zimbabwe were every farmer was allowed to perform drama and songs which were always held at farmer field days, as there was no restriction on who could perform.

Despite the fact that all folklore activities played a key role in sharing IK, most literature in the KM field has emphasized the role of storytelling as an effective way to communicate change, and promote and stimulate values in the communities (Connell 2006; Denning 2005; Groff and Jones 2003:70; Snowden 2006). Story telling offers an ability to illustrate extremely complicated concepts in a brief, memorable, and easily repeated way (Groff and Jones 2003:70). The present findings showed that songs and dances were the major folklore activities practiced in the communities followed by stories and storytelling. These stories were mostly used for disciplining, educating and for passing on culture to the next generation in the communities. They were not used to a large extent to share and distribute agricultural knowledge amongst farmers. However other case studies conducted in the corporate environment in Africa and other developed countries have shown that knowledge circulates fasters when it is shared in tales. Denning (2005) looked specifically at the World Bank in the mid-1990s and found that

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narratives were quicker and more effective tools for explaining complex concepts, and strange new ideas, in comparison with analytic abstract thinking. In South Africa, Tobin and Snyman (2008) found that storyboards could be effective ways to support oral delivery of stories in the mining companies. It is thus important to find inspiring tales about agricultural activities, and share them to improve the agricultural activities in the surveyed local communities.

### 6.4.4.1.2 Apprenticeships

The present findings showed that despite their importance in articulating tacit knowledge through observation, imitation and practice, indigenous apprenticeships were less practiced in the surveyed local communities, accounting for 47 (26% of 181 respondents). Apprenticeships in blacksmith work, 33 (70.2%) was the predominant apprenticeship practiced in the communities, followed by wood carving 13 (27.7%), bead making, eight (17%), clay pot making, six (12.8%), gourd making, three (6.4%), basket making, two (4.3%), and tailoring, two (4.3%). Most of these apprenticeships focused on instilling agricultural indigenous techniques and practices in the children and the community at large, such as the fabrication of agricultural tools, storage structures for crops and seeds varieties, traps for controlling pests, and traditional irrigation system. These findings indicate that apprenticeships are mainly used to share agricultural IK, and thus there is a need to strengthen them for improving farming activities.

Most of the apprenticeships were inherited within families or clans in the surveyed communities, with the exception of being a blacksmith, which was restricted to certain families or clans in some of the surveyed communities. For example, the Makundi clan was specialized in making of iron tools in Moshi Rural, while the Olokononi in the Maasai community, Kilosa (Twatwatwa Village) was committed to the fabrication of knives and blades for security reasons in the community. These findings support views expressed by Kauzeni (2000) who reported that tin smithery/pottery knowledge was accessed through clan lines in Tanzania. This finding is also in accordance with a study by Obidi (1995) who reported that skills and techniques in many crafts and trades (for example, pottery-making, calabash carving, blacksmithing, drumming and circumcising of babies) were inherited in Yorubaland, Nigeria. These findings from the present study and literature indicate that traditional culture can enable or inhibit the sharing of

agricultural IK in the local communities. It is thus important to understand these cultural norms of a certain locality to ensure effective KM processes in the local communities.

The present findings also showed that apprenticeships were transmitted according to gender in the surveyed communities. For instance, young women were allowed to learn about how to build houses, make baskets, clay pots, beads, and milk gourds, while young men of age were allowed to learn about blacksmith work, traditional irrigation systems, wood carving, cars and bicycle repairing. Similar observations were made by Obidi (1995) in Yorubaland, Nigeria who reported that young women did not learn blacksmith work because it was too demanding and rigorous for them. In Zimbabwe, Mudege (2005) revealed that some types of knowledge were gendered with women monopolising the fields of health, pottery and sewing. Thus, both genders possessed various kinds of agriculturally-related IK in the surveyed communities.

There was no specific period for learning these apprenticeships. Children of age were initiated in the long processes of learning until they became knowledgeable enough to start practicing on their own. However, the present study indicated that with the advent of the formal education system, children became apprentices as soon as they completed their primary education in some communities, such as Kilosa district (Twatwatwa Village). In another study in Nigeria, Obidi (1995) reported that formal apprenticeship in blacksmith work started between five to seven years of age, and it varied slightly from one community to another. Some boys, however, started their apprenticeship at a later age, probably at the age of 15 years, when they could withstand the rigours of the training and the intense heat in blacksmith work. These findings from the present study and literature show that the period for learning these apprenticeships is determined by the cultural norms of a certain locality.

### 6.4.4.1.3 Initiation rites during adolescent age

Initiation rites during adolescence were used at a low rate to share agricultural IK, that is 32 (17.7%) of 181 respondents in the surveyed communities, since their major aim was to prepare young women and men for adolescence and responsible sexual and reproductive behaviour. These initiation rites were mainly used to share IK on animal production 30 (94%), followed by

crop production 20 (63%) and markerting of agricultural produce 17 (53%). Thus, if these initiation rites are formally recognised and promoted, they could be a useful way to share agricultural knowledge in the communities.

### 6.4.4.1.4 Farmer groups

Farmer groups are not only important to agricultural research and extension, but they can also form an entry point to communities of practices or knowledge communities as emphasized by various KM models (Earl 2001; McAdam and McCreedy 2000). Communities of practices are driven by a kind of shared curiosity about what other members know and what the group might eventually accomplish if they continue to explore their common interests and skills (Wenger 1998). The present study showed that few farmers 74 (40.9%) were involved in the associations that existed in their communities, while 107 (58%) were not. Few farmers were involved in farmer groups due to various reasons, such as farmers had not seen any good changes resulting from farmers joining farmer groups, lack of awareness on the importance of farmer groups, social factors (such as age), and inaccurate perceptions about farmer groups. The findings suggest that there is a need to encourage farmers to join farmer groups to cultivate the community of practices which are effective ways to share knowledge in the local communities. According to Wennink and Heemskerk (2006), farmer groups represent social capital that is crucial for the necessary transformation of the African agricultural sector.

The present findings showed that 63 (85.1%) of the respondents were involved in agriculurally related associations, while 14 (18.9%) were involved in non-agriculturally related groups. This fact indicates that most farmer groups focused on the agricultural activities in the local communities. It was evident from the present findings that the majority of the agriculurally related associations were registered 49 (77.8%), while 17 (27%) were not. Most of the registered farmer groups were formed with the facilitation of knowledge intermediaries such as NGOs and public extension officers. These findings suggest that knowledge intermediaries play a key role in facilitating communities of practices. According to the organisation school of Earl's (2001) KM model, knowledge intermediaries can be a necessary condition for the success of communities of practices.

The study findings revealed that farmer groups were mainly used to share knowledge on conventional farming 26 (65%) as compared to indigenous farming. IK was shared at a low rate in the farmer groups because most of the farmer groups received extension services from NGOs and extension officer whose aim was to promote conventional farming. Thus, farmers were able to share and create knowledge in the social and scientific paradigm as illustrated by various KM models (Earl 2001; McAdam and McCreedy's 1999; 2000; Probst, Raub and Romhardt 2000; Rowley 2001).

Further, the existence of informal and self-managed farmer groups in the local communities showed that communities of practices already existed in the local communities since they were voluntary and members shared a common interest and language. These findings were in line with Earl's (2001) KM model which shows that the essential feature of communities of practices is the exchange and sharing of knowledge interactively, often in nonroutine, personal and unstructured ways, as an interdependent network. Communities of practices can also be used to bridge the knowledge divide between farmers and research, and thus the fusion of indigenous and exogenous knowledge systems would be possible as suggested by Zannou, Richards and Struik (2006).

The findings indicated that the majority of the respondents knew about their farmer groups' decisions through group meetings, accounting for 45 (71.4%) of formal farmer groups and six (9.5%) of informal farmer groups. On the other hand, group members were major sources of knowledge in the communities regarding their farmer groups' decisions, accounting for 26 (41.3%) of formal farmer groups, and two (33.3%) of informal farmer groups, followed by group leaders. These results indicate that most farmers participated in decision making processes in their group meetings which shows that they participated in knowledge creation and sharing activities in their groups. These results also show that farmers belonging to groups and group leaders played a key role in sharing and distributing agricultural knowledge in the communities.

The research findings revealed that there was low rate of collaboration among farmer groups. Only formal groups which were organised by NGOs and researchers were found to collaborate in

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two districts (Moshi Rural and Songea Rural). Mistrust, distance and lack of interest in relationship building contributed to lack of collaboration among different associations in the local communities. Nevertheless, village leaders played a key role in organising village meetings, and fund raising activities which provided a forum for both informal and formal farmer groups to share their experiences in three districts (Moshi Rural, Karagwe and Kilosa). If strengthened and nurtured by village leaders and knowledge intermediaries, farmer groups would be able to forge relationships to improve the knowledge sharing and distribution activities in the local communities.

### 6.4.4.2 Creating the right conditions for knowledge sharing and distribution in the local communities

Various KM models have emphasized that effective KM activities need to embrace policies, culture, content, leadership, measurement, legal framework, ICTs, context and space to create a conducive environment for individuals to share and utilize their tacit knowledge and expertise to increase organisational performance (Davenport 1998; Earl 2001; Nonaka, Toyama and Konno 2000; Probst, Raub and Romhardt 2000:33; Small and Tattalias 2000). This section primarily focuses on the following KM principles: culture, trust, status, and context and space as they influence knowledge sharing activities in the communities, based on the theoretical framework (see Section 3.3.2.1 of Chapter Three) and findings presented in Chapter Five, section 5.4.1.4.5 and the summaries 5.11.2.4. Other KM principles such as policies and legal frameworks as identified in various KM models are discussed in section 6.5, while ICT issues are discussed in sections 6.8 and 6.9.

### 6.4.4.2.1 Traditional culture and customs

The study findings as in line with the KM principle that deals with culture as illustrated in KM models (Noeth 2006; Probst, Raub and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) showed that culture in terms of norms, values and principles can enable or inhibit the sharing and distribution of knowledge in the local communities. The findings indicated that most of the knowledge was made public (such as, knowledge acquired through seed and animal exchanges, using the lady's print cotton wrap "kanga", and animal lending systems), while some of it was

accessed through clan-based structures (such as blacksmithing). Other knowledge was accessed by inheritance, and thus it was not disclosed to the public, such as knowledge on local animal and plant medicines. Thus access to agricultural knowledge was influenced by cultural values and the norms of a specific location and ethnic group in the surveyed communities.

The findings support the views of Kauzeni (2000) who reported that IK in Tanzania was shared in three basic categories, which were "public" knowledge, "discretionary" knowledge which was accessed along clan lines (iron smith), and "secretive" knowledge which was accessed through inheritance. The findings further indicated that another category can be added to Kauzeni's (2000) IK sharing categories to include "restricted" or controlled knowledge which was accessed through social structures such as initiation rites during adolescence age and the age-set system. The age-set system was practiced by the Maasai ethnic group in Kilosa (Twatwatwa Village), while initiation rites were only used to share agricultural knowledge in four districts although they were practiced in all districts.

The research findings also showed that some knowledge can be codified and diffused (public knowledge), while other knowledge can be codified but it cannot be diffused, namely proprietary knowledge as indicated in Boisot's (1987) KM model. The latter, proprietary knowledge can be related to the discretionary, secretive and restricted knowledge categories as identified in the present study. Another Boisot's (1987) knowledge category (that is, personal knowledge) was identified in earlier research findings (see Section 6.4.2.1).

The present findings also showed that IK was transmitted according to gender due to cultural norms that existed in various communities under the sample of the study (see Section 5.4.1.4.5.1). The findings of the present study also showed that various kinds of apprenticeships were transmitted according to gender in the surveyed communities (see Section 6.4.4.1.2). These findings also support the earlier findings in section 6.2.4 which showed that there were differences in the roles that women and men undertook in their farming activities due to dissimilar patterns of access to agricultural knowledge in the surveyed communities. These findings were supported by a similar study of KM practices in rural Uzbekistan, where peasant

knowledge was transmitted within families following gender lines due to their cultural norms (Wall 2006). Thus, traditional cultures and customs defined the extent to which women and men could access and share different forms of knowledge.

The present findings also showed that there were cultural differences in various locations due to the ethnic groups' differences, population pressure and cross-cultural interferences in the surveyed regions. The present findings showed that most regions were dominated by a specific tribe, which influenced KM practices. For instance, the sharing of IK through clan-based system, inheritance, seed and animal exchange system, and lady's print cotton wrap "kanga" were practiced across all the surveyed regions, while the age-set system was practiced by the Maasai ethnic group in Kilosa (Twatwatwa Village), the animal lending system was practiced by Chagga ethnic group in Moshi Rural (Lyasongoro and Mshiri Villages), and apprenticeships were practiced in five of six surveyed districts. Despite the fact that initition rites were practices across all research sites, they were only used to share agricultural knowledge in four districts.

### 6.4.4.2.2 Trust

The study findings were in line with various KM models (Nonaka, Toyama and Konno 2000; Probst, Raub and Romhardt 2000) which show that mutual trust amongst organisational members is important as it forms the foundation of knowledge to be shared and for the self-transcending process of knowledge creation to occur. The study findings from focus group discussions established that parents/families were regarded as the most reliable sources of knowledge in the communities. Despite their infrequent contact with the extension officers, farmers regarded them as the most reliable sources of knowledge. Similarly, a study conducted in Eritrea found that the Ministry of Agriculture experts were less accessible and had less frequent contact, but their information and advice were more reliable and useful (Garforth 2001). The present findings also showed that farmer groups, NGOs, cooperative unions, and agricultural researchers were reliable sources of knowledge in those communities that they were active.

Despite their frequent contact with neighbours/friends and agricultural input suppliers, some farmers considered them as untrustworthy sources. Neighbours/friends were considered as

unreliable due to perceptions of selfishness and jealousy. These results are not surprising given the fact that 78% of Tanzanians do not trust each other, which means that of every ten Tanzanians, two trust each other (URT 2007). The results of the present study concur with a study by Batchelor, Scott and Eastwick (2005) who found that the level of confidence was low for neighbours and traders of inputs as sources of information in Tanzania. Similar observations were made in other studies in Eritrea (Garforth 2001), and Uganda (Bagnall-Oakeley *et al.,* 2004), where family and friend information networks were deemed untrustworthy. These findings also illustrated what KM models (Davenport 1998; Nonaka, Toyama and Konno 2000) have indicated that knowledge creates power, and thus an individual may be motivated to hide it even from his or her colleagues. It is thus important to foster mutual trust and a knowledge sharing culture to enable the communities to be selfless, inspired and committed to share their knowledge amongst each others. According to Disterer (2001), trust results in common expectations of reliability, consistency, and plausibility. Trust reduces the fear that others will act opportunistically.

At the same time, agricultural input suppliers were not reliable sources of knowledge because their services were market oriented, and thus farmers' needs were not catered for. Seminars held by NGOs and extension officers were also not reliable sources of knowledge because they were rarely organised in the communities. Despite their unavailability, farmers considered printed materials as reliable sources of knowledge, which included books, newsletters and posters. Similar results were also reported on the use of printed materials by farmers in Eritrea (Garfoth 2001), and South Africa (Stefano *et al.,* 2005).

With respect to ICTs, the study findings established that radio was the most reliable source of knowledge in the communities, followed by cell phones, television and internet. At the same time, some communities thought that radio, television, cell phone, internet, and email were not reliable sources of knowledge. Internet was not reliable due to the lack of local content, and the low level of awareness and ICT skills. Radio and television agricultural programmes were not reliable because they were not consistently aired, a short time was allotted to the programmes, and there was poor reception of the broadcasts. Indications are that problems related to the radio

and television agricultural programmes need to be rectified so that the communities can rely on them to access agricultural knowledge.

In the present study, cell phones were not regarded as a reliable source of knowledge in some communities because some middlemen delivered incorrect market prices in order to buy the agricultural produce at low prices. These findings correspond with those of Garforth (2001) in Eritrea who found that traders seemed less reliable than most other sources of knowledge because they were market oriented. Further, despite the introduction of the agricultural marketing information systems by the Ministry of Industry, Trade and Marketing and Vodacom Telecom Company in Tanzania, farmers in the surveyed regions were not aware of the service. This agricultural marketing information system allows farmers and traders to demand the latest prices for cash crops via text and receive the latest information on their mobile phone (CTO 2008). These findings indicate a need for the Ministry of Industry, Trade and Marketing to promote its services to increase the flow of reliable information to the communities. There is also a need for awareness creation among traders to deliver correct information and knowledge via cell phones.

### 6.4.4.2.3 Status

The study findings demonstrated what KM models (Davenport 1998; McAdam and McCreedy 2000; Probst, Raub and Romhardt 2000; Nonaka and Takeuchi 1995) have indicated that both individuals and groups throughout the organisation may be both sources of knowledge and major influencers and power sources in regard to sharing and distribution of knowledge within the organisation. Similar to previous studies (Mudege 2005; Siebers 2003; Wall 2006), this study found that factors relating to farmers, such as wealth, political issues and being knowledgeable influenced access to agricultural indigenous and exogenous knowledge in the local communities. The findings showed that some village leaders lacked authority in the villages they were supposed to head, despite the fact that they had institutional power invested in them (for example, Moshi Rural (Mshiri Village), and Kasulu (Kidyama Village). The wealthy village leaders were more influential in making all decisions regarding village matters more than poor leaders. Similarly, Wall (2006:95) found that some masters who are socially determined experts and they hold a special place within the agricultural knowledge system, they are consulted for

advice and often possess political or economic power on the basis of their knowledge in the rural Uzbekistan.

The present findings established that the traditional leaders in the Maasai ethnic group (laibon and laigwenan) had supreme power concerning all socio-cultural and livestock management issues. Thus, they were people to be respected and whose opinions must be listened to. Further, most of these traditional leaders were men (see Section 5.4.1.4.5.3). A study in rural Uzbekistan also found that knowledge and power intersected within the cultural situation in the local communities (Wall 2006). These findings indicated that cultural leaders had power which influenced access to knowledge in some of the surveyed local communities.

Other influential people in knowledge sharing were either progressive farmers, or richer people or the more knowledgeable farmers. However, the importance of their power was exercised once they recognised the power they had appropriately. Similar observation were made by Mudege (2005) that the status of person (political position, best farmer, and richer person) influenced access to knowledge in the local communities of Zimbabwe. Further, Mudege (2005) found that sometimes status did not depend on how much one knew, neither was it dependent on the benevolence of other villagers, but it depended on how one was able to network and access resources that other villagers could not in Zimbabwe. The findings from the present study and the literature indicate that farmers' decision to act on knowledge was based on the status of the knower from whom it was derived in the local communities. Thus, there is a need to consider all these socio-economic factors as they affect the sharing and distribution of knowledge in the communities for effective KM activities and sustainable agricultural practices.

### 6.4.4.2.4 Context and space

Effective knowledge creation, sharing and utilisation depend on an enabling context which is a shared space and time (Davenport and Prusak 1998; Ichijo 2007), or is often described as spatial school (Earl 2001) or *"ba"* [4] concept ( Nonaka, Toyama and Konno 2000) (see Section 3.3.2 of

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[4] *Ba* is defined as a shared context in motion, in which knowledge is shared, created and utilised. It is a concept that unifies physical space such as an office space, virtual space such as e-mail, and mental space such as shared ideals (Nonaka and Toyama 2003).

Chapter Three). The present study established that shared context or *ba* as proposed by Nonaka, Toyama and Konno's (2000) knowledge creation model was partially fulfilled in enabling farmers to create, share and apply knowledge for farming purposes in the surveyed communities. The majority of respondents shared their knowledge for farming purposes, 102 (56.4%), followed by political, 93 (51.4%), social, 81 (44.8%), and business purposes, 58 (32%). According to Nonaka, Toyama and Konno (2000), *ba* is identified in four categories, which include: originating *ba,* dialoguing *ba,* systematizing *ba* and exercising *ba* (see Section 3.3.2 of Chapter Three). The present findings illustrated that all four types of *ba* were practiced by the local communities to share knowledge for farming purposes, but the systematic and exercising *ba* were partially fulfilled.

Originating *ba* was commonly found in the local communities. Individual and face-to-face interactions amongst farmers and between farmers and knowledge intermediaries were common and occurred in a physical location. Farmers mainly met at their farm fields 45 (44.1%) to create, share and utilize knowledge. Other major places were homestead and village offices as shown in section 5.4.1.4.5.4. Farmers also communicated individually for agri-business purposes in the village markets, homesteads, NGO offices, open grounds, village offices, and cooperatives.

In dialoguing *ba,* the findings showed that the dialoguing *ba* existed in the surveyed communities. Collective and face-to-face interaction amongst farmers and knowledge intermediaries was common and occurred in a physical location. For farmer group meetings, evaluation and training, farmers mainly met at the farmer group, offices 20 (33%), followed by village offices, nine (15.3%) and church, eight (13.6%). Informal farmer groups mainly used groups members' houses and grazing fields to hold their meetings. However, formal farmer groups had more access to village facilities (such as, village and ward offices) than informal farmer groups. Most interesting of all was that the telecentres (that is, FADECO, KIRSEC) were not just providing ICT support services, but they were also important places for local farmers to socialize and create knowledge. Similar observations were made in other studies where telecentres organised community members into groups and provided a space where these groups

could meet to share knowledge on farming issues in China (Soriano 2007), Nigeria (Ha, Okigbo and Igboaka 2008), Tanzania (Chilimo 2008) and Uganda (Parkinson 2005).

Systematic *ba* was also found as indicated by the virtual interactions which were practiced at a low rate in the communities, as explained further in sections 6.9 and 6.10. Local farmers mainly shared their knowledge amongst each others or with the knowledge intermediaries through cell phones, while other ICTs such as email and electronic forums and explicit sources of knowledge such as books and newsletters were used at a low rate for farming purposes. Only a few farmers in Kilosa district used electronic forums to share their agricultural knowledge through KIRSEC (Kilosa Rural Services and Electronic Communication) telecentre.

Exercising *ba* occurred when local communities were able to apply both indigenous and exogenous knowledge from explicit sources of knowledge and ICTs (such as email, internet, books, newsletters, written notes from training) into their farming systems as explained in detail in sections 6.4.6, 6.6.3, 6.8.5, and 6.9.3. This knowledge enabled them to improve their productivity, increase income, and conserve their environment. However, the present findings showed that farmers applied knowledge received from tacit sources of knowledge (such as neighbour/family, and farmer groups) as compared to ICTs. Indications are that the oral communication channels were the major sources of knowledge in the surveyed communities as compared to explicit sources of knowledge and ICTs.

### 6.4.5 Preservation of agricultural indigenous knowledge

Similar to previous studies (Akiiki 2006:1; Campilan 2002; Mosia and Ngulube 2005; Wall 2006), IK was limited by knowledge loss due to the lack of prescribed structures and rules in the surveyed local communities to facilitate the preservation of knowledge as one would find in formal organisations. The present study showed that IK was largely transferred through oral traditions and demonstrations and preserved in human minds and thus it was disappearing at a high rate. Few respondents 24 (13.3% of 181 respondents) acknowledged preserving their agricultural IK. The written formats were the dominant method used by farmers to preserve agricultural IK, with a score of 21 (87.5%) respondents, followed by carvings, four (16.7%), and

still pictures, two (7.4%). Similarly, a study by Mearns and du Toit (2008) demonstrated that the extent of IK conservation at cultural villages was rated as fairly poor in South Africa. These findings from the present study and those from the literature call for a need to preserve knowledge by embodying within people's understanding, practices and awareness, and through the creation of explicit knowledge repositories as highlighted by Rowley's (2001) KM model. These KM interventions would enable the communities to learn from their own experience and that of others drawn from a wealth of tacit knowledge held in people's minds as well as updated explicit sources held in repositories.

### 6.4.6 Application of indigenous knowledge and technologies in the farming systems

The research findings demonstrated the position of various KM models that KM practices are neither complete nor successful if no efforts are made to ensure the use of stored and shared knowledge (Bouthillier and Shearer 2002; Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub, and Romhardt 2000; Rowley 2001; Small and Tattalias 2000). The study findings showed that most farmers 157 (86.7%) applied IK which was obtained from tacit and explicit sources of knowledge in their farming systems. These findings are consistent with the research results of Olatokun and Ayanbode (2008) who reported that the majority of women used IK to ensure food security 143 (62.8%) and improve their farming activities 101 (44.3%) in Nigeria. It is apparent that farmers rely on their IK to improve their agricultural practices in the surveyed rural societies.

The present study indicated that farmers applied indigenous techniques for crop husbandry, 99 (63.1%), new techniques and varieties, 40 (25.5%) and animal husbandry, 38 (24.2%). The least applied indigenous techniques were control of animal diseases, value added techniques, soil fertility, control of plant diseases and pests, agricultural tools and environment conservation. High use of crop husbandry techniques explains why intercropping and random sowing techniques were the dominant techniques applied by farmers despite their ineffectiveness for farming activities (see Section 6.3.2.2). On the other hand, low use of IK in the control of animal and plant diseases and value added techniques support the earlier findings in section 6.3.2 that

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farmers ignored their own knowledge system in these aspects in favour of conventional approaches.

The major reasons for applying IK were the effectiveness of the indigenous techniques 67 (42.7%) respondents, increased productivity 39 (24.8%), and no alternative in the form of other technologies 33 (21%). Further, IK was applied because its resources were available 29 (18.5%), cheap 24 (15.3%), were inherited technologies 15 (9.6%), a source of income 15 (9.5%), easy to use 10 (6.4%), and many other factors (see section 5.4.1.6). Akullo *et al.,* (2007) also reported similar results in a study to analyze the use of IK to improve agricultural productivity in Uganda. Kolawole (2004) also reported that Nigerian farmers used IK to conserve their soil because it was cheaper, economically advantageous, ecologically favourable and because of a lack of access to inorganic fertilizers. The use of local herbs was also contributed by their availability, safety and effectiveness in Uganda (Mugisha-Kamatenesi *et al.,* 2008). Indications are that local people tend to apply IK because it is the knowledge they are familiar with. These findings are in agreement with Lehaney's *et al.,* (2004:34) proposition that more often people choose to apply knowledge that they already agree with and that does not challenge their own assumptions. These findings were also in line with the process school of Earl's (2001) KM model which shows that access to relevant knowledge can enhance the performance of business and management processes in the organisations.

The major reasons provided by the farmers on the application of IK were also similar to the reasons provided by farmers who did not apply indigenous techniques (see section 5.6.14 and 5.6.1). On one hand, farmers applied indigenous techniques on some aspects of their farming systems due to effectiveness and increased productivity, and on the other hand, farmers did not apply indigenous techniques on some aspects of their farming systems due to low production and ineffectiveness as elaborated in Section 6.4.7. These findings show that IK may be effective for some farming activities such as manure, while it may also be ineffective for other farming aspects, such as random sowing.

The study findings were also in line with Probst, Raub and Romhardt's (2000) KM model which shows that the extent to which new knowledge is used depends on organisational blindness (that is, the more familiar and automatic the task is, the more difficult it is for individuals to recognise the importance of using new knowledge), fear of revealing one's own weakness, a general mistrust of outside knowledge, and the quality (that is, the potential benefits of using it), convenience of accessing it, and the media in which it is available. The findings of the present study also demonstrated what Rowley's (2001) KM model has indicated that knowledge may be used as the basis for developing new knowledge through integration, creation, innovation and extension of existing knowledge and/or it may be used as the basis for actions or decisions which impact on business performance. Through this process, individual knowledge is tested and validated.

**6.4.7 Non-application of indigenous knowledge and technologies in the farming systems**

The present findings showed that few respondents 69 (38.1% of 181 respondents) had not applied agricultural indigenous techniques obtained from explicit and tacit sources of knowledge in their farming systems. However, when compared to the non-application of exogenous knowledge in the farming system, the findings established that many farmers had not applied more IK, 69 (38.1%) in their farming systems than exogenous knowledge, 54 (29.8%). These findings confirm that IK is disappearing at a high rate, and thus it is important to acquire, share and preserve it before it is lost completely. This finding agrees with previous KM literature (Jashapara 2004:19; Lehaney *et al.,* 2004) that individuals selectively discard certain knowledge and retain only that which they consider important at the time.

The present study showed that more than half of the farmers 40 (58%) did not apply indigenous techniques on crop husbandry, followed by animal husbandry, 13 (18.8%), new varieties and techniques, 12 (17.4%), value added, 10 (14.5%), control of plant diseases, 2 (2.9%), control of animal diseases, 2 (2.9%), agricultural tools, 1 (1.4%) and soil fertility, 1 (1.4%). The major reasons for the non-application of agricultural indigenous technologies were low agricultural production 23 (33.3%), ineffectiveness of some indigenous techniques 21 (30.4%), difficulties in carrying out field operations 13 (18.8%), and land scarcity 8 (11.6%). Thus, farmers had stopped

using IK in their farming systems because it was not seen as effective in improving agricultural productivity.

Another reason for the non-application of agricultural indigenous technologies was the traditional beliefs and taboos, six (8.7%). These taboos affected the availability of labour in the farming systems and IK practices in the local communities. Those taboos included the following: women were prohibited from managing livestock and closing animal sheds in the Maasai ethnic group (Kilosa), the Maasai tribe were not allowed to keep poultry, and they were supposed to wash their hands with cow dung when assisting cattle during delivery. It was also very clear from previous studies that taboos and traditional beliefs limited farmers from practicing indigenous techniques in their farming systems in South Africa (Vorster, Stevens and Steyn 2008), and rural Uzbekistan (Wall 2006). These findings also indicate that not only does culture determine the use of IK, but also influences the extent to which one should have access and possess knowledge.

In some communities, poor recognition of IK, three (4.3%) was another reason that contributed to the non-application of IK in the farming activities. This finding illustrated what Probst, Raub, and Romhardt's (2000) KM model had emphasized that a psychological barrier may inhibit the use of new knowledge in the communities. Thus, just as people are willing to share their knowledge, they must also be prepared to use their knowledge. Other reasons for the non-use of IK in the farming activities were the unavailability of local inputs, lack of access to adequate information on indigenous techniques such as local herbs and many other factors (see Section 5.4.1.7). Similar findings were observed by Akullo *et al.,* (2007), who reported that there were no standardized measures for applying IK which discouraged the use of IK for farming activities in Uganda. In Swaziland, Dube and Musi (2002) also noted that IK was not used due to lack of access to knowledge, access to inappropriate technology, shortage of land, poor attitudes to IK, drought and lack of recorded IK. Other studies also reported the non-use of IK due to the environmental impact of some of its techniques such as field burning in Ghana (Chapman *et al.,* 2003) and Nigeria (Kolawole 2004). These findings indicate that the non-use of IK may be attributed to many factors, which may be cultural, personal, resource based and low productivity.

**6.4.8 The role of knowledge intermediaries in managing agricultural indigenous knowledge in the local communities**

Knowledge intermediaries form an important part in KM activities since they are not only involved in generating, organising and communicating information to the communities, but also in how information is interpreted and used to create new knowledge in the communities (Wolfe 2006). To draw conclusions on the IK management issues, it was pertinent to find out the role of knowledge intermediaries in managing IK in the local communities. The present findings showed that the knowledge intermediaries played a key role in transforming the farmers' tacit knowledge into explicit form, and sharing it back to the communities. This stage is also similar to what Nonaka and Takeuchi (1995) referred as externalization. According to Boateng (2006), incorporating farmers' tacit knowledge in the extension and research activities also represents a conceptual shift from knowledge as a 'thing or product' to be transferred top-down, to knowledge as a process involving multiple steps, players/actors, as well as networking and negotiations at various levels of managing knowledge for agricultural practice. Thus, the integration of indigenous and exogenous would be feasible.

The present study showed that the majority of knowledge intermediaries, 20 (80% of 25 respondents) were aware of farmers who possessed agricultural IK. It was also very clear from other studies that most knowledge intermediaries were aware of IK custodians. For instance, Ocholla and Dlamini (2007) found that the awareness of owners and/or sources of IK was significantly high amongst the knowledge intermediaries in South Africa. The findings of the present study also showed that most of the knowledge intermediaries, 18 (72%) consulted IK custodians to collect IK in the local communities. This finding is in conformity with the results of Ocholla and Dlamini (2007), who reported that more than half (76%) of the knowledge intermediaries in their study consulted IK holders in South Africa. These findings of the current study indicate that most knowledge intermediaries recognised the importance of capturing tacit IK and incorporating it in the extension and research activities for effective KM practices and knowledge integration processes in the surveyed local communities.

In this study, the major purpose for collecting IK was for extension services 12 (48%), followed by interest in managing IK, six (24%), research, six (24%), marketing agricultural inputs, four (16%), to raise the profile of IK, three (12%), and to purchase crop and animal produce, two (8%). Some of the major reasons were similar to another study conducted in South Africa which showed that knowledge intermediaries consulted IK custodians for historical purposes, research, interest in preserving IK, and to help the community to realise the importance of using IK (Ocholla and Dlamini 2007). These findings significantly show that there is an increasing interest in the management of IK amongst knowledge intermediaries, especially for extension and research purposes.

In the present study, most of the knowledge intermediaries captured IK on control of plant diseases, nine (50%). Other types of IK that were captured by the knowledge intermediaries were crop husbandry, value added, animal disease control, local crop varieties, soil improvement, and agro-forestry. The least cited IK types were credit, environmental conservation, and traditional irrigation system. These findings corroborate earlier findings in Section 6.3.1 that farmers had an extensive base of knowledge on the treatment of plant and animal diseases, and value added technologies.

The study findings also showed that the knowledge intermediaries acknowledged that not all types of IK were effective for improving agricultural performances, such as crop husbandry techniques (that is, random sowing). Instead, they captured some of IK in order to understand the local communities' knowledge system and advice them accordingly to improve their practices. These findings emphasize the importance of validating knowledge as indicated in various KM models (Earl 2001; Small and Tattalias 2000; Probst, Raub and Romhardt 2000). It is apparent from the study findings that knowledge intermediaries played a significant role in validating farmers' knowledge in the surveyed communities.

The study findings further indicated that more than half of the knowledge intermediaries, 15 (60%) disseminated IK in the local communities. The majority of the knowledge intermediaries used oral communication channels to disseminate IK in the communities (see Section 5.4.5.2).

Explicit formats were less used to disseminate IK in the local communities. These findings support the earlier findings in Section 6.4.2.1 that farmers mainly acquired agricultural IK through oral communication channels. Indications are that the oral medium is the major mechanism for disseminating agricultural IK since it is inherent to the indigenous culture and thus farmers are more likely to acquire and understand knowledge disseminated through this mechanism rather than in explicit formats as emphasized by the Merger model (Meyer and Boon 2003) (see Section 3.10.2 of Chapter Three).

On the effectiveness of oral communication channels in disseminating IK in the communities, the present findings revealed that half of the respondents ranked these channels as effective means for disseminating agricultural IK in the communities, with a score of seven (28%) and five (20%) in the effective and very effective categories. A study carried out by Ocholla and Dlamini (2007) showed that most 45 (57.6%) of the respondents strongly disagreed and/or disagreed that passing IK by word of mouth is a waste of time when compared to ICT tools, while 32 (41%) of the respondents strongly agreed and/or agreed with the same. These findings from the literature and the present study show that the oral communication channels are seen as effective ways to disseminate IK to the communities, while they may not be appropriate in other circumstances where ICTs can play a key role as suggested by Ocholla and Dlamini (2007).

The present findings also showed that few 10 (40%) knowledge intermediaries preserved IK in printed format due to various reasons, which included: lack of IK policy both at the national and institutional level, inadequate training in KM issues, and lack of funds and facilities. These findings suggest that not only was IK inadequately preserved by the local communities, but it was also stored at a low rate by the knowledge intermediaries in the surveyed communities.

## 6.5 Policies and legal framework relevant for the protection of agricultural indigenous knowledge in Tanzania

The study findings in this section are discussed in relation to the objective eight of the study, and data presented in Section 5.5 of Chapter Five. In general, various KM models have emphasized that not only should knowledge be governed by a strategy before detailed KM plans can be

made, but KM practices should be based on predetermined principles and strategies for effective KM activities in organisations (Davenport 1998; Earl 2001; Kruger and Snyman 2005; Small and Tattalias 2000). With regard to intellectual property rights (IPR), various KM models (Davenport 1998; Earl 2001; Probst, Raub and Romhardt 2000) have emphasized the importance of protecting and exploiting a firm's knowledge or intellectual assets to produce revenue streams. It is thus important to focus on the policies and legalities of KM if IK is to become a valued resource in the communities and effective for farming activities. The findings in this section are discussed according to the following themes: the need for establishing IK policy, current state of IPR in protecting agricultural IK in the country, and awareness of policies and IPR on IK issues in the local communities.

### 6.5.1 The need for establishing policy on indigenous knowledge

The present study findings support Kaiza-Boshe's (2003) observation that the IK does not receive adequate treatment in the entire policy framework in Tanzania. All IK policy makers reported that IK was covered by various sectoral policies, however these policies inadequately addressed IK issues. That is why the majority of knowledge intermediaries, farmers and policy makers agreed that it was important to establish policy that would deal with IK issues within the country. It is thus significant to establish IK policy, so that farmers' KM practices can be based on predetermined principles and strategies for effective KM activities in the country as already suggested by various KM models (Davenport 1998; Earl 2001; Kruger and Snyman 2005; Small and Tattalias 2000).

The study found that there were some initiatives on the ground to steer the establishment of an IK policy. These initiatives included the newly established committee under the Ministry of Trade, Industries and Marketing, and the IK trust fund (see Section 5.5.1.1). However, these initiatives had not managed to come up with a significant IK policy document for institutionalization in the country due to lack of political will, awareness, funds and poor coordination among the public and private actors that deal with IK issues. It is apparent that public and private partnership efforts are needed to foster the development of an IK policy in the country.

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In this study, both knowledge intermediaries and farmers indicated that it was important to establish IK policy in order to protect and preserve IK for future generations; to improve the use of IK because it was effective, affordable, and safe; improve IK sharing and agricultural production and many other factors (see Section 5.5.2 and 5.5.3). Similar to this study, Berckmoes (2008) examined the protection of IK in South Africa and found that IK holders were concerned about recognition of IK by government, their inclusion in knowledge development and dissemination or as "co-owners of patents", and preservation of IK and genetic resources for future generations. Indications are that it is important to establish a policy to guide the management of IK and access to it for future generations.

In this study, another reason for the establishment of IK policy was to recognise the vernacular languages in order to prevent loss of IK. IK is embedded in language, and its extinction is very easy as it is orally transmitted to other generations. A study carried out by Kamper (2006) revealed that indigenous languages in South Africa are endangered, particularly by the perceived status and utility value of English. According to Crystal (2000), about 80% of the world's 6000 living languages could disappear within the next century. In Tanzania, out of nearly 125 languages, nearly 70 percent are threatened (Mascarenhas 2003). It is thus important to establish IK policy to tackle language issues since IK is dependent on the use and development of indigenous languages.

### 6.5.2 The current state of intellectual property rights in protecting agricultural indigenous knowledge

In the present study, all IK policy makers acknowledged that IPRs were not effective to protect agricultural IK such as genetic resources and expressions of traditional culture. Similar to observations made by various studies (Appleton *et al.,* 1995; Brush 2005; Kargbo 2006:75; Kabudi 2000; 2004; Simeone 2004), the present study found that the IPR framework did not recognise the communal ownership of IK. Instead, they emphasized the protection of individual rights over IK, a concept which was derived from the western cultures.

IPR were weak in protecting IK due many reasons, such as poor recognition of IK in the current IPR such as plant breeders' rights (PBR), and the patent act. The findings of this study support Eyong's (2007) views that the protection of biodiversity without conserving associated knowledge systems is just a short-term sustainability solution, as future generations will not benefit from the centuries of experimentation and knowledge accumulation by indigenous peoples. In this study, the condition of novelty (must be new) required by patent law was also difficult for farmers to meet, which contributed to the failure of IPR to protect IK. Similar observations were also made in a similar study in Australia (Githaiga 1998). IPR were also weak in protecting IK due to the contradictions between IPR instruments. For instance, the patent act prohibited the registration of plant varieties under section seven, while the plant breeders' rights recognised the registration of plant varieties. Similar to Kabudi's (2004) observation, the study findings showed that the copyright and neighbouring act recognised only cultural expressions and folklore, instead of all IK issues. Other factors that contributed to the failure of IPR in protecting IK are illustrated in Section 5.5.1.2 of Chapter Five. The findings suggest the need for the government to review the current IPR in order to protect IK, which will enhance KM practices and agricultural production in the rural societies.

In the absence of effective IPR, other people (both local and international) had misappropriated IK under the auspices of intellectual property. These bio-prospectors had either commercialized or published some of the IK without any attribution, reciprocity, or benefit sharing with the local communities. For instance, in 2007, the plant *usambara* was patented in UK as a garden plant due to the weak plant breeders' rights in Tanzania. A traditional song owned by the Haya tribe in Karagwe which was called *Indega inaondoka* (aircraft is taking off) was also abused by the African Band in Tanzania (see Section 5.5.1.2). These findings were similar to research on 762 randomly chosen patents issued in the United States, where 49% of these were based on IK (UNU-IAS 2003). It is thus important to improve the existing IPR in order to protect IK from being misappropriated.

The findings from the present study showed that there were ongoing processes to review the industrial property rights which may incorporate IK issues, and to draft a bill for controlling the

access to and benefit sharing of genetic resources. However, this bill will not directly protect IK, instead it will help to protect genetic resources.

### 6.5.3 Awareness of the policies and intellectual property rights concerning indigenous knowledge in the local communities

The study findings indicated that there was low level of awareness of the IPR and policies on IK issues among farmers (5.5% of 181 respondents) and knowledge intermediaries (12% of 25 respondents) in the surveyed communities. Further, the findings showed that few communities had expressed their concerns with regard to the protection of their agricultural IK to the IPR related offices. According to the IK policy makers, most farmers did not raise their concerns with regard to the protection of their knowledge due to the lack of awareness on the importance of IPR and policies in IK issues, difficult conditions that one needs to attain to apply for IPR, and secrecy and lack of trust among farmers to share their knowledge. Lack of trust and unwillingness to share knowledge were also a major concern for IK holders in South Africa (Berckmoes 2008), and Central Africa (Eyong 2007). Although the conventional ways of disclosing tacit IK may be a challenge, the traditional ways of managing tacit IK may continue to encourage pharmaceutical companies to patent IK under the auspices of IPR. It is thus important to improve the existing IK policies and IPR to promote and protect IK for effective KM practices in the communities as emphasized by various KM models (Davenport 1998; Earl 2001; Probst, Raub and Romhardt 2000).

### 6.6 Access to agricultural exogenous knowledge in the local communities

The study findings are discussed according to the research objective five, which are based on data presented in section 5.6 of Chapter Five. The findings are discussed according to the following themes: tacit and explicit sources of exogenous knowledge in the local communities, the frequency of accessing exogenous knowledge, types of knowledge obtained from tacit and explicit sources, and the application and non-application of agricultural exogenous knowledge in the farming systems.

**6.6.1 Tacit and explicit sources of agricultural exogenous knowledge**

The study findings as in line with the KM process that deals with knowledge acquisition as indicated in various KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub, and Romhardt 2000; Rowley 2001) showed that farmers acquired exogenous knowledge from within or outside their communities to improve their farming activities. The study findings also demonstrated what Earl's (2001) KM model and Meyer and Boon's (2003) merger model have indicated that face-to-face communication is the major mechanism for accessing knowledge in the organisations and local communities because it is inherent to the indigenous culture. The findings indicated that informal and face to face contacts with friends/neighbours 132 (72.9%) and parents/family 103 (56.9%) were the major sources of agricultural exogenous knowledge in the local communities. The local sources of knowledge such as friends, neighbours, and family were also the primary sources of exogenous agricultural knowledge in other studies in developing countries, such as Ecuador (Bode, Victoria and Valencia 2008), Myanmar (Cho 2004), Peruvian Andes (Godtland *et al,.* 2004), and other African countries, including Eritrea (Garforth 2001), Ethiopia (Dixon 2002; Mariam and Galaty 1993), Kenya (Rees *et al.,* 2000), Nigeria (Adomi, Ogbomo and Inoni 2003), Tanzania (Matovelo, Msuya, and de Smet 2006), Uganda (Adupa and Düvel 1999; Campbell and Garforth 2001), and Zambia (Kalusopa 2005).

These findings also agree with others, for instance Leach (2001) and Kari (2007), who stated that the nature of information and knowledge required by rural communities is based on the oral tradition more than on the written word. These findings also support Hartwich's *et al.,* (2007) views that poor farmers, would not feel comfortable to absorb one type of knowledge promoted by a certain technology provider if they have not cross-checked its usefulness with other farmers, community members and authorities, other development agents and even with product buyers. Using data from several surveys in India, Foster and Rosenzweig (1995) pointed out that knowledge and information from neighbours on new agricultural technologies were as important as information from public extension services. The rationale here is that farmers try to reduce risk by contacting multiple sources of knowledge in order to trust a certain type of technology.

However, the study findings in respect of neighbours/friends were inconsistent with the research results by Opara (2008) which showed that neighbours/friends were not a major source of agricultural information and knowledge to the farmers they surveyed at Imo State in Nigeria. Farmers mainly accessed agricultural knowledge from extension officers (88.1%) and radio (63.2%). Similarly, a study by Banmeke and Olowu (2005) revealed that women farmers' information needs were mainly met by extension agents (90.5%), fellow women farmers (73.8%), neighbours/friends (70.9%) and radio (63.8%). Findings may vary due to different locations, the people, and other factors such as socio-economic, political and cultural contexts.

In this study, the extension officers were important sources of exogenous knowledge, though farmers were dissatisfied with the frequency of their interactions, as it was also found in Kenya (Rees *et al.,* 2000), Myanmar (Cho 2004), Nigeria (Adomi, Ogbomo and Inoni 2003), and Vietnam (Castella *et al.,* 2006). Agricultural input suppliers, village meetings, and farmer groups were important sources of agricultural exogenous knowledge in some regions. Cooperative unions and NGOs were significant sources of agricultural exogenous knowledge in those places that they were active as it was found in Kenya (Rees *et al.,* 2000) and Myanmar (Cho 2004). Explicit sources of knowledge with the exception of books had low use due to their unavailability and illiteracy. This finding is consistent with the research findings observed in Nigeria (Adomi, Ogbomo and Inoni 2003), South Africa (Mosia and Ngulube 2005), and India (Conroy *et al.,* 2004). In the present study, lack of access to printed materials, lack of a reading habit and financial ability to purchase those materials were the major reasons that limited farmers from using explicit sources of knowledge. Similarly, Mosia and Ngulube (2005) also found that literacy, language and technological barriers limited local people in accessing explicit knowledge on the management of estuaries contained in documents and databases. Thus, there are still gaps in access to exogenous knowledge and its integration into the communities' knowledge system which need to be strengthened.

The study findings showed that farmers had a wider range of sources to access exogenous knowledge rather than IK in the communities. Farmers accessed exogenous knowledge from a network that went beyond the confines of the communities, such as  explicit sources (newsletter,

posters, books, newspapers), local sources (farmer groups, village meetings, religious bodies), and formal sources of knowledge such as extension officers, cooperatives, researchers, agricultural shows, input suppliers, seminars and NGOs.

The present study found that there were significant variations in knowledge sources and media preferences between various locations. This finding was found to be similar to cases in other studies in Ethiopia (Mariam and Galaty 1993), Eritrea (Garforth 2001), Kenya (Rees *et al.,* 2000), India (Conroy *et al.,* 2004) and Uganda (Bagnall-Oakeley *et al*., 2004; Adupa and Düvel 1999). The findings suggest the need to have flexible KM strategies which can take account of such variations.

The findings also indicated that there were variations in sources of knowledge according to gender. The findings showed that males dominated most of the formal sources and explicit sources of exogenous knowledge, while female farmers relied on NGOs and local sources of knowledge (such as neighbours/friends and parents/family). Other studies also showed that women were frequently disadvantaged in accessing exogenous knowledge, such as studies in India (Conroy *et al.,* 2004), Nigeria (Adomi, Ogbomo and Inoni 2003), Uganda (Adupa and Düvel 1999), Zimbabwe (Mudege 2005). Illiteracy and cultural responsibility could be some of the factors which limited women to spare time for meetings and training to access exogenous knowledge.

## 6.6.2 Types of agricultural exogenous knowledge received

The type of exogenous knowledge received from various sources of knowledge in the communities was assessed to ascertain if farmers' information and knowledge needs were being met. The majority of the respondents obtained exogenous knowledge on new varieties and techniques from various sources of knowledge, followed by crop husbandry, control of animal diseases, animal husbandry, control of plant diseases, soil fertility, value added, marketing,  and other types of knowledge (see Section 5.6.1.2). The findings indicated that the exogenous knowledge received from tacit and explicit sources of knowledge was partially consistent with the farmers' needs as highlighted in section 6.4.1.1. The findings show that knowledge on

markets and credits was accessed at a low rate from the tacit and explicit sources of knowledge, although they were the farmers' major knowledge and information needs (see Section 6.4.1.1). The study findings demonstrate that it is imperative for knowledge intermediaries to determine farmers' information needs in order to disseminate relevant knowledge in the surveyed communities for effective KM practices as suggested by Probst, Raub and Romhardt's (2000) KM model.

### 6.6.3 The application of exogenous knowledge and technologies in farming systems

Although farmers had a wider range of sources to access exogenous knowledge than IK in the communities, they mainly applied IK in their farming system as compared to exogenous knowledge. The study findings established that the majority of the respondents 157 (86.7%) used IK received from tacit and explicit sources of knowledge more than exogenous knowledge 141 (77.9%) in the farming systems. It was evident from the present findings that farmers mainly applied exogenous knowledge on crop husbandry 87 (61.7%), and new varieties and techniques 50 (35.5%) as shown in section 5.6.1.4. This finding is in line with Probst, Raub, and Romhardt's (2000) KM model which emphasizes that most people tend to over-estimate their own skills or fear of losing their own expert status, which blocks the use of new knowledge. This finding also demonstrates what Davenport's (1998) KM principle has emphasized that "sharing and using knowledge may often seem unnatural acts". This means that the identification, sharing and distribution processes of agricultural exogenous knowledge do not guarantee that it will be utilised for farming activities, since farmers tend to believe in their own knowledge and skills over external knowledge.

On the other hand, the earlier findings showed that as farmers acquired more exogenous knowledge, they tended to ignore other knowledge modes including their own knowledge on some aspects of farming activities as illustrated in section 6.3.2 and 6.4.6. The study findings indicated that there was high use of conventional knowledge and techniques in the preservation of planting materials and crops, control of animal diseases and animal husbandry as compared to indigenous inputs and practices. Local inputs were mainly used in the improvement of soil fertility, acquisition of planting materials, crop husbandry, and control of plant predators as

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compared to conventional inputs. There is thus a need to find a healthy balance between ignorance concerning applying new knowledge on the one hand and excessive curiosity on the other as suggested by Probst, Raub, and Romhardt's (2000) KM model.

While some farmers applied exogenous knowledge because of improved agricultural production and the effectiveness of the techniques, other farmers applied exogenous techniques because they simplified their field operations; increased their income; enabled them to prevent soil erosion; ensured food security; and other factors (see Section 5.6.1.4). These findings show that the application of exogenous knowledge in the farming systems may also be linked to increased production and income, and lack of indigenous skills and resources. The findings also demonstrate what various KM models (Probst, Raub and Romhardt 2000; Rowley 2001) have indicated that the extent to which new knowledge is used depends on the quality, convenience of accessing it, and the media in which it is available.

## 6.6.4 The non-application of agricultural exogenous knowledge and technologies

The study findings indicated that few farmers 54 (29.8%) had not used exogenous knowledge and techniques from tacit and explicit sources of knowledge. The study established that the control of plant diseases and pests 31 (57.4%) was the main exogenous technique that was not applied by farmers on their farms, followed by improvement of soil fertility 19 (35.2%), new varieties and techniques 15 (27.8%), livestock husbandry 5 (9.3%), control of animal diseases 5 (9.3%), agricultural tools 5 (9.3%), crop husbandry and value added knowledge (5.6%). Despite the fact that knowledge on the control of plant diseases was their main knowledge need (see Section 6.4.1.1), the findings indicated that most farmers did not apply this technique to fulfil their needs. Farmers did not apply these exogenous techniques due to the high cost of agricultural inputs such as seeds, agricultural tools, pesticides, animal special supplements and fertilizers. Financial costs also restricted farmers from using improved seeds and fertilizers in other studies in Ethiopia (Dixon 2002), Nigeria (Adedipe, Okuneye and Ayinde 2004; Gana 2003; Kolawole 2004), Uganda (Mugisha-Kamatenesi *et al.,* 2008), and Zimbabwe (Mudege 2005). These findings show that farmers may not apply certain technologies to their farming systems even if they are relevant to their needs due to the high cost of inputs.

The toxicity and the hazardous effects of inputs (such as insecticides) on human health and the environment were other reasons for the non-application of exogenous techniques in farming systems in the local communities. Other studies also reported that many farmers did not use chemical fertilisers because they were harmful to the soil in Ghana (Chapman *et al.,* 2003) and Nigeria (Adedipe, Okuneye and Ayinde 2004; Gana 2003). Other reasons included the following: conventional techniques were labour intensive; the unavailability of inputs; the lack of a reliable market; and other factors as indicated in section 5.6.1.5. Similarly, Hart (2007) revealed that farmers used their IK to improve their vegetable production due to the absence of conventional inputs in Uganda. These findings indicate that farmers do not only apply exogenous knowledge due to psychological barriers, but also because of other factors such as cost, availability, access to knowledge, relevancy, hazardous effects, markets, and land scarcity which play a key role in influencing their decisions on adopting a certain agricultural technology. Thus, all these factors may contribute to farmer's decision to trust and apply their own knowledge and ignore external knowledge. The findings were also in line with Probst, Raub and Romhardt's (2000) KM model which shows that new knowledge may not be applied due to the organisational blindness and a general mistrust of outside knowledge.

### 6.6.5 The role of knowledge intermediaries in disseminating agricultural exogenous knowledge in the local communities

The present study indicated that more than half of the knowledge intermediaries, 15 (60%) used various means to disseminate agricultural knowledge in the local communities, while few knowledge intermediaries, nine (36%) had a follow up mechanism in their rural information and knowledge provision strategies. These findings show that knowledge providers disseminated exogenous knowledge to the local communities, without making follows ups on the usage of those technologies. These findings call into question Wolfe's (2006) view that knowledge intermediaries are not only concerned with the generation, interpretation, organisation and communication of information to the communities, but also with how information is interpreted and used to create new knowledge in the communities. These findings illustrate that knowledge intermediaries in the surveyed communities were more involved with information management than KM. These findings show that Davenport's (1998) KM principle was partially fulfilled

which emphasizes that knowledge is an asset, but its effective management requires the investment of other assets, such as knowledge capturing, repackaging, distribution, and use. Further, the findings showed that face-to-face communication was the dominant method used by intermediaries to disseminate and to make follow up on the adoption exogenous knowledge in the surveyed communities. These findings were in line with various models which emphasize that face-to-face communication is important in sharing knowledge as suggested by Earl's (2001) KM model and merger model (Meyer and Boon 2003).

## 6.7 The integration of agricultural exogenous and indigenous knowledge in the local communities

The study findings are discussed in relation to the research objective seven which sought to investigate the current approaches of integrating indigenous and exogenous knowledge in the local communities. The study findings of this objective are presented in Section 5.7 of Chapter Five, and they are discussed according to the following themes: the need to integrate indigenous and exogenous knowledge, the identification and prioritization of agricultural IK, farmers' information and knowledge needs in their rural KM strategies, and the role of knowledge intermediaries in integrating indigenous and exogenous knowledge in the local communities. The research findings from the local communities are discussed in sections 6.7.1, 6.7.2 and 6.7.3, while results from the knowledge intermediaries are interpreted in section 6.7.4.

### 6.7.1 The need to integrate agricultural exogenous and indigenous knowledge in the local community

Despite the fact that local people created and shared their knowledge to improve their knowledge system, the findings from the present study showed that the majority of the respondents 113 (62.4%) acknowledged that agricultural IK was not sufficient to solve some of their farming problems. High use of conventional knowledge and techniques in the preservation of planting materials and crops, control of animal and plant diseases and pests, and animal husbandry as illustrated in earlier findings (see Section 6.3.2 and 6.4.7) show that IK was not sufficient to solve these problems and thus local farmers had to use exogenous techniques to solve these problems. These findings corroborate the results of a study conducted in other developing

countries and Africa in particular that farmers' knowledge may not be sufficient, and may not be effective in solving all farming problems, such as in Eritrea (Garforth 2001), Indonesia (Jesajas and Packham 2003), Tanzania (Chilimo 2008) and Uganda (Akullo *et al.,* 2007). However, these findings from the present study and the literature should not be interpreted as indicating that exogenous knowledge is better than local innovation, but that it needs to be put into the local context to increase understanding and strengthen IKS as suggested by Millar and Curtis (1998).

Farmers' knowledge was not sufficient to solve their farming problems due to many factors such as low agricultural productivity; lack of proven scientific procedural explanations; ineffectiveness of some of the indigenous techniques; lack of IK records; poor recognition of IK in rural KM strategies and many other factors as shown in section 5.7.1.1. These findings indicate the need to integrate indigenous and exogenous knowledge in order to improve IK and agricultural performances as already highlighted by various sources in the literature (Behera and Nath 2005; Brodt 2001; Eyong 2007; Gorjestani 2000; Karlsson 1995; Mariam and Galaty 1993; Mchombu 2002; Meyer and Boon 2003; Millar 2004; Scoones and Thompson 1994a; Shiruma 2004). The study findings as in line with KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub and Romhardt 2000; Rowley 2001) showed that local communities need to access knowledge from within or outside their environment for effective KM processes.

The present study findings showed that most farmers 150 (82.9%) were willing to share their knowledge with the development agencies so that it could be improved for effective farming activities in the sample under investigation. Indications are that rural communities have now realised the potential of exogenous knowledge in the farming activities, and they are willing to strengthen their knowledge system by integrating it with exogenous knowledge for improved KM practices and their farming activities (see Section 5.7.1.1).

**6.7.2 Identification and prioritization of indigenous knowledge in the rural areas**

In this study, few farmers acknowledged that rural knowledge intermediaries interacted with them in an effort to identify their IK 52 (28.7%), and to prioritize their knowledge 42 (23.2%) when developing and disseminating their agricultural technologies in the surveyed communities.

Similarly, Apantaku, Oloruntoba and Fakoya (2003) found that the level of farmers' involvement in agricultural problems identification and prioritization was low in Nigeria, which shows that the knowledge intermediaries inadequately involved farmers when identifying and prioritizing their knowledge and their needs. The findings of the present study corroborate earlier findings (see Sections 6.4.6 and 6.6.3) that most farmers applied IK as compared to exogenous knowledge in their farming systems due to the fact that their knowledge was inadequately incorporated in the exogenous knowledge system. Thus, these study findings were in line with Boateng's (2006) circular KM model which emphasizes that knowledge intermediaries should recognise and identify farmers' knowledge to enhance the integration of indigenous and exogenous knowledge systems in the surveyed communities.

In the IK identification, the study findings showed that the public extension officers 44 (84.6%) were the main knowledge intermediaries that had identified farmers' knowledge, followed by NGOs 11 (17.3%), and researchers 6 (11.5%). Personal visits were the most dominant approach used by knowledge intermediaries to identify farmers' IK, followed by farmer groups, seminars, demonstration plots, farmer field schools, and exchange visits (see Section 5.7.1.2). IK was identified through personal visits when farmers sought for knowledge regarding their farming problems from intermediaries, or when the intermediaries visited individual farmers to advise them in various farming issues especially the public extension officers. The findings indicated that the participatory approaches had already been introduced, and intermediaries (extension officers, researchers and NGOs) used these approaches to identify and prioritize IK in the surveyed communities, but at a low rate. Despite the fact that the knowledge intermediaries have become so responsive to farmer's demands in the surveyed communities through participatory approaches as indicated in the study findings, the public extension and research services were characterised by inadequate funds and fewer researchers and extension agents were available to engage in participatory research with smallholder farmers. Similarly, Isinika (2000) and Rutatora and Mattee (2001:164) also highlighted problems in operationalizing participatory approaches in Tanzania, that most public extension staff were deficient in participatory problem-solving skills, and thus some elements of training and visit training were there.

Previous studies in developing countries have shown that collective interactive approaches such as participatory approaches can be effective ways to integrate indigenous and exogenous knowledge systems in the local communities. A study on the use of participatory approaches to combine indigenous and exogenous knowledge indicated that Indonesian farmers were eager to learn and understand some agricultural science principles and were willing to re-adjust their understanding of their social reality, as long as it was not beyond their capacity to learn through their collective consciousness (Jesajas and Packham 2003). Another study in Kenya showed that it was possible to have a constructive fusion of external and indigenous sources of knowledge in the communities through farmer field schools. Farmers showed a higher level of adoption when new technology options were introduced by other farmers (Duveskog, Mburu and Critchley 2002). The fundamental view grounding KM perspectives is that no one individual can possess all the necessary knowledge, and thus a group or community, where knowledge is naturally distributed, becomes an effective mechanism for integration (Munkovold 2006). Thus, the recognition and identification of farmer innovators and involving them in the collective interactive approaches such as participatory techniques can be effective ways for integrating indigenous and exogenous knowledge in the local communities.

In the prioritization of IK, despite their infrequent interaction with the extension officers, farmers still considered extension officers as the major knowledge intermediaries that prioritized agricultural IK in their rural knowledge and information provision strategies, followed by NGO and researchers in the sample districts. The evidently high importance of extension officers in identifying and prioritizing farmers' IK implied the need to strengthen public extension officers by increasing the number of extension officers, with adequate training, facilities, and linkages. The findings further showed that the intermediaries mainly prioritized IK on the use of herbs to treat animal and plant diseases, crop and animal husbandry practices, seed varieties, improvement of soil quality, and environment conservation. These findings relate to those on the types of IK that knowledge intermediaries captured in the local communities as illustrated in section 6.4.8. It is evident from the findings that high value was placed on the indigenous techniques of controlling of plant and animal diseases, and crop husbandry by most of the knowledge intermediaries in order to understand and improve them when necessary.

### 6.7.3 Identification and prioritization of knowledge and information needs in the rural areas

The findings again highlight that knowledge intermediaries interacted inadequately with farmers in their effort to identify farmers' information and knowledge needs. Few respondents 56 (30.9%) indicated that knowledge intermediaries interacted with them in an effort to determine their information needs. Public extension officers were the major knowledge intermediaries who determined farmers' needs, followed by NGOs and researchers. Public extension officers mainly used personal visits, followed by farmer groups and demonstration plots, while NGOs used farmer groups, demonstration plots and personal visits. Researchers mainly used farmer groups. These findings indicate that the use of individual and collective interactions were still prevalent in the identification of farmers' needs.

The study findings showed that a low number of knowledge intermediaries prioritized farmers' information needs. Few farmers 51 (28.2% of 181 respondents) reported that knowledge intermediaries prioritized their information needs in their KM strategies. Similarly, Apantaku, Oloruntoba and Fakoya (2003) found that only 37.27% of the 220 farmers indicated that the disseminated agricultural technologies were based on their identified problems and felt needs in Nigeria. An ethnographic study on the knowledge production and dissemination in Zimbabwe also concluded that extension services need to be structured in such a way that they address problems as defined by farmers, instead of addressing problems as defined by experts (Mudege 2005). It is thus important for the knowledge intermediaries to disseminate knowledge according to farmers' needs for effective adoption of the conventional technologies to enable the fusion of indigenous and exogenous technologies in the communities.

### 6.7.4 The role of knowledge intermediaries in integrating agricultural exogenous and indigenous knowledge in the local communities

This section discusses findings from the knowledge intermediaries as according to the following themes: involvement of farmers in agricultural technology development and dissemination, prioritization of agricultural IK and the identification and prioritization of farmers knowledge needs by the knowledge intermediaries.

**6.7.4.1 Involvement of farmers in agricultural technology development and dissemination**

Although findings from farmers indicated that knowledge intermediaries inadequately identified their IK, the findings from knowledge intermediaries showed that more than half of the knowledge intermediaries involved farmers when developing agricultural technologies, 14 (56% of 25 respondents). Lack of adequate resources (such as farm inputs), refresher training courses and the limited number of extension officers inhibited knowledge intermediaries from being able to involve all farmers in technology development. It is thus important to increase the number of extension officers with adequate resources and training in the local communities. The findings further showed that the knowledge intermediaries mainly used demonstration plots and farmer groups, accounting for four (28.6%) of the respondents each. Other methods were farmer field schools, three (21.4%), seminars, three (21.4%), on farm trials, two (14.3%), personal visits, two (14.3%), and farmer forums, one (7.1%). Indications were that farmers were involved in the technology development through collective and participatory approaches which are effective ways to incorporate farmers' ideas and knowledge into the extension services as suggested by the Boateng's (2006) circular KM model.

Almost half of knowledge intermediaries 12 (48%) involved farmers in the dissemination of agricultural technologies in the local communities. The research findings established that demonstration plots and farmer-to-farmer promotion approaches were the main methods used by knowledge providers to involve farmers in technology dissemination, with a score of four (33.3%) respondents each. Other methods were farmer field schools, farmer groups, and training, and other strategies as shown in Section 5.7.2. Indications are that farmer-to-farmer promotion and other participatory approaches can be effective ways to integrate exogenous and indigenous knowledge in the communities since farmers tend to easily accept new knowledge if they receive it from their fellows. However, it is important to equip the knowledge intermediaries with adequate facilities, funds and training for effective dissemination of agricultural technologies in the communities.

**6.7.4.2 Prioritization of agricultural indigenous knowledge**

In the prioritization of IK, the study findings confirmed that few knowledge intermediaries, 11 (44%) prioritized farmers' IK in their rural information and knowledge provision strategies. The demonstration plots, 6 (54.5%) were the main methods used by knowledge intermediaries to prioritize IK. Other methods were seminars, four (36.4%), researchers, four (36.4%), farmer groups, four (36.4%), and farmer field schools, three (27.3%), and many other approaches as shown in Section 5.7.2. These findings concur with the earlier findings from the local communities that few knowledge intermediaries prioritized agricultural IK (see Section 6.7.2). These findings indicate a need to prioritize farmers IK in order to improve ways of integrating farmers' knowledge with exogenous knowledge for effective KM practices as suggested by the Boateng's (2006) circular KM model.

**6.7.4.3 Knowledge and information needs assessment in the rural areas**

The study findings indicated that the majority of the knowledge intermediaries, 19 (76%) determined farmers' knowledge needs, while more than half of the respondents, 14 (56%) prioritized farmers' knowledge and information needs in their rural knowledge provision strategies. Personal interviews 13 (72.2%) were the dominant approach used by the respondents to determine farmers needs, followed by farmer groups, four (22.2%), training needs assessment, four (22.2%) and other methods as shown in Section in 5.7.2. Most of the knowledge intermediaries, 18 (72%) reported that it was important to identify farmers' needs when carrying out their extension services in the surveyed communities. It was evident from the findings that slightly more than half of the knowledge intermediaries, 13 (52%) thought that they satisfied their users' needs, while 12 (48%) did not. This finding shows that there is a growing interest on the part of knowledge intermediaries to assess farmers' needs and disseminate relevant knowledge in the communities.

On the whole, the findings show that knowledge intermediaries used participatory methods, which were collective and interactive approaches to learn about farmers' knowledge and their needs. However, the findings from the local communities showed that farmers were not satisfied with the level of their interaction with the intermediaries in an effort to identify and prioritize

their knowledge and needs. There is thus a need for knowledge intermediaries to be more active in interacting with farmers in an attempt to identify their knowledge and needs for effective integration of indigenous and exogenous knowledge systems. It is thus important for both farmers and knowledge intermediaries to respect, appreciate and recognise each others' potential, expertise and knowledge, to enable the linkages between indigenous and exogenous knowledge systems.

## 6.8 The role of ICTs in managing agricultural indigenous knowledge

This section discusses study findings of the research objective four which sought to determine the role of ICTs in managing agricultural IK in the local communities. The study findings of this objectives are discussed in relation to the KM processes as presented by various KM models (see Section 3.3.2 of Chapter Three), and data presented in Section 5.8 of Chapter Five. Various KM models (Bouthillier and Shearer 2002; Davenport 1998; Earl 2001; Kruger and Snyman 2005; McAdam and McCreedy 2000; Nonaka and Takeuchi 1995; Probst, Raub and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) have indicated that ICTs are significant in KM since they allow the movement of knowledge at increasing speeds and efficiencies, and thus facilitate sharing as well as the accelerated growth of knowledge. This section therefore discusses the role of ICTs in the acquisition, sharing, preservation and use of agricultural IK by farmers, and the role of knowledge intermediaries in managing agricultural IK in the local communities.

### 6.8.1 The acquisition of agricultural indigenous knowledge through ICTs

The study found that farmers rely more heavily on person-to-person communication than ICTs for acquiring IK, although ICTs were already in existence in the surveyed villages. The study findings showed that almost half of the respondents 82 (45.3%) had used ICTs to acquire agricultural IK. This finding is probably due to lack of awareness, culture and skills on how to use advanced ICTs such as internet, and cell phones. Other factors may also contribute, which include poor ICT infrastructure in the rural areas, lack of local content in ICTs, the language barrier, lack of electricity and financial capability to purchase ICTs. Despite the fact that the Tanzania ICT policy recognises the importance of documenting local content, little has been done to build the capacity of the local communities to document their own knowledge via ICTs.

Thus, whilst developments in ICT have enabled access to IK, the digital divide is still prevalent in the surveyed regions despite the fact that the study was carried out in those areas which had ICTs. These findings were in line with various KM models (Bouthillier and Shearer 2002; Davenport 1998; Earl 2001; Kruger and Snyman 2005; McAdam and McCreedy 2000; Probst, Raub and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) which emphasize that people should be central to any technological intervention in KM.

It was evident from the findings that radio 73 (89%) was the predominant tool used by farmers to acquire IK in the surveyed communities. Radio was more likely to have high use due to low cost, use of local languages, as well as being an appropriate tool that fulfills farmers' needs. For instance, the study findings showed that about 70% of the content of FADECO community radio in Karagwe was focused on agricultural issues. Similar to previous studies, Akullo *et al.,* (2007) found that radio programmes were the major ICT channel used by farmers to acquire agricultural IK in Uganda.

The study findings also showed that cell phones 39 (47.6%) were becoming an important communication medium for accessing agricultural IK mainly due to high ownership in the surveyed communities. This finding, however, is not in complete agreement with the findings of Souter *et al.,* (2005) who reported that telephone had not had any impact on knowledge acquisition in the rural societies of India, Mozambique and Tanzania. The reasons for this inconsistency appear to be varied levels of development for the surveyed villages, and penetration of ICT infrastructure. The findings of the present study established that cell phones enabled farmers to communicate amongst each other, or with the knowledge intermediaries to acquire agricultural indigenous techniques in the surveyed communities (see Section 6.8.2 and 6.8.3).

The present study showed that television 30 (36.6%) had moderate use in the local communities which shows that there is increasing use and trust of TV broadcasts. However, television did not receive high use as compared to radio probably due to high cost, lack of electricity power, inadequate local content in agricultural IK, and lack of a community television which could

focus on the community's needs. Nevertheless, lack of TV did not limit most farmers from accessing IK. Most farmers accessed agricultural IK from their neighbours' TVs or through kiosks where they had to pay to enter.

However, the study findings established that there was low use of email and internet to acquire agricultural IK, in spite of the availability of internet facilities in the surveyed communities. It was also very clear from other studies that internet use was not very common, and did not have any significant effect on knowledge acquisition in the rural populations of India, Mozambique and Tanzania (Souter *et al.,* 2005), the rural areas of Tanzania (Chilimo 2008), and rural and urban areas of India and Nepal (Pigato 2001). Nevertheless, a study by Ha, Okigbo and Igboaka (2008) in Nigeria established that telecentres could help to make knowledge flow from the local communities outward (indigenous practices) and from the global community inward (exogenous practices). It is thus important to create relevant knowledge and information services at the telecentres, and to promote the use of telecentres, in order to improve the management of IK in the local communities.

There were no differences with respect to the use of ICTs to access IK in the sampled districts. However, there were variations with regard to the use of ICTs to access agricultural IK by gender. The research findings showed that male farmers dominated the use of cell phones, 30 (55.6%) and television, 20 (37%) to acquire agricultural IK in the local communities. Further, cultural responsibility in agriculture and housekeeping activities and the low status accorded to women limited most women in accessing television from social clubs or their neighbours to acquire agricultural IK. Similary, a study in Bolivia found that the participation of women was low (30%) in the ICT projects which had been intended to enhance the exchange of experiences of small farmers producing ecological products (IICD 2008). It is obvious that the gender digital divide is still prevalent, where the share of female users is considerably lower than males in the use of ICTs to access IK in the local communities.

There were also age differences in the use of ICTs to access agricultural IK in the rural communities. The present findings showed that the percentages of young farmers between the

age of 26 and 35 was higher regarding the use of ICTs to acquire IK than other age categories, which include radio 19 (26%), television 11 (36.7%), cell phone 13 (33.3%), internet 5 (100%) and email 3 (50%). Low level of ICT literacy, awareness and cultural barriers limited elderly farmers from using ICTs especially internet and email to access knowledge.

**6.8.2 The types of agricultural indigenous knowledge received from ICTs**

The study findings indicated that new varieties and techniques were the dominant types of IK accessed by farmers through ICTs, followed by knowledge on crop and animal husbandry, and soil fertility (see Section 5.8.1.3). The findings indicated that the IK received from ICTs was not consistent with the farmers' needs as highlighted in section 6.4.1.1. Farmers mainly accessed IK on new varieties and techniques, crop husbandry practices, and soil fertility from ICTs, which did not cater for their major knowledge needs which were control of plant diseases, marketing and credit. However, these findings indicated that there were similarities between IK received from ICTs and that obtained from tacit and explicit sources of knowledge in the communities. The findings revealed that IK on new varieties and techniques and crop husbandry obtained from ICTs was also the dominant knowledge types received from tacit and explicit sources of knowledge in the communities.

The findings showed that radio was mainly used to disseminate IK on new varieties and techniques, crop husbandry, and other types of IK as shown in Section 5.8.1.3. Further, cell phones were used to disseminate IK on crop husbandry and animal husbandry. For instance, cellphones were used by Maasai pastoralists to contact livestock headers to inquire about an appropriate location for pasture and safe drinking water at Twatwatwa Village, in Kilosa. Similarly, Jallov (2007a) reported the use of cell phones by Maasai pastoralists to share information about water sources for animals in Arusha, Tanzania. On the other hand, television was mainly used to disseminate IK on new techniques, followed by crop husbandry, soil fertility and animal husbandry. The use of internet and email for IK acquisition was generally not a common practice. Advanced ICTs such as internet and email were used by farmers to acquire effective IK on new techniques. For instance, knowledge intermediaries (such as NGOs) enabled farmers to acquire effective indigenous techniques for controlling plant diseases from research

institutes. These findings indicate that ICTs, especially radio and cell phones, can play a key role in equipping farmers with relevant IK, while capacity building programmes and a knowledge culture are needed to enable the communities to fully exploit advanced ICTs (such as internet and email) to access IK in the rural areas.

### 6.8.3 The sharing of agricultural indigenous knowledge through ICTs

ICTs were less used to share agricultural IK in the communities, in spite of their availability in the surveyed communities. The study findings as in line with various KM models and the related literature showed that it is people who turn knowledge into timely and creative decisions, although ICTs can process and transfer information and knowledge (Awad and Ghaziri 2004:13; Brown and Duguid 2000; Davenport 1998; Earl 2001; Kaniki and Mphahlele 2002:7; Kruger and Snyman 2005; Lwoga and Ngulube 2008; Wiig 2004). The study findings showed that few farmers 34 (18.8%) had used ICTs to share IK. Most farmers 32 (94.1%) had used cell phones to share IK, while email and radio were less used to share IK. Local villagers had limited access to personal telephones, faxes, computers and other modern communication means. These findings show that knowledge culture, capacity building pragrammes and improved infrastructure are important aspects for improving the use of ICTs for sharing IK in the surveyed communities.

### 6.8.4 The preservation of agricultural indigenous knowledge through ICTs

There was low use of ICTs to preserve agricultural IK in the sample under investigation. Only two (1.1%) of the 181 respondents acknowledged of using ICTs to preserve their IK. These respondents used personal computers, cell phones, audio cassettes, and email. In actual fact, the use of ICTs to preserve IK was related to the education status of the respondents. The findings showed that of the farmers who had sought to preserve IK, one farmer had attained secondary education, and the other farmer had a University Bachelor's degree. However, a research project in Bolivia showed that it is possible for farmers to document their knowledge and experience themselves, provided guidance and capacity development in the use of audiovisual means are given (IICD 2008). In Tanzania, Lwoga and Ngulube (2008) demonstrated that IK can be documented by the local people and disseminated through telecentres and online databases. Similar observations were made by the Honey Bee Network in India (SRISTI 2001), and the

Orkonerei community radio in Tanzania (Jallov 2007b). It is thus possible for small scale farmers in the surveyed communities to document and share their knowledge if they are guided and empowered.

### 6.8.5 The application of the agricultural indigenous knowledge through ICTs

There was low use of agricultural IK which was received from ICTs. The study findings established that the majority of the respondents applied IK, 157 (86.7%), received from tacit and explicit sources of knowledge in the farming systems, as compared to the IK received from ICTs 18 (9.9%). The majority of the respondents used IK on animal disease control 10 (33.3%) and animal husbandry 10 (33.3%), followed by new varieties and techniques 5 (16.7%), and soil fertility 5 (16.7%). Despite the fact that knowledge on animal disease control was less disseminated through ICTs, most farmers seemed to use this technique because it was among the major knowledge type needed in the communities.

IK received from ICTs was adopted in the farming systems due to increased production and income 25 (83.3%). Farmers improved their productivity due to the use of radio, television and cell phones. The simplicity and availability of indigenous technologies and inputs that were disseminated through radio were other reasons for adopting indigenous technologies in local communities. Similarly, IICD (2008) reported that almost 50% of the small farmers producing ecological products perceived a direct improvement in their income after they had used ICTs to exchange their experiences in Bolivia. It is thus important to foster a knowledge culture, and capacity building programmes in the communities in order to increase the use of ICTs in managing IK since they can play a key role in improving farming activities.

### 6.8.6 The role of knowledge intermediaries in managing agricultural indigenous knowledge through ICTs

The study findings showed that low number of knowledge intermediaries used ICTs to acquire, share and preserve agricultural IK in the surveyed communities. Few knowledge intermediaries (40% of 25 respondents) used ICTs to capture agricultural IK in the communities. Most knowledge intermediaries, six (60%) used cell phones to capture IK from the local communities,

followed by digital photographs and the internet, with a score of five (50%) respondents each. Other ICTs were video and audio cassettes. The findings suggest that the level of utilisation of these ICTs by knowledge intermediaries was rather limited probably due to lack of facilities, funds, ICT training and skilled personnel. Most knowledge intermediaries preferred to use oral communication channels as compared to ICTs, since the oral medium is more inherent in the indigenous communication approaches as emphasized by the Merger model (Meyer and Boon 2003) (see Section 3.10.2 of Chapter Three). Although face-to-face communication facilitates good understanding of knowledge to be shared and distributed, Mosia and Ngulube (2005) cautioned that it is slow and requires a lot of time of interaction for it to be effective.

Similar, the study found that few knowledge intermediaries (36% of 25 respondents) used ICTs to preserve agricultural IK. Personal computers nine (47.4%) were the main ICTs used to preserve IK, followed by email, cell phones, and CDs, while the radio and video cassettes were less used. A study by Ocholla and Dlamini (2007) in South Africa also showed that computers were the major ICTs used by knowledge intermediaries to preserve IK, followed by databases, internet and video cassettes. Indications are that computers play a key role in preserving IK, while the internet and used databases are still at infancy stages for preserving IK in the surveyed communities.

There was also low use of ICTs to disseminate agricultural IK in the local communities. Eight (32%) knowledge intermediaries used ICTs to disseminate agricultural IK in the local communities. Radio was the main ICT used by knowledge intermediaries to disseminate agricultural IK in the communities, accounting for four (16.7%) respondents. Other major ICTs were land-line phones, internet, email, and television, while film shows, cell phones, video cassettes and CDs were the least used ICTs. In South Africa, Ocholla and Dlamini (2007) also revealed that computers were the major ICTs used by knowledge intermediaries to disseminate IK, followed by land-line phone, radio and television. These findings show that the oral media are important in disseminating IK to farmers, since they are inherent in the indigenous communication channels that the local communities are familiar with.

The study findings showed that most knowledge intermediaries ranked ICTs as effective tools for acquiring, preserving and disseminating agricultural IK. These results indicate that if the knowledge intermediaries are equipped with adequate ICT training, staff and equipments, they may be able to use ICTs to manage agricultural IK in the communities. The effective use of ICTs in this regard would prevent the disappearance of IK through IK holders' death or memory lapses which are common amongst farmers in the sample districts.

## 6.9 Access to agricultural exogenous knowledge through ICTs in the local communities

The study findings in this section are presented according to the research objective six that focuses on the role of ICTs in providing access to agricultural exogenous knowledge in the local communities. This section discusses the following themes: access and use of agricultural exogenous knowledge through ICTs in the local communities, and the role of knowledge intermediaries in disseminating agricultural exogenous knowledge in the local communities based on data presented in Section 5.9 of Chapter Five.

### 6.9.1 Use of ICTs to access agricultural exogenous knowledge

The study findings as in line with KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub, and Romhardt 2000; Rowley 2001) showed that farmers acquired knowledge from within or outside their communities to improve their farming activities. The findings showed that there was a higher use of ICTs to access agricultural exogenous knowledge 161 (89%) than IK 82 (45.3%) in the surveyed local communities. These findings indicate the predominance of the exogenous knowledge system over IK in the surveyed communities as suggested by various studies (Ngulube 2002). These findings also confirmed earlier findings in section 6.6.1 and 6.4.2.1 that farmers had a wider range of sources for accessing exogenous knowledge as compared to IK in the surveyed communities, which included explicit sources (newsletter, posters, books, and newspapers), and formal sources of knowledge such as extension officers, cooperatives, researchers, agricultural shows, input suppliers, seminars and NGOs. This finding is however not in complete agreement with the findings of Shoki (2004), who reported that farmers were not aware of any ICTs that provided access to agricultural information and knowledge at the Karagwe district in Tanzania. The reasons for this divergence could be due to

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slight variations in the state of development per village including road and ICT infrastructure and the presence of active knowledge intermediaries such as extension officers, and NGOs.

It was evident from the present findings that radio 155 (96.3%) was a major ICT used by farmers to access agricultural exogenous knowledge on farming systems in the local communities. Similar findings were observed in other studies in African countries such as Ghana (Chapman *et al.,* 2003), Nigeria (Ha, Okigbo, and Igboaka 2008; Kolawole 2004; Fawole 2008), South Africa (Bembridge and Tshikolomo 1998), Uganda (Bagnal *et al.,* 2004; Campbell and Garforth 2001) and Zambia (Kalusopa 2005). The study findings also corroborate findings from other studies in developing countries such as India (Conroy *et al.,* 2004), Nepal and India (Pigato 2001). The findings from the present study and the literature suggest that radio is an appropriate channel for accessing exogenous knowledge for large numbers of farmers in the rural areas probably due to its oral nature, low cost and its independence of electricity. The study findings also indicate that the mass media and interpersonal channels are the major sources of exogenous knowledge in the local communities.

The study findings showed that cell phones, 71 (44.1%) were also becoming important ICTs for rural farmers to seek advice regarding their farming problems (such as animal and plant diseases, and technical details of farming) from knowledge intermediaries, farmer group members and village leaders. High use of cell phone was attributed to the mobility, ease of use, flexible deployment, and relatively low and declining rollout costs of wireless technologies as was suggested by Khalil, Dongier and Qiang (2009).

The study findings also indicated that television, 64 (39.8%) was also an important ICT used by farmers to access exogenous knowledge in the surveyed villages. Similar observations were made in other studies that apart from radio, television was also the principal ICT used by farmers to access agricultural information and knowledge in the rural areas, such as India (Conroy *et al.* 2004), Nepal and India (Pigato 2001), Nigeria (Kolawole 2004), and Uganda (Campbell and Garforth 2001). However, the impact of television on providing access to exogenous knowledge could be enhanced if access to power was improved in the rural areas as already highlighted in

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the other studies in Mozambique (Batchelor, Scott and Eastwick 2005). Television has more advantages than radio due to its audio-visual nature and thus it can be an effective tool to disseminate exogenous knowledge in the local communities.

Despite the introduction of community telecentres in the surveyed communities, this study revealed that few farmers used email 12 (7.5%), and internet 9 (5.6%) to access exogenous knowledge. Similar findings were reported in other studies that few farmers had used internet and email services for knowledge acquisition, such as India and Nepal (Pigato 2001), India, Mozambique and Tanzania (Souter *et al.,* 2005), Nigeria (Adomi, Ogbomo and Inoni 2003; Ha, Okigbo and Igboaka 2008), Tanzania (Chilimo 2008), and Uganda (Aregu, Bagaya and Nerbonne 2008). In this study, other ICTs such as film shows, eight (5%), and video cassettes, six (3.7%) were used at a low rate to access exogenous knowledge in the local communities. Similar observations were made in Uganda (Campbell and Garforth 2001). Thus, any initiative that needs to invest in the rural knowledge management should focus on the use of radio and cell phones to provide adequate access to knowledge in the local communities. The use of new ICTs such as internet and email for disseminating agricultural exogenous knowledge is still yet to be realised.

There were no differences with respect to the use of ICTs to access exogenous knowledge in the sampled districts. However, there were gender differences on the use of ICT services to access exogenous knowledge in the surveyed regions. The present study indicated that a higher percentage of male farmers accessed exogenous knowledge from ICTs than female farmers in the local communities, which included radio 104 (98.1%), cell phones 49 (46.2%), and television 44 (41.5%). The situation among rural farmers in the surveyed regions of Tanzania is not very different from that of other farmers in rural areas of Africa in particular and developing countries in general. A study of thirty-five ICT projects over six years in nine countries in Africa and Latin America indicated that 30% of the users were female, while 70% were male (IICD 2006). Similar observations were made in Canada (Greyling and Smith 2008), India (Conroy *et al.,* 2004; Meera, Jhamtani and Rao 2004:6), Uganda (Campbell and Garforth 2001), and Tanzania (Chachage 2001; Chilimo 2008; Furuholt and Kristiansen 2007). These findings indicate that the

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gender digital divide is still prevalent in the sample under investigation, other rural areas of Tanzania and in other developing countries as well.

The study findings showed that there were age differences in the use of ICTs in the sampled districts. The present study indicated that the percentages for the younger farmers aged between 26 and 35 years were relatively higher in the use of ICTs to access exogenous knowledge than for elderly farmers. ICTs used included cell phones, 16 (22.5%), internet, five (55.6%) and video cassettes, three (50%). There was not so much difference in the use of radio to access exogenous knowledge across various age categories. These findings concur with a study by Chilimo (2008) which analyzed the use of four telecentres in Tanzania, and reported that most telecentre users were between the ages of 18 to 35 years. Greyling and Smith (2008) also found that the ICT services at information kiosks were mostly used by people in the age group 10 to 26 years in South Africa. Similar observations were made by other studies in Tanzania where most of the ICT users especially internet, were generally young (Chachage 2001; Furuholt and Kristiansen 2007; Mercer 2005:250). These findings indicate a need for fostering a knowledge culture, and establishing capacity building programmes in order to encourage elderly farmers to use ICTs especially the advanced ICTs such as internet and email in the sampled districts, and in other African countries as well.

### 6.9.2 The type of agricultural exogenous knowledge received through ICTs

The findings indicated that the majority of the respondents accessed exogenous knowledge on new varieties and techniques, with a score of 86 (67.2%) radio, 29 (22.7%) television, 11 (8.6%) cell phones, and two (1.6%) film shows. Other major knowledge types which were obtained from ICTs were crop husbandry, livestock husbandry and markerting (see Section 5.9.1.2). Although interview results indicated that farmers mainly accessed exogenous knowledge on new varieties and techniques, the focus group discussions showed that knowledge on crop husbandry was a major type of exogenous knowledge obtained through ICTs, followed by knowledge on new varieties and techniques, marketing, plant diseases control, soil fertility, animal disease control, and early warning (see Section 5.9.1.2). Despite these discrepancies, major patterns

could be drawn that new varieties and techniques, and crop husbandry practices were the main exogenous knowledge types received from ICTs in the surveyed communities.

These findings also indicated that there were similarities between exogenous knowledge received from ICTs and that knowledge obtained from tacit and explicit sources of knowledge in the surveyed communities. The findings revealed that exogenous knowledge on new varieties and techniques, and crop husbandry were the dominant knowledge types received from ICTs and tacit and explicit sources of knowledge in the communities. The findings also indicated that exogenous knowledge received from ICTs did not fulfil farmers' information and knowledge needs as already highlighted in section 6.4.1.1. Farmers mainly accessed exogenous knowledge on new varieties and techniques, and crop husbandry practices from ICTs, which did not cater for their major knowledge needs which were control of plant diseases, marketing and credit.

In the present study, radio was mainly used to disseminate knowledge on new varieties and techniques, crop husbandry, soil fertility, livestock husbandry, control of plant diseases, marketing, control of animal diseases, and agricultural tools. Similarly, a study by Jallov (2007a) reported that farmers mainly accessed knowledge on crop and livestock management, credit services, crop prices and environmental conservation through community radio in East Africa. In the present study, farmers in Karagwe depended on the community radio (that is, FADECO radio in Karagwe), while Kasulu farmers accessed knowledge from a Kwinzera community radio from another nearby district. Despite the fact that Kilosa district had a community radio, this radio station focused on entertainment, and thus it was not a helpful source of agricultural knowledge to farmers. Further, most farmers in other districts relied on national and other private radio broadcasts to access exogenous knowledge. However, these national and other private radio broadcasts tended to focus on large city markets, and thus their information and knowledge were not relevant to farmers.

The present findings indicated that cell phones were important in providing access to knowledge on crop husbandry, marketing, new varieties and techniques, and animal diseases control. Informal contacts were made amongst farmers or between farmers and knowledge intermediaries

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to access exogenous knowledge. Similarly, a study by Myhr (2006) indicated that fishermen used cell phones to keep in contact with their colleagues who were fishing in the sea to acquire information about the present weather at the fishing grounds in Tanzania. Cell phones also enabled faster contacts between farmers and extension officers in Fiji (Prakash 2003). These findings suggest that cell phones are emerging as good tools that can enable farmers to improve their KM practices and farming activities in the rural areas.

The findings indicated that cell phones were used at a high rate to deliver market information as compared to other ICTs. High use of cell phones to access marketing information was also observed in other studies in Tanzania (Myhr 2006; Mwakaje, Mwakipesile and Nyakisinda 2009) and Uganda (Pott 2003). These findings from the present study and other studies in Africa show that cell phones play a great role in disseminating marketing information and knowledge in the local communities. However, the present study showed that farmers in the surveyed regions were not aware of the SMS service hosted by the Ministry of Industry, Trade and Marketing that provides marketing information service through cell phones in Tanzania. Similar observations were made by Chilimo (2008) in a study to analyze the use of four telecentres in Tanzania. According to ESRF (2007) and McNamara (2008), the marketing information service has not yet been publicized in the rural communities apart from by word of mouth, and there has been no impact evaluation of this initiative yet. There is thus a need to promote this service in the rural areas to equip farmers with relevant information and knowledge on market prices and outlets.

The study findings showed that television was used to access knowledge on new varieties, crop and animal husbandry practices, control of animal and plant diseases, and markets. On the other hand, film shows were used to access knowledge on new varieties and crop husbandry, while video and audio cassettes were used to access knowledge on crop husbandry. However, these ICTs were used at a low rate in the local communities.

Advanced ICTs (internet and email) were important in accessing knowledge on crop husbandry and marketing. Knowledge intermediaries (such as WIDA NGOs in Songea Rural) helped farmers to negotiate crop prices through email and market their products to countries in Europe,

to look for donors, and access knowledge on technical solutions for plant diseases and pests and environmental conservation from agricultural researchers. On the other hand, internet was used by farmers to access information and knowledge on crop and animal husbandry, marketing and natural resource management through community or regional telecentres. A few farmers were able to secure markets for their agricultural produce (such as bananas) from electronic fora and the internet such as in Kilosa and Moshi Rural. However, these farmers had not been successful in selling their crops due to lack of assistance from the government authorities in selling their products online. These findings show that through intermediaries, advanced ICTs (such as email) can be meaningful to farmers to improve their agricultural livelihoods especially in the rural areas where ICT literacy is very low. These findings also show that capacity building is an important factor in encouraging farmers to use the internet to access exogenous knowledge on farming systems.

### 6.9.3 The application of agricultural exogenous knowledge received from ICTs

The study findings established that the majority of the respondents applied exogenous knowledge, 141 (77.9%) received from tacit and explicit sources of knowledge in the farming systems, as compared to the exogenous knowledge received from ICTs 64 (35.4%). These findings show that oral communication channels are effective ways of delivering exogenous knowledge in the surveyed local communities to a greater extent than ICTs. Similary, Chapman *et al.,* (2003) found that the use of participatory communication techniques and indigenous communication channels (such as drama) through local languages and rural radio had some influence on the majority of the farmers regarding their decisions whether or not to cut down trees and to discontinue bush burning on their farms in future in Ghana. Reddy and Reddy (2005) found that the Web-based Agricultural Expert Advice System improved access to knowledge and the technology adoption rate as compared to their counter parts in a non-project area in India. Indications are that the combination of participatory techniques, indigenous communication channels and ICTs can improve the sharing and adoption of agricultural technologies in the local communities.

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The present study established that the majority of the respondents had mainly adopted the following exogenous techniques received from ICTs, which included crop husbandry techniques 31 (48.4%), followed by new techniques and varieties 21 (32.8%), improvement of soil fertlity 15 (23.4%), and other types of exogenous knowledge (see Section 5.9.1.4). Despite the low use of agricultural exogenous knowledge from ICTs, the results indicated that there were no differences between the major knowledge types adopted from tacit and explicit sources of knowledge, and those ones adopted from ICTs. Thus, these results confirmed that exogenous knowledge on crop husbandry practices and new techniques and varieties were the most adopted types of exogenous knowledge in the local communities.

The major reasons for adopting these agricultural exogenous technologies and knowledge were improved crop and animal production 63 (98.4%). These findings were similar to the major reasons for adopting exogenous knowledge from tacit and explicit sources of knowledge in the surveyed communities as illustrated in Section 6.4.6. Other major reasons were to: control animal diseases 5 (7.8%), simplify field operations 4 (6.3%), and increase income 3 (4.7%) (see Section 5.9.1.4). Similary, a study carried out to analyze the impact of three community radio broadcasts in East Africa revealed that knowledge on livestock husbandry and crop farming enabled farmers to improve their productivity and reduce poverty (Jallov 2007a). Indications are that ICTs can also play a key role in providing access to relevant and effective exogenous knowledge which can improve agricultural productivity and increase income in the local communities.

### 6.9.4 The non-application of agricultural exogenous knowledge received from ICTs

The study found that few farmers had not applied the exogenous techniques which they accessed through ICTs. The results indicated that 23 (12.7% of 181 respondents) respondents had not applied some of the agricultural exogenous techniques they accessed through ICTs. Most of the farmers, eight (34.8%) had not applied techniques on how to improve soil fertility, followed by new varieties and techniques, seven (30.4%), and other techniques as indicated in section 5.9.1.5. The major reasons for not applying these agricultural exogenous technologies were high costs of agricultural inputs and agricultural tools, 14 (60.9%), and access to irrelevant technologies for

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their agroecological conditions, 3 (13%). Although most of the agricultural inputs were subsidized by the government, these inputs were not adequate to suit all small scale farmers. Further, the findings indicated that farmer-to-farmer promotion of agricultural technologies is very important even when ICTs are used. Farmers tend to adopt new technologies when they have seen successful changes made by their fellow farmers.

### 6.9.5 The role of knowledge intermediaries in disseminating agricultural exogenous knowledge through ICTs

To draw conclusions on the use of ICTs for disseminating exogenous knowledge, it was pertinent to find out the extent to which knowledge intermediaries used ICTs to disseminate agricultural exogenous knowledge to small scale farmers in the country, and the effectiveness of those ICTs in disseminating agricultural exogenous knowledge. The research findings showed that more than half of the knowledge intermediaries, 16 (64%) used ICTs to disseminate agricultural exogenous knowledge in the rural communities. A Zambia study by Kalusopa (2005) showed that the use of ICTs by the information intermediaries was yet to have full impact. Indications are that digital divide still remains wide in the region.

The current study found that internet services provided through telecentres, 7 (46.7%) and cell phone 6 (40%) were the main ICTs used by knowledge intermediaries to disseminate exogenous knowledge to farmers. Despite the fact that most knowledge intermediaries provided internet services to the rural communities, few farmers used internet directly to access agricultural exogenous knowledge due to the high costs of ICTs, lack of awareness, ICT skills, and local content. However, the study findings showed that internet services were more useful to farmers when they were accessed through knowledge intermediaries. The study findings showed that out of seven telecentres, three of them repackaged their information and disseminated it to farmers and extension officers, two of them linked farmers to market outlets, while one telecentre assisted farmers to access technical solutions for their farming problems through email, and one telecentre linked farmers to online farmer discussions forums for knowledge exchange. These results indicate that ICTs can only be meaningful to farmers if there is relevant content, assistance from knowledge intermediaries and ownership as it was found in Nigeria (Ha, Okigbo,

and Igboaka 2008). Further, the findings of the present study showed that there was high use of cell phones because they were affordable, portable and simple to use.

The study findings showed that out of two surveyed community radio stations, only one radio station (that is, FADECO) used to download useful web-based agricultural knowledge and disseminate it to farmers in response to farmers' queries and their needs. Radio was used at a low rate by the knowledge intermediaries due to the high cost of producing radio programs. Further, even in those villages where community radio stations existed, there was poor cooperation between different agricultural actors (such as extension officers, researchers) and community radio in the production of agricultural radio programs due to lack of incentives, especially at Kilosa district.

The study findings further showed that the majority of the respondents ranked ICTs as effective tools for disseminating exogenous knowledge in the communities, with a score of eight (50%) and four (25%) respondents in the very effective and effective categories. These findings indicate that multiple and a variety of ICTs could be identified and used in the future as new ICTs emerge since there is increasing awareness and growing interest in the use of ICT to disseminate exogenous knowledge in the surveyed rural areas.

## 6.10 Barriers that hinder the management of agricultural indigenous knowledge and access to exogenous knowledge in the local communities

This section discusses research objective nine and themes that emerged from Section 5.10 of Chapter Five, which included the following: challenges that faced farmers in their farming activities, and the challenges that faced farmers and knowledge intermediaries in the management of agricultural IK, access to exogenous knowledge in the local communities, and use of ICTs in managing agricultural IK and providing access to exogenous knowledge in the local communities.

**6.10.1 Barriers that hinder the management of agricultural indigenous knowledge**

This section discusses challenges that faced farmers in acquiring, sharing and preserving their agricultural IK in the local communities.

**6.10.1.1 Barriers that inhibit the acquisition of agricultural indigenous knowledge**

The major problems that faced farmers when acquiring agricultural IK were poor recognition of IK and resistance to change, with a score of 121 (66.9%) each. On one hand, most farmers ignored the IK system, especially the present generation, due to the formal education system, socialization and development of ICTs which have totally excluded the IKS. Similar observations were made in other studies in Ecuador (Bode 2006), Swaziland (Dube and Musi 2002) and Uganda (Agea *et al.,* 2008). This finding indicates that farmers inadequately recognised and explored their knowledge and capacities to innovate to improve their farming activities. On the other hand, other farmers were resistant to change and adopted IK in their farming systems, which shows that they were comfortable with their personal experiences and thus it was difficult for them to acquire IK from other sources. Reluctance to change is directly related to human nature, which leads individual to resist change (Croteau and Dfouni 2008). Other major problems as identified from the findings were lack of IK records, 120 (66.3%), poor knowledge sharing culture, 116 (64.1%), lack of a resource centre, 112 (61.9%), and lack of trust, 102 (56.4%). Overall, barriers to knowledge acquisition can be categorised at three levels which include: personal, social and external environment.

Personal barriers were related to the poor recognition of IK; lack of trust; the selfishness of farmers to share their knowledge; agricultural indigenous inputs were time demanding; differences in age, gender, social, and economic status; illiteracy; some indigenous techniques were not effective to solve farmers' problems; IK being suspected of being linked to witchcraft; and low income from agricultural activities. All these factors limited farmers in personally acquiring knowledge from various explicit and tacit sources of knowledge in the communities. These findings were in line with Rowley's (2001) KM model which shows that individuals are willing to share their knowledge if they are convinced by the fact that they need to share their knowledge.

Social barriers were related to poor recognition of IK; poor knowledge sharing culture, and the disappearance of culture that would influence knowledge acquisition in the communities. Most of the traditional culture had disappeared due to the modernization, ICTs, population pressure and education. The settlement of professionals from different ethnic backgrounds and intermarriages had also contributed to the disappearance of traditional cultures in the surveyed communities. The disappearance of vernacular languages was another social problem that limited acquisition and sharing of agricultural IK in the local communities. It is thus important to find ways to prevent the disappearance of local languages since the continuous use and impact of IK on farming systems depend on these languages.

Social barriers were also associated with the difficulties in knowing who IK holders were and where they were located due to the lack of an established structure to identify them. These findings were in line with various KM models (Davenport 1998; Earl 2001; Nonaka, Toyama and Konno 2000) which emphasize that KM activities benefit from maps since they increase access to knowledge in the organisations. It is thus important for the local communities, and public and private knowledge intermediaries to map IK holders for effective KM practices and the integration of indigenous and exogenous knowledge in the surveyed local communities.

Other social barriers were related to following: conflicts at family level, existence of traditional structures, and customs and taboos that inhibited knowledge acquisition in the local communities. Other barriers were the disappearance of plant species, and small-scale farming. As according to various KM literature and models (Jashapara 2004; Rowley 2001; Small and Tattalias 2000), the cultural factors determine the extent to which people who possess the knowledge are willing to share it and place it in a social domain. It is thus important for the village leaders and knowledge intermediaries to foster a knowledge sharing culture where knowledge would be easily acquired, created and shared among community members.

Other problems were related to the external environment, which included the inadequate government efforts to recognise and record IK, to establish rural knowledge resource centres, and to improve the existing IPR system. Other problems which can be solved by the government

were the low number of extension officers; public extension officers being more concerned with conventional approaches and thus not being helpful sources of IK; exclusion of IK in the formal education system; and low priority was given to the agricultural sector by the government. These results show that while some problems can be solved by individual farmers and their communities, other problems would require public and private partnership interventions to improve the acquisition of agricultural IK in the local communities.

### 6.10.1.2 Barriers that inhibit the sharing of agricultural indigenous knowledge

The study findings showed that poor recognition of agricultural IK, 119 (65.7%) was the major barrier which inhibited farmers from sharing their IK. It is apparent from the findings that the government needs to promote the use of IK in order to raise the profile of this knowledge and improve IK sharing activities in the local communities. Other major barriers that inhibited the sharing of agricultural IK in the local communities were a poor knowledge sharing culture, 116 (64.1%), lack of a knowledge resource centre, 111 (61.3%), lack of trust, 104 (57.5%), and social-economic status, 76 (42%). On the whole, these barriers that inhibited sharing of IK can be categorised into four levels, which include personal, social, technological, and external environment.

Personal barriers included the following: a poor recognition of IK; poor knowledge sharing culture; lack of trust; selfishness; differences in social-economic status in the local communities; growing some of local herbs was time demanding; and illiteracy. These findings as in line with various KM models (Earl 2001; Kruger and Snyman 2005; Probst, Raub and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) emphasize the necessity of creating a knowledge-sharing culture which includes norms and values that encourages the sharing of knowledge for effective KM activities in the local communities. It is thus important for the village leaders and knowledge intermediaries to foster a knowledge sharing culture, mutual trust and relationship building to enable local people to openly share their knowledge.

Social barriers were related to the poor recognition of IK; a poor knowledge sharing culture; disappearance of culture and practices that could influence knowledge sharing; occurrence of

conflicts within the families; presence of traditional structures, customs and taboos that inhibit knowledge sharing; some of IK holders required to be paid in order to share their knowledge; disappearance of vernacular languages; IK was suspected of being linked to witchcraft; lack of markets for organic products; and the settlement of professionals from different ethnic backgrounds and intermarriage which limited sharing of agricultural IK.

Another social problem was related to lack of commitment from village leadership to encourage knowledge sharing activities in the communities. Lack of leadership commitment was also found to be one of the major barriers for knowledge sharing activities at Air Force Centre of Excellence in the USA (Myers 2006). The findings as in line with various KM models (Probst, Raub and Romhardt 2000:192; Nonaka, Toyama and Konno 2000; Rowley 2001) show that the village leadership has a key role to play in creating a culture to enhance knowledge sharing activities in the local communities. It is thus important for the knowledge intermediaries to work closely with village leaders to nurture a conducive environment for knowledge sharing activities in the local communities.

Other problems were related to the external environment, which included the following: the failure of government to recognise and preserve IK, to establish rural knowledge resource centre, and relevant IPRs. Other external environment problems were related to the knowledge intermediaries, who inadequately recognised IK, and thus they focused on disseminating contemporary technologies which had undermined the sharing and use of indigenous techniques in the local communities. At the technological level, the advancement of ICTs such as TV and radio had replaced oral culture and folklore. The present generation was more interested in listening to music and tales from TV and radio broadcasts rather than attending the traditional folklore activities.

Overall, these barriers to IK sharing may also fall under the Holsapple and Joshi's (2000) and Myers (2006) knowledge sharing barriers categories, which include: management (leadership), resources (financial, human, material, and knowledge), and environment (markets; ICTs; time; and government, economic, political, social, and educational climate). These study findings also

show that the sharing of knowledge encounters barriers at individual and cultural levels, which primarily involve issues of power and trust as indicated by Probst, Raub and Romhardt's (2000:189) KM model. In a similar study in Uganda, Akullo *et al*., (2007) found that formal education, disappearance of local inputs, large scale farming, government laws, lack of clear prescription, ignorance, and selfishness inhibited sharing of agricultural IK in the local communities in Uganda. Thus, these problems require government, knowledge intermediaries, community and personal efforts to improve the sharing of agricultural IK in the communities.

### 6.10.1.3 Barriers that hinder the preservation of agricultural indigenous knowledge

The study findings further highlighted that poor recognition of IK and lack of efforts to preserve IK were major barrier for preserving agricultural IK in the communities, accounting for 117 (64.6%) and 116 (64.1%) of the respondents respectively. Similarly, a study by Agea *et al.,* (2008) found that lack of records on IK was the major limiting factor to the use of IK in enhancing food security in Uganda. Other major barriers were a poor knowledge sharing culture, lack of trust, and social status. Indications are that it is important to preserve IK before it disappears since it is mainly stored in human minds which may be subjected to either ultimately death or memory lapses. Based on the study findings, problems related to knowledge loss were classified at the following categories: personal, social, and external environment.

Personal barriers included the following: poor recognition of IK; poor knowledge sharing culture; lack of trust; and personal characteristics (that is, age, gender, status) which inhibited farmers in sharing their knowledge. Social barriers were related to the poor recognition of IK; a poor knowledge sharing culture; disappearance of traditional seeds and plant species; the difficulty of knowing the IK custodians; disappearance of IK holders; the dominant use of contemporary technologies; traditional structures, customs and taboos that inhibited sharing of IK; high illiteracy level of the early IK custodians; and disappearance of oral culture such as folklore.

The problems at the external environment level were related to the inadequate efforts by the government to recognise IK in its policies and plans; lack of appropriate IPR; exclusion of IK in

the formal education system; and lack of professionals, such as extension agents to manage IK. On the hand, knowledge intermediaries (both public and private sectors, such as researchers and NGO) who conducted research on agricultural IK never disseminated their findings to farmers, and they inadequately recognised IK. It is thus important to consider these factors at different levels (personal, social, external) in an effort to prevent IK loss in the surveyed local communities.

## 6.10.1.4 Barriers that hinder the knowledge intermediaries to manage agricultural indigenous knowledge

The findings showed that the major challenges that faced knowledge intermediaries in managing IK were lack of IK policy, 10 (40%), lack of facilities, 9 (36%), lack of funds, 9 (36%), inadequate training on the management of IK, 9 (36%), lack of intellectual property rights that recognize IK, 8 (32%), poor knowledge sharing culture in the communities, 8 (32%), and long distances to the communities, 7 (28%). Other barriers were inadequate number of staff, using local techniques (such as using herbs) were time demanding, disappearance of indigenous species, lack of a reading habit in the communities, lack of access to proven scientific procedural explanations on agricultural IK, poor recognition of IK, lack of national efforts to document IK, and language barrier since most farmers were not comfortable with English language. While most of these problems may require institutional efforts to solve them (that is, skills, funds, facilities and transport), other problems such as policy and IPR issues may require public and private partnerships, and other problems may require both knowledge intermediaries and village leaders to foster knowledge sharing culture, reading habit, and awareness of IK values in the local communities as suggested by various KM models (Probst, Raub and Romhardt 2000; Nonaka, Toyama and Konno 2000; Rowley 2001).

## 6.10.2 Barriers that hinder access to agricultural exogenous knowledge in the local communities

The findings indicated that major problems that limited farmers from accessing agricultural exogenous knowledge were poor extension services, 143 (79%), lack of access to information materials, 133 (73.5%), lack of a knowledge resource centre, 131 (72.4%), and low level of

literacy, 118 (65.2%). Similarly, Adomi, Ogbomo and Inoni (2003) reported that lack of visitation by agricultural extension officers, absence of a nearby library, and illiteracy were major factors that hindered farmers from having access to agricultural information in Nigeria. Indications are that extension services are very important to farmers, since most of them are illiterate and they largely depend on the face-to-face interactions to access knowledge. It is thus important to improve extension services, access to printed information materials and literacy levels in the communities.

Other barriers were related to farmers who were exposed to the extension services, but they were not willing to share their knowledge due to selfishness, and memory lapses, where they could not remember what they had learnt. This finding is consistent with the findings of Dixon (2002) who reported that farmers who had been trained were often reluctant to share their knowledge with their fellow farmers in Ethiopia. This finding as in line with Probst, Raub and Romhardt's (2000:193) KM model also shows that the ability to share knowledge depends primarily on the individual's talent for communication, the pride in the ownership of one's own expert knowledge, lack of time, and fear of endangering one's own position in the community once one shares knowledge. Other related problems from the present findings were related to: resistance to change; poor knowledge sharing culture; social-economic factors (such as age, gender, status); village leaders not encouraging farmers to share their knowledge; and the infrequent occurrence of village meetings. These findings show that there is a need to foster a knowledge sharing culture and care in the local communities to create a conducive environment for knowledge sharing activities in the communities as suggested by Von Krogh, Ichijo and Nonaka (2000:49). Village leaders and knowledge intermediaries could play a great role in this.

Other problems were related to farmer groups which included the following: no beneficial effects perceived by farmers who had joined farmer groups; lack of awareness on the importance of farmer groups; resistance to join farmer groups due to old age; lack of sensitization and encouragement from the village leaders; wrong perceptions about farmer groups; and late delivery of inputs. Similarly, Wambura *et al.,* (2007) also found that poor leadership and lack of a constitution were found to be some of the key factors that inhibited farmer groups to access

knowledge, inputs and markets in the rural areas of Morogoro region in Tanzania. This indicates a need for awareness creation and training on the management of farmer groups to improve access to exogenous knowledge in the local communities.

Other problems included: unavailability and/or high cost of inputs; agricultural input suppliers and middlemen were not reliable sources of knowledge; lack of funds to purchase information materials; access to irrelevant knowledge; lack of awareness of the available information services; distant location; lack of a bookshop and agricultural shops; and ineffectiveness of some of the conventional inputs; poor recognition of agricultural practices by the government; low awareness on the part of farmers to demand their rights for adequate access to knowledge; and exclusion of agricultural subjects in most of the primary and secondary schools. These findings indicate that barriers that limited farmers from accessing exogenous knowledge were related to skills, literacy, distance, relevancy of technology, knowledge sharing culture in the communities, management of farmer groups, inputs, and village leadership commitment.

### 6.10.3 Barriers that hinder the knowledge intermediaries in disseminating agricultural exogenous knowledge in the local communities

The study findings showed that lack of funds was the major barrier that hindered knowledge intermediaries in disseminating agricultural exogenous knowledge in the communities, with a score of 19 (76%) respondents. Other major barriers were lack of facilities, 16 (64%), inadequate trained personnel, 16 (64%), and long distances to the communities, 16 (64%). Other barriers were related to farmers (that is, illiteracy, management of farmer groups, low adoption rate, and poor reading habits). Other problems were related to inadequate refresher training courses for the extension officers, poor cooperation from district officials and other governmental agencies in knowledge provision, and delivery of subsidized inputs. Thus, problems that limited knowledge intermediaries from disseminating exogenous knowledge could be identified in the following categories, which include: funds, infrastructure, staff development, farmers' related problems, and coordination among knowledge intermediaries.

**6.10.4 Barriers that inhibit farmers' use of ICTs in managing indigenous knowledge and access to exogenous knowledge on farming systems**

The study findings indicated that high cost of ICTs was the predominant problem that limited farmers in managing agricultural IK and accessing exogenous knowledge through ICTs, accounting for 152 (84%) of the respondents. Other major problems were lack of electricity, 129 (71.3%), lack of local and relevant content, 122 (67.4%), lack of awareness, 119 (65.7%), poor telecommunication infrastructure, 104 (57.5%), and ICT illiteracy, 114 (63%). These findings agree with those of Kari (2007) who found that high cost, unavailability, lack of knowledge, and limited access to ICT were the major factors militating against the use of information sources in the rural communities of Nigeria. Kalusopa (2005) also found that lack of access to ICTs and electricity were the major barriers that hindered farmers in using radio and TV in Zambia. Similar observations were made in South Africa and Kenya (Wafula-Kwake and Ocholla 2007), and South Africa (Pade 2006). Thus, there is a need to find ways to make ICTs and electricity affordable and available to farmers. Capacity building, sustainability and integrating ICT at the public and private institutions that deal with rural KM are also important issues to be considered for effective access to agricultural knowledge in the surveyed communities.

Another barrier was related to the radio and TV broadcasts, which included poor timing, broadcasts not being participatory, the short period of time allotted to the programs, programs not being consistent and poor quality. Garforth (2001) also found that lack of regular agricultural programming on the radio limited farmers in using radio systematically as an information source in Eritrea. In a study carried out to analyze the use of radio in Ghana, Chapman *et al.,* (2003) found that most farmers agreed that radio broadcasts between 4 and 5 p. m. were suitable, but if given a choice, they would have preferred evening broadcasts, between 7 and 9 p. m. The poor timing of radio broadcasts also limited farmers in accessing marketing information via radio at Rungwe District in Tanzania (Mwakaje, Mwakipesile and Nyakisinda 2009). Since radio broadcasts were the most preferred mechanism for knowledge acquisition and sharing in the local communities, then the timing, sustainability and continuity of radio programmes must be taken into consideration for future agricultural development work.

Delivery of incorrect and unreliable information and knowledge from traders also limited farmers from accessing knowledge through cell phones. Similar observations were made in Eritrea (Garforth 2001) and Uganda (Bagnall-Oakeley *et al.,* 2004). These studies found that most farmers accessed agricultural information from traders although they did not regard them as trustworthy sources of knowledge. In Tanzania, Mwakaje, Mwakipesile and Nyakisinda (2009) revealed that key barriers that limited farmers to use ICTs were related to costs, electricity, availability, and reliability of the content at Rungwe district. It is thus important to promote the existing market information system by the Ministry of Industry, Trade and Marketing which delivers reliable market information to farmers through cell phones in the country.

Personal barriers were also found to limit access to knowledge through ICTs, which included age, gender, social and economic class. Farmers also accorded low status to ICTs as compared to agricultural activities which inhibited use of ICTs in the local communities. Social barriers also inhibited farmers in using ICTs to manage knowledge. For instance, the Kilosa problem tree showed that livestock herders were not allowed to listen to the radio when they were grazing animals to prevent animal loss. The study findings are in line with the Probst, Raub and Romhardt's (2000:189) KM model which emphasizes that the creation of infrastructure is not in itself enough to set the KM activity in motion, but there are a number of individual and cultural barriers for managing knowledge. It is thus not important to focus only on the factors such as cost, infrastructure, literacy, content and electricity, but it is also significant to consider personal and social barriers as they affect KM activities through ICTs in the surveyed local communities.

Other problems as identified in both interviews and problem trees were related to inadequate ICT services to cater community needs (such as telecentres and community radio), language barriers, lack of follow up from professionals, theft, and lack of assistance on the use of ICTs to market farmers' produce. Omana (2008) also found that factors related to infrastructure and languages were the major barriers that hindered rural women in Kerala in accessing agricultural knowledge. The findings show that apart from infrastructure issues, other factors may also limit farmers from accessing indigenous and exogenous knowledge through ICT, which include relevancy, skills, language, theft of ICTs, and follow up from professionals.

**6.10.5 Barriers that hinder knowledge intermediaries to manage agricultural indigenous knowledge and disseminate exogenous knowledge through ICTs in the local communities**

The study findings indicated that lack of funds 18 (72%) was the major barrier that inhibited knowledge intermediaries in managing IK and disseminate exogenous knowledge in the local communities. Other major barriers included inadequate ICT expertise, 16 (64%), high levels of ICT illiteracy on the part of farmers, 14 (56%), lack of awareness on ICT on the part of farmers, 13 (52%), high cost of ICT facilities, 9 (36%), poor ICT infrastructure, 9 (36%), lack of institutional ICT policy, 7 (28%), inadequate efforts to generate local and relevant content, 7 (28%), unreliable power supplies, 6 (24%), and low use of telecentres by farmers, 5 (20%). These findings were consistent with the research findings of Akpabio, Okon and Inyang (2007) who reported that poor ICT infrastructure, high cost of broadcast equipment, high charges for radio/television presentations, high cost of access/interconnectivity and electricity power limited Nigeria's extension officers to use ICTs. Similar observations were made in South Africa (Ocholla and Dlamini 2007), and Tanzania (Development Associates Ltd 2004).

In the present study, other barriers that hindered use of ICTs were high user fees to access internet in the telecentres which limited farmers to access knowledge, lack of public and private partnership in rural ICT investments, difficulties in changing farmers' mindsets and other barriers as indicated in Section 5.10.3.2. Although most problems could be solved by the knowledge intermediaries (such as institutional policies, ICT literacy, awareness, funding, and content), other challenges require efforts of both public and private sectors' to be solved, which include trust between macro and micro companies, coordination among agricultural actors, capacity building, establishment of rural telecentres, content, and knowledge culture in the communities. Further, other problems would require government support to be solved, which include issues related to the regulations of community radio, rural electrification, subsidies for rural ICTs and improved infrastructure.

**6.11 Summary of the chapter**

This chapter examined and analysed data relating to the application of KM models and ICTs in managing agricultural IK and access to exogenous knowledge in the selected six rural districts of

Tanzania. An attempt was made to show how the findings of the present study support or differ from the KM models and previous research on the management of IK, access to exogenous knowledge, and ICTs in the local communities. This chapter discussed the findings of all specific objectives indicated in section 1.5 of Chapter One, with exception of the last specific objective, namely to propose a KM model for managing agricultural indigenous and exogenous knowledge in the local communities. This objective is covered in Chapter Seven.

Based on the findings of the study, Chapter Six demonstrated that KM models can be used to manage IK and appropriately introduce exogenous knowledge in the local communities, and thus the integration of both indigenous and exogenous knowledge would be feasible. Despite the fact that various KM models (Bouthillier and Shearer 2002; Nonaka, Toyama and Konno 2000; McAdam and McCreedy 1999; Probst, Raub, and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) use different labels to identify KM processes, the study findings showed that farmers can manage their knowledge through the following KM processes: knowledge identification, acquisition, sharing, preservation, application and development.

Drawing from the research findings, local farmers had an extensive base of IK which they rely for their farming activities. The study findings showed that farmers mainly identified, acquired and shared their agricultural IK through informal network of families, friends and neighbours. Formal sources and explicit sources of knowledge were less used to acquire IK. There were also marked location, and gender differences in information needs and people's acquisition of IK from formal sources of knowledge. The study found that knowledge was mainly created within the social paradigm rather than the scientific paradigm in the surveyed communities. The findings further demonstrated that IK was largely preserved in human mind and thus it was disappearing at a high rate. Thus, the need for the application of KM models in order to prevent knowledge loss in the surveyed communities cannot be over-emphasized.

The findings of the present study demonstrated what various KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub, and Romhardt 2000: 30; Rowley 2001) had proposed that it is important to acquire knowledge from within or outside the organisation for effective KM

processes. The findings showed that local farmers also relied on their informal networks of friends, families and neighbours to access agricultural exogenous knowledge. There were also marked location, and gender differences in access to exogenous knowledge in the local communities. The findings further showed that exogenous knowledge can be used to improve the existing IKS, since IK cannot solve all farming problems such as frequent disease outbreaks. However, knowledge intermediaries interacted inadequately with farmers in an effort to identify and prioritize farmers' knowledge and needs in their rural KM strategies. Thus, the study findings are in line with Boateng's (2006) circular KM model which indicates that farmers' knowledge has to be recognised and identified by knowledge intermediaries to enhance the integration of indigenous and exogenous knowledge systems in the surveyed communities.

The study findings showed that various KM principles determined access to knowledge in the communities, which included policies, legal framework, ICTs, culture of a certain locality, trust, context and space as suggested by various KM models (Davenport 1998; Earl 2001; Nonaka, Toyama and Konno 2000; Probst, Raub and Romhardt 2000; Small and Tattalias 2000). With regard to ICTs, Chapter Six indicated that farmers relied heavily on the face-to-face communication more than on ICTs to access indigenous and exogenous knowledge, although ICTs were already in existence in the surveyed communities. Some of the major findings outlined above are summarized in the next chapter. A conceptual KM model for effective management of agricultural IK and access to relevant exogenous knowledge in the local communities is proposed next.

# CHAPTER SEVEN: SUMMARY OF STUDY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

## 7.1 Introduction

On the basis of the data presented and interpreted in the two previous chapters, this chapter presents a summary of the findings, significance and contribution of the study, originality of the study, conclusions and recommendations of the study. The summary of the findings of the study is presented based on the research objectives (See Chapter One, Section 1.5), and the conclusions are derived from the data presented in Chapter Five. The recommendations are followed by the presentation of the conceptual KM model developed to fulfil the purpose of this study. The last part of this chapter identifies areas for further research.

## 7.2 Summary on research findings based on research questions

This section presents a summary of the research findings based on the objectives of the study presented in Chapter One, Section 1.5.

### 7.2.1 Summary of the characteristics of the respondents

- Middle aged and elderly farmers were involved in crop and/or animal production, while young farmers (below 30 years) were less involved in farming activities in the surveyed regions. More men participated in the study than women;

- The literacy level in terms of ability of the respondents to read and write in the national language (Swahili) was quite high at all sites. Males dominated the highest education category more than female farmers;

- The majority of the respondents were small-scale farmers;

- Although nearly two-thirds of the respondents were men, and more than half of the respondents indicated that there were no differences between the roles of men and women regarding farming activities, the analysis of farming roles carried by both men and women indicated that women were more involved in the farming activities than men;

- The majority of the farmers in the sample owned ICTs, where radio was the predominantly owned ICT, followed by cell phones and televisions ;

- There were no major differences in the ownership of ICTs by gender; and

- Most owners and users of ICTs in the sample were younger farmers (26 to 36 years) than elderly farmers.

## 7.2.2 Summary of the types of agricultural indigenous knowledge and the role of indigenous and exogenous knowledge in the farming systems in the local communities

- Local communities had an extensive base of IK on farm tasks, which included soil fertility assessment of arable land, crop husbandry, preservation of planting materials and crops, plant diseases and pest control, animal breeding and disease control;
- IK on farming systems was location specific;
- Farmers mainly employed indigenous and exogenous knowledge and practices in crop production as compared to livestock management;
- Knowledge on plants that repel insects, and medicinal plants for controlling plant and animal diseases and for preserving crops was generally low;
- There was high use of IK in the improvement of soil fertility, acquisition of planting materials, crop husbandry, and control of plant predators as compared to conventional inputs;
- The majority of the farmers did not generally use measures to control plant diseases and pests. However, when the use of local herbs and conventional inputs was compared in the control of plant diseases and pests, the latter was more commonly used than the former;
- Indigenous practices were also the dominant methods for controlling plant pests; and
- There was also high use of exogenous knowledge and techniques in the preservation of planting materials and crops, control of animal diseases, and animal husbandry, as compared to local inputs.

## 7.2.3 Summary of the management of agricultural indigenous knowledge in the local communities

This section presents a summary of the findings of the research objectives two and three which were analysed in this study in relation to KM processes. These KM processes include the following: knowledge needs and identification, acquisition, development, sharing, preservation and application of IK for farming activities. The summary of the results on the role of knowledge intermediaries in managing agricultural IK in the local communities is also presented.

**7.2.3.1 Knowledge and information needs and identification**

- The majority of the respondents needed knowledge on the control of plant diseases and pests, marketing, credits, and control of animal diseases;

- Knowledge and information needs of the farmers were location specific;

- There were slight variations in the information and knowledge needs across gender categories;

- Half of the respondents had tried to look for ways to solve their knowledge and information problems in the local communities;

- Farmers largely sought knowledge from friends/neighbours, followed by extension officers, agricultural inputs suppliers and family/parents to fulfil their knowledge needs; and

- Poor extension services, lack of awareness, distant location, low response from the authorities, personal and social barriers, and lack of funds and resources were the major barriers that hindered farmers to seek knowledge and information in their communities.

**7.2.3.2 Knowledge acquisition**

- Sources of agricultural IK were predominantly local, including parents and/or family, personal experience, and neighbours and/or friends; and

- There were marked location differences in people's acquisition of IK from formal sources of knowledge. However, there were slight variations in access to IK across gender categories in the surveyed communities.

**7.2.3.3 Knowledge development**

- Knowledge was mainly created within the social paradigm more than the scientific paradigm in the surveyed communities;

- Farmers developed new knowledge by carrying out local experiments driven by personal curiosity, seeking for solutions and as an adaptation to new knowledge in the social paradigm; and

- All four types of Nonaka and Takeuchi's (1995) knowledge creation model (socialization, combination, externalization, and internalization) were practiced by the local communities to create new knowledge for farming purposes, but the externalization, combination and internalization processes were practiced at a low rate.

**7.2.3.4 Knowledge sharing**

- Indigenous practices, such as apprenticeships, folklore activities and initiation rites influenced sharing of agricultural IK in the local communities, although they were practiced at a low rate;

- Few farmers were involved in farmer groups in the sample of the study. Farmer groups were mainly used to share knowledge on conventional farming as compared to indigenous farming;

- Access to agricultural indigenous and exogenous knowledge in the local communities was determined by the following principles: culture, status, trust, and context and space;

- Traditional culture was location specific, and they determined access to agricultural IK in four ways, which included public, discretionary, secretive, and restricted, or in two ways as referenced by Boisot's (1987) KM model, which were public and proprietary knowledge categories. Cultural norms also defined access to IK according to gender in the local communities;

- Neighbours/friends, agricultural industries input suppliers were not regarded as reliable sources of knowledge which inhibited knowledge sharing activities in some communities;

- Socio, economic, and political status, and knowledgeable farmers determined access to agricultural indigenous and exogenous knowledge in the local communities; and

- All four types of *ba* of Nonaka, Toyama and Konno's (2000) knowledge creation model (originating *ba,* dialoguing *ba,* systematizing *ba* and exercising *ba*) were practiced by the local communities to create and share knowledge for farming purposes, but the systematic *ba* and exercising *ba* processes were only partially fulfilled.

**7.2.3.5 Knowledge preservation**

- Most of agricultural IK was preserved in human minds; and

- Explicit sources of knowledge and artifacts were less used to preserve IK.

**7.2.3.6 Knowledge application**

- The majority of the respondents had applied IK received from explicit and tacit sources of knowledge in their farming systems; and

- Few farmers had not applied agricultural indigenous techniques obtained from explicit and tacit sources of knowledge in their communities.

**7.2.3.7 The role of knowledge intermediaries in managing agricultural indigenous knowledge in the local communities**

- Most knowledge intermediaries captured IK from the local communities, while few of them preserved IK in printed formats; and

- More than half of the knowledge intermediaries used oral communication channels to disseminate IK in the communities, while explicit formats were less used.

**7.2.4 Summary of the legal framework relevant for the protection of agricultural indigenous knowledge in Tanzania**

- There was no overarching policy on IK issues, instead IK was covered by various sectoral policies. However, these policies addressed IK issues inadequately;

- The majority of knowledge intermediaries and all policy makers agreed that it was important to establish policy on IK issues;

- More than half of the farmers indicated that it was important to have a specific policy that would address IK issues within the country;

- The Ministry of Trade, Industries and Marketing, and the IK Trust Fund (a public and private partnership) were still working on the formulation of the IK policy in the country;

- All IK policy makers acknowledged that IPRs were not effective in protecting agricultural IK such as genetic resources and expressions of traditional culture;

- Few local communities and knowledge intermediaries were aware of IPRs that address IK issues in the local communities;

- The policy makers indicated that few communities had expressed their concerns with regard to the protection of their agricultural IK to the IPR related offices; and

- Most farmers did not raise their concerns with regards to the IK protection due to lack of awareness, secrecy and lack of trust to share their knowledge. In addition, the conditions required to apply IPRs were difficult.

**7.2.5 Summary of the access to agricultural exogenous knowledge in the local communities**

- Neighbours/friends were the main sources of agricultural exogenous knowledge, followed by public extension officers and parents/family;

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- Agricultural input suppliers, village meetings, farmer groups, cooperative unions, and NGOs were important sources of agricultural exogenous knowledge in some regions;
- Explicit sources of knowledge were less considered by farmers as important sources of exogenous knowledge for farming activities;
- There were variations of tacit and explicit sources of exogenous knowledge within the regions and within gender categories that existed within them;
- Exogenous knowledge received from various tacit and explicit sources of knowledge was not adequate to fulfil farmers' needs;
- Although farmers had a wider range of sources to access exogenous knowledge from formal sources than IK, they mainly applied IK as compared to exogenous knowledge in their farming systems;
- Few respondents had not applied exogenous knowledge on control of plant diseases and pests, and soil fertilization into their farming systems;
- More than half of the knowledge intermediaries disseminated agricultural exogenous knowledge in the local communities;
- Face-to-face communication was the dominant method used by the intermediaries to disseminate exogenous knowledge in the local communities; and
- Most knowledge intermediaries were involved with information management rather than KM due to inadequate means to evaluate the application of knowledge.

## 7.2.6 Summary of the integration of agricultural exogenous and indigenous knowledge in the local communities

- The majority of the respondents indicated that IK was not sufficient to solve their farming problems;
- Most of the respondents were willing to share their knowledge with the development agencies for improved IKS and farming activities;
- Few farmers indicated that knowledge intermediaries interacted with them in an effort to identify and prioritize their knowledge and needs;
- More than half of the knowledge intermediaries indicated that they involved farmers when developing agricultural technologies;

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- Almost half of the knowledge intermediaries indicated that they involved farmers when disseminating agricultural technologies;
- Almost half of the knowledge intermediaries indicated that they prioritized IK into their rural dissemination strategies;
- Most knowledge intermediaries indicated that they determined farmers' information and knowledge needs; and
- More than half of the knowledge intermediaries indicated that they prioritized farmers' information and knowledge needs in their rural knowledge provision strategies.

### 7.2.7 Summary of the role of ICTs in managing agricultural indigenous knowledge

- Farmers relied more heavily on face-to-face communication than ICTs for IK acquisition, although ICTs were available in their villages;
- Almost half of the farmers had used ICTs to acquire IK;
- Radio was the predominant tool used by farmers to acquire IK in the surveyed communities, followed by cell phones and television;
- Men were more likely to use cell phones and television to acquire agricultural IK than women;
- Most farmers who used ICTs to acquire agricultural IK in the areas under investigation were generally young, with ages between 26 to 35 years;
- Few farmers had used ICTs to share and preserve their agricultural IK;
- Farmers mainly used cell phones to share agricultural IK in the local communities;
- Few respondents applied indigenous techniques gained from ICTs; and
- There were few knowledge intermediaries who used ICTs to capture, preserve and disseminate agricultural IK in the communities.

### 7.2.8 Summary of the access to agricultural exogenous knowledge through ICTs in the local communities

- Most farmers used ICTs to access agricultural exogenous knowledge as compared to IK in the local communities;

- Radio was the dominant ICT used by farmers to access exogenous knowledge on farming systems, followed by cell phones and television;
- There was low use of internet and email to access agricultural exogenous knowledge, despite the fact that community telecentres were already established in the surveyed communities;
- There were no differences on the use of ICTs to access exogenous knowledge in the sampled districts;
- Male farmers were more likely to access exogenous knowledge through ICTs than female farmers across the surveyed communities;
- There was low number of farmers who had applied the exogenous techniques obtained through ICTs;
- Few farmers had not applied the agricultural exogenous techniques they accessed through ICTs; and
- More than half of the knowledge intermediaries had used ICTs to disseminate agricultural exogenous knowledge.

## 7.2.9 Summary of the barriers that hinder the management of agricultural indigenous knowledge and access to exogenous knowledge in the local communities

- Poor recognition of IK, resistance to change, lack of IK records, and poor knowledge sharing culture were the major barriers that inhibited farmers from acquiring IK in their communities;
- Poor recognition of IK, lack of IK records, poor knowledge sharing culture, lack of a knowledge resource centre, lack of trust, and social-economic status were the major barriers which inhibited farmers from sharing their agricultural IK in their communities;
- Lack of efforts to preserve IK, poor recognition of IK, poor knowledge sharing culture, lack of trust, and social status were the major barriers that inhibited farmers from preserving their agricultural IK;
- Lack of IK policy, facilities, funds and training on the management of IK were the major barriers which inhibited knowledge intermediaries in managing agricultural IK in the local communities;

- Poor extension services, lack of access to information materials, lack of a knowledge resource centre, and illiteracy were the major barrier which inhibited farmers in accessing agricultural exogenous knowledge in the local communities;

- Lack of funds, facilities, and trained staff, and long distances were the major factors that limited knowledge intermediaries in disseminating agricultural exogenous knowledge in the communities;

- High cost of ICTs, lack of electricity, lack of local and relevant content, lack of awareness, poor telecommunication infrastructure, and ICT illiteracy were the predominant problems that inhibited farmers in managing IK and access exogenous knowledge through ICTs; and

- Lack of funds, and ICT skills, high level of ICT illiteracy and awareness on the part of farmers, high cost of ICT facilities and poor ICT infrastructure were the major barriers that inhibited knowledge intermediaries from using ICTs to manage IK and disseminate exogenous knowledge in the local communities.

## 7.3 Significance and contribution of the study

This study sought to assess the application of KM approaches and ICTs in managing agricultural IK and introducing relevant exogenous knowledge in the local communities of Tanzania. The study findings were thus of significance by providing the empirical evidence of how KM principles and ICTs can be applied to manage IK and integrate exogenous knowledge to the rural knowledge system for improved agricultural activities. In reality, there are a lot of theoretical studies about KM and IK in developing countries, with very little empirical evidence on the subject under investigation. Few studies (Boateng 2006; Ha, Okigbo and Igboaka 2008) have attempted to analyze the role of KM approaches in the management of farmers' knowledge with few efforts to assess the integration of indigenous and exogenous knowledge in the local communities. This study positively supplemented previous studies and contributed to the body of existing knowledge by assessing how KM approach and ICTs can be used to manage agricultural IK, and to introduce relevant exogenous knowledge in local communities for improved farming activities.

The study was the most comprehensive research to date on the assessment of the application of KM principles and ICTs in managing IK in Tanzania. As a matter of fact, not much has been done in the Tanzanian context with regard to IK management. Previous studies in Tanzania have focused on the role of IK and local innovation for sustainable agricultural development processes (FAO 2006a; Kamwenda 2002; Kilongozi, Kengera and Leshongo 2005; Kweka 2004; Komwihangilo, Goromela and Bwire 1995; Mattee 1998; Mollel 1991; Mshana 1992). The findings of the study were thus of significance by providing a framework on how to improve the management of IK together with the accessibility of the relevant exogenous knowledge in the local communities.

Further, the study's contribution was of significance since it was in line with the recommendations made by various IK studies carried out in Tanzania (FAO 2006a:4; Kilongozi, Kengera and Leshongo 2005; Kweka 2004; Mshana 1992:310). These studies proposed a need to quickly recognise, identify, validate and document agricultural IK for improved farming activities. In addition, Kilongozi, Kengera and Leshongo (2005) and Mascarenhas (2003) emphasized the importance of integrating indigenous and exogenous knowledge for improved farming activities in Tanzania. The findings of this study provided an approach which can be used to improve the management of IK, and access to exogenous knowledge for improved farming activities in the rural areas.

The study was also significant because the policy makers and agricultural development planners are beginning to recognise the need to understand existing IK, its integration with conventional knowledge and its role in decision-making processes (Nakashima and Rou´e 2002; Prakash 2000; Sibisi 2004; Warren and Rajasekaran 1993). For instance, national IK strategies and policies have already been formulated in some of the African countries (Uganda and South Africa) in order to reduce poverty, increase local participation in the development process and ease a transition to outside methods (Ngulube 2007; Nyiira 2003; Sibisi 2004; WIPO 2006). In Tanzania, the president endorsed a six-point action plan in 2004 in order to raise the profile of IK, mainstream IK in country development programs, and secure additional funding from development partners (World Bank 2009a). The study was thus of significance by providing a

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framework for the policy makers on how to improve the management of IK together with exogenous knowledge in the local communities for improved agricultural development processes in Tanzania that could be adopted for us elsewhere in Africa.

The study was also important because agricultural knowledge in Tanzania, if sensitively and wisely applied, "can provide important insights into resource process, possibilities and problems in a particular area and can serve as a link between ecological gaps" (Brokensha, Warren and Werner 1980). Essentially, IK provides opportunities for designing development projects that emerge from priority problems identified within a community and which build upon and strengthen community level knowledge systems and organisations (NUFFIC and UNESCO 1999). Eventually, by suggesting a KM model on the management of IK, and its integration with exogenous knowledge, research and extension systems in Tanzania will be able to develop and disseminate agricultural technologies in collaboration with local farmers, in order to increase the adoption of these technologies for sustainable agricultural development practices.

Theoretically, this study made constructive additions to the existing body of knowledge with regard to the topic in question by applying KM approaches and ICTs in managing agricultural IK. Further, the study provided a foundation for further studies related to the management of indigenous knowledge, and its integration to exogenous knowledge in the local communities.

**7.4 Originality of the study**

The originality of the study involved making an original contribution to knowledge in the following ways: carrying out empirical work that has not been done before in Tanzania; bringing about a synthesis that has not been made before in the country; using already known material such as previous literature but with a new interpretation for IK and KM studies; bringing new evidence to bear on old issues in IK studies; and looking at areas that people in the discipline have not looked at before such as IK and KM issues in the rural areas (Dunleavy 2003:27; Philips 1993 cited in Phillips and Pugh 2005: 63). Further, originality in this study was found in the following: trying out something in Tanzania that has previously been done in other countries;

taking a particular technique such as KM and applying it in the local communities of Tanzania; and being cross-disciplinary (Philips 1993 cited in Phillips and Pugh 2005: 63).

Although this study was built on previous studies of indigenous knowledge from various parts of Africa, it brought new knowledge by focusing on how KM principles and ICTs can be applied to manage agricultural IK in the Tanzanian context. Previous studies in Tanzania have focused on the role of IK and local innovation for sustainable agricultural development processes (FAO 2006a; Kamwenda 2002; Kilongozi, Kengera and Leshongo 2005; Kweka 2004; Komwihangilo, Goromela and Bwire 1995; Mattee 1998; Mollel 1991; Mshana 1992). Apart from assessing the role of IK in farming activities, the present study provided the empirical evidence of the management of agricultural IK, and its linkages to exogenous knowledge by using KM approaches and ICTs in the local communities to improve agricultural activities. The findings of this study were explicitly focused on the Tanzanian context, hence they were original in the use of this perspective.

This study used mixed methods research design in order to expand an understanding from one method to another, and to converge or confirm findings from different sources of data (Creswell 2003:210). The dominant-less-dominant model was used in this study. The qualitative approach was the dominant method because it is regarded as providing better understanding of complex situation, which is social in nature than quantitative method and hence providing a more holistic picture (Cohen, Manion and Morrison  2000: 137-39; Leedy and Ormrod 2005: 95; Powell and Connaway 2007). Qualitative methods are also considered to be more effective in collecting data for IK studies rather than quantitative techniques (Grenier 1998; IIRR 1996; Langill 1999; Sillitoe, Dixon and Barr 2005). Various KM models were also used to provide the theoretical guidance for this study (Boisot 1987; Bouthillier and Shearer 2002; Davenport 1998; Earl 2001; Kruger and Snyman 2005; McAdam and McCreedy 1999; Nonaka and Takeuchi 1995; Probst, Raub and Romhardt 2000; Rowley 2001; Small and Tattalias 2000). Hence, the study anticipated being able to propose a more holistic approach to the management of farmers' knowledge in Tanzania, and thus provided an original contribution to IK management studies.

## 7.5 Conclusions

The conclusions of the study were derived from the research findings. The conclusions were linked to the management of agricultural IK and access to exogenous knowledge in the local communities and how KM approaches could be used to improve the situation. Conclusions about each research objective are presented in the following sections.

### 7.5.1 Conclusions on the characteristics of the respondents

The findings on the characteristics of the respondents indicated that the middle aged and elderly farmers were more involved in the farming activities than young farmers (below 30 years) in the surveyed regions. It can thus be concluded that IK was mainly possessed by elderly people as compared to young farmers because they were well experienced and knowledgeable in the indigenous methods of farming.

The findings of the study revealed that more men farmers participated in the study than women farmers in the sampled districts. The gendered nature of the social, economic and policy systems may have limited women farmers' participation in the study. Indications are that male farmers are more likely to attend the developmental activities (such as, agricultural extension services) in the rural areas than female farmers. Thus, more efforts are needed to link gender issues in the rural KM activities to ensure equal gender participation in KM practices.

The literacy level in terms of ability of the respondents to read and write in the national language (Swahili) was quite high at all research sites. However, more male farmers dominated the highest education category than female farmers. This finding means that there is a low level of formal education among farmers and more often than not women farmers are disadvantaged in terms of access to formal education in the surveyed local communities.

The majority of the respondents were small-scale farmers in the sampled districts. Most of the farming activities were carried out within the family, and thus most farmers possessed agricultural IK. However, there was a difference in the distribution of labour and responsibility between the sexes and age groups in the farmers' families in the surveyed districts. Although

nearly two-thirds of the respondents were men, and more than half of the respondents indicated that there were no differences on the roles of men and women in the farming activities, the analysis of farming roles carried by both genders indicated that women were more involved in the farming activities than men. It can thus be concluded that both genders had different levels of knowledge in the farming systems which could affect their patterns of managing IK and accessing exogenous knowledge in the local communities.

Most farmers under the sample of the study owned a radio followed by, cell phones and televisions. The findings showed that farmers mainly accessed television from their neighbours' homes or social clubs, while cell phones were accessed from neighbours, friends, families, or telephone operators. Thus, the present study established that even if there is limited ownership of some ICTs such as cell phones and television, there are various communal and neighbourly ways and means of accessing these devices. Advanced ICTs such as internet and email had not yet registered high use due to low level of awareness and literacy. Thus, KM projects are more likely to improve agricultural productivity if they use radio and cell phone in the rural areas. More efforts would be needed to enhance the use of other ICTs such as improved infrastructure, awareness, literacy, provision of relevant content, knowledge culture, and language issues.

There were no major variations in the ownership of ICTs by gender. However, there were notable age differences in ICTs ownership. Most owners and users of ICTs in the sample were younger (26 to 36 years) rather than elderly farmers. Indications are that young and male farmers are more likely to use ICTs (especially cell phones) for KM practices than elderly and female farmers. It can be concluded that although there is some progress in ICT ownership especially on radio and cell phones, there are still challenges which need to be considered for effective KM practices in the rural areas. The "digital divide" between various locations and between individuals still existed in the surveyed areas, despite the efforts that had been done to improve access of ICTs in the local communities.

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**7.5.2 Conclusions on the types of agricultural indigenous knowledge and the role of indigenous and exogenous knowledge in the farming systems in the local communities**

Although KM involves a number of processes that move back and forth between different phases, the study findings showed that knowledge identification can form an entry point to the KM processes as indicated in KM models (Noeth 2006; Probst, Raub, and Romhardt 2000). The identification of the company's knowledge environment is important to assess what the organisation knows and how that knowledge adds value to the organisation for effective KM processes (Noeth 2006; Probst, Raub, and Romhardt 2000). The results of the study indicated that local communities possessed a broad base of IK on farming activities, which has proven its worth over centuries, and was very well adapted to the scarcity of resources in the surveyed communities. This knowledge on farming systems was location specific due to differences in agro-ecological conditions, ethnic groups, farming systems, population pressure, and existence of intermediaries who foster the application of organic farming. It can thus be concluded that farmers possessed a wide range of farming knowledge which was closely related to their environmental conditions, farming systems, culture and their interaction with the outside environment which formed the basis for local–level decision making on various issues of farming activities.

The findings indicated that similar local herbs and indigenous inputs were applied in various regions to preserve the same crops and planting materials, and to control the same plant pests. Since IK is site-specific, it can therefore seldom be scaled up without an adaptation, however it can be used to stimulate experimentation and innovation in other communities. It is therefore important to capture, preserve and disseminate this knowledge to other communities for improved agricultural activities.

Although farmers had a broad base of knowledge on various farm tasks, the knowledge and use of plants that repel insects, and medicinal plants for controlling plant and animal diseases and for preserving crops was generally low in the sample under investigation. High use of medicinal plants was found in the Moshi Rural district due to the existence of both FLORESTA NGO and Tanzania Coffee Research Institute (TACRI) which promoted the sharing and use of knowledge

on organic farming. Thus, the knowledge and resources were there, but what was lacking was an effective mechanism of identifying IK holders, in order to acquire, share and preserve IK in the surveyed local communities.

On the role of indigenous and exogenous knowledge in the farming systems, the findings indicated that farmers mainly employed indigenous and exogenous knowledge and practices in crop production as compared to livestock management. This finding indicates that farmers possessed an extensive base of knowledge on crop farming as compared to livestock management in the sampled communities. High costs of livestock management and lack of skills may have limited most farmers' involvement in animal husbandry.

The findings indicate that there was high use of indigenous knowledge and techniques for improving soil fertility, acquisition of planting materials, cropping systems, crop planting systems, weed control, irrigation, and control of predators and plant pests as compared to conventional inputs in the sample communities. There was also high use of exogenous knowledge and techniques in the preservation of planting materials and crops, control of animal diseases, and animal husbandry, as compared to local inputs. However, the majority of the farmers did not use any measure to control plant disease and pests. When the use of local herbs and conventional inputs was compared in the control of plant diseases and pests, the latter was more commonly used than the former. The extensive use of exogenous knowledge in some farming aspects was linked to ignorance because as farmers acquired more exogenous knowledge, they tended to ignore other knowledge modes including their own knowledge. It is therefore the conclusion of this study that there is a need for awareness creation to enable farmers to find a balance between unhealthy and healthy ignorance for effective KM activities in the rural areas as proposed by Probst, Raub, and Romhardt (2000).

Overall, it can be concluded that the identification of IK types was important to determine and understand what farmers knew and how that knowledge could be located to add value to the agricultural activities. Agricultural development would best be served by educating researchers and extensionists in the significance, complexity and usefulness of local knowledge (Hart 2007).

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### 7.5.3 Conclusions on the management of agricultural indigenous knowledge in the local communities

Despite the fact that various KM models (Bouthillier and Shearer 2002; Nonaka, Toyama and Konno 2000; McAdam and McCreedy 1999; Probst, Raub, and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) use different labels to identify KM processes, the following KM processes were practiced by the local communities to manage their agricultural knowledge and the conclusions in this section are provided according to these KM processes: knowledge and information needs and identification, acquisition, development, sharing, preservation, and application (see Section 3.3.2 of Chapter Three). The study findings as in line with the Rowley's (2001) KM model showed that both tacit and explicit knowledge contributed to each of the KM processes.

### 7.5.3.1 Conclusions on the knowledge and information needs and identification

The study findings demonstrated what various KM models (Earl 2001; Noeth 2006; Probst, Raub, and Romhardt 2000) have emphasized that it is important to identify internal and external knowledge to guarantee transparency, and to help individual and groups locate what they need for effective KM practices. Despite the fact that the communities possessed an extensive base of IK, the findings showed that there was a huge knowledge gap in the sampled districts. The major knowledge gaps identified in this study included control of plant diseases and pests, marketing, credit and loan facilities, and control of animal diseases. It is therefore the conclusion of this study that most of the knowledge intermediaries' services were inadequately driven by the farmers' needs in the surveyed communities. Issues related to resources and finances contributed to this situation.

The knowledge and information needs of the farmers were location and gender specific due to slight variations in agricultural activities, agro-ecological conditions, state of development per village and the presence of knowledge intermediaries such as extension officers, and NGOs. The information needs were gender specific due to different cultural responsibilities of the genders in the farming activities. In view of the data presented, it can be concluded that individuals may have different levels of knowledge on farming systems, and various knowledge needs which may dictate different patterns of seeking knowledge to fulfil their knowledge gaps.

It was evident from the findings that slightly more than half of the respondents had tried to look for ways to solve their knowledge and information problems in the local communities. The major reasons for those ones who did not tackle their problems appeared to be poor extension services, lack of awareness, distant location, low response from the authorities, personal and social barriers, and lack of funds and resources. The study's findings as in line with Probst, Raub and Romhardt's (2000:73) KM model showed that the knowledge gaps are mainly caused by the lack of a way to identify particular kinds of knowledge, both internally and externally. While, it is important to nurture a culture for learning and knowledge sharing in the local communities, it is also important to map knowledge sources for easy identification of knowledge bearers. The government should also address finance and resources based problems for effective extension and research services.

The study findings illustrated what various KM models (Earl 2001; Probst, Raub and Romhardt 2000) have indicated that the face-to-face communication is a key way to identify knowledge sources anywhere in organisations rather than ICTs and knowledge databases. The study findings showed that farmers largely sought knowledge from friends/neighbours, followed by extension officers, agricultural input suppliers, and family/parents to fulfil their knowledge needs. Farmers made little use of ICTs (that is radio and television), and printed materials. This study can also conclude that even if ICTs and printed sources are available, the local communities are more likely to use face-to-face communication and probably radio to fulfil their needs.

These findings also indicate that farmers identified both indigenous and exogenous knowledge from within and outside the community to fulfil their knowledge gaps. The study findings as in line with other KM models (Earl 2001; Probst, Raub, and Romhardt 2000) showed that the identification of both local and external sources is important for effective KM activities. It is actually at this stage that mapping becomes significant for locating experts within and outside the local communities, and for the purpose of integrating indigenous and exogenous knowledge systems.

**7.5.3.2 Conclusions on the acquisition of agricultural indigenous knowledge**

The study findings showed that the acquisition of knowledge involves the importation of substantial amounts of knowledge from internal and outside sources of the community as indicated in the KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub, and Romhardt 2000). The study findings showed that IK was predominantly local, tacit and it was mainly transmitted through oral cultures, such as individual and collective interactions, observation, demonstrations, mentoring, and own experiments. Farmers made little use of formal sources of knowledge (public and private extension services) and printed materials to acquire IK. The findings suggest that rural KM initiatives did not prioritize IK, which indicates the dominance of exogenous knowledge system over IK. It can thus be concluded that even if printed materials are used, rural people will continue to rely on face-to-face communication. Therefore, there is a need to strengthen these social networks to share and distribute IK beyond the narrow ranges of these networks in the local communities for effective KM practices.

There were also marked location differences in people's acquisition of IK from formal sources of knowledge. However, there were slight differences in access to IK across gender categories in the surveyed communities. Women farmers seemed dependent on local sources of knowledge, while male farmers had access to a much larger set of formal sources of knowledge. Given the fact that more men participated in the study than women, this finding shows the socio-economic, cultural and educational imbalances of gender in the development activities in the surveyed communities. Based on the findings, it can thus be concluded that the rural KM initiatives inadequately prioritized IK and its linkages to gender in the surveyed communities.

It was clear from the findings that the majority of respondents obtained IK on crop husbandry, new varieties and techniques, and value added techniques from tacit and explicit sources of knowledge. There was limited access to knowledge on animal and plant diseases, markets and credits from tacit and explicit sources of IK, and that is why they were amongst the major knowledge needs of the farmers. Indications are that IK cannot solve all farming problems in the communities. This finding suggests that the integration of exogenous knowledge in the IKS is important to strengthen the existing knowledge system in the local communities.

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**7.5.3.3 Conclusions on the development of agricultural knowledge**

The findings as in line with KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub, and Romhardt 2000; Rowley 2001) showed that knowledge can be constructed within the social and scientific paradigms. The social paradigm of various KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub and Romhardt 2000) was also similar to the socialization sub-process of Nonaka and Takeuchi's (1995) knowledge creation model. At the same time, the findings showed that all four types of Nonaka and Takeuchi's (1995) knowledge creation model (socialization, combination, externalization, and internalization) were practiced by the local communities to create new knowledge for farming purposes, but the externalization, combination and internalization processes were practiced at a low rate. On the whole, it can be concluded that knowledge was mainly created within the social paradigm more than the scientific paradigm in the surveyed communities. Knowledge was created through creativity and problem solving at the individual level, while it was generated through learning from others at the collective and individual levels. However, there is a need to increase farmers' participation in the agricultural participatory research activities, and to nurture the knowledge sharing culture so that the communities can externalize their knowledge, and combine multiple sources of explicit knowledge, to create new knowledge.

These findings demonstrated what KM models (McAdam and McCreedy 1999; 2000; Probst, Raub, and Romhardt 2000; Rowley 2001) have emphasized that internal knowledge may be combined with other internal or external knowledge to create new knowledge. Thus, new knowledge may be indigenous knowledge or a blend of indigenous and other forms of knowledge which is closely related to the agro-ecological conditions of a certain locality. It can thus be concluded that it is important to identify and recognise local innovators or IK bearers as an entry point for linking holders of local and conventional knowledge in a better-functioning participatory approach in the local communities as suggested by Waters-Bayer *et al.,* (2006).

**7.5.3.4 Conclusions on the sharing of agricultural indigenous knowledge**

The study findings were in line with Probst, Raub and Romhardt's (2000:168) KM model which shows that various instruments are important to support the sharing and distribution of organisational knowledge which cover all physical, technical and organisational aspects of

individual and group working contexts. The findings of the study indicated that various indigenous cultures and structures enabled the sharing of knowledge in the local communities, which included farmer groups, and cultural practices such as apprenticeships, folklore and initiation rites. However, these cultural practices were practiced at a low rate to share agricultural knowledge in the surveyed local communities. It can thus be concluded that it is important to strengthen these cultural practices to improve sharing of IK in the local communities.

Although few farmers were involved in farmer groups in the sample of the study, these groups were a useful means to share agricultural knowledge in the local communities. Farmer groups were mainly used to share knowledge on conventional farming as compared to indigenous farming, which indicates the dominance of exogenous knowledge over IK. It was evident from the present findings that the majority of the agricultural related associations were registered (77.8%), while few (27%) farmer groups were self-managed. Most of the registered farmer groups were able to acquire training from the public and private agricultural actors which activated knowledge creation and sharing activities through the scientific paradigm as illustrated by various KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub and Romhardt 2000; Rowley 2001). The existence of informal social gatherings and self-managed farmer groups in the surveyed regions showed that CoPs were already there, and thus they needed to be nurtured and strengthened for effective knowledge sharing activities in the communities.

The findings established that access to agricultural indigenous and exogenous knowledge in the local communities was determined by the traditional cultures, status, trust, and context and space in the local communities as was suggested by various KM models (Davenport 1998; Earl 2001; Nonaka, Toyama, and Konno 2000; Probst, Raub and Romhardt 2000; Small and Tattalias 2000). In traditional cultures, the findings indicated that while most of the knowledge was made public, some of it was accessed through clan-based structures (discretionary), other knowledge was accessed through inheritance (secretive), and some knowledge was accessed through social structures, and thus it was restricted to the public. These research findings related to Boisot's (1987) KM model which shows that some knowledge can be codified and diffused (public

knowledge), while other knowledge can be codified but it cannot be diffused, namely proprietary knowledge. Proprietary knowledge can be linked to the discretionary, secretive and restricted knowledge categories as identified in the current study. Cultural norms also defined access to IK according to gender in the local communities. Further, access to knowledge in the communities was exerted through the power that the cultural leaders had on some agricultural issues in some communities. It can thus be concluded that access to agricultural knowledge was shaped and informed by the cultural context from which it was drawn. Power relationships within communities also determined the type and level of knowledge creation, sharing and use in the local communities, and they occurred within a cultural context.

The findings indicated that while trust enabled knowledge sharing between farmers and parent and/or family, farmer groups and public and private extension officers, other sources of knowledge such as neighbours/friends, agricultural industries input suppliers were deemed untrustworthy and thus knowledge sharing activities were inhibited. These findings indicate that while trust can enable knowledge sharing in the local communities, it can also inhibit access to knowledge if it is not nurtured. Thus, the study findings demonstrated what KM models (Nonaka, Toyama and Konno 2000; Probst, Raub and Romhardt 2000) have indicated that mutual trust amongst organisational members is important as it forms the foundation of knowledge to be shared and for the self-transcending process of knowledge creation to occur.

Status such as wealthy, political position, and being a knowledgeable farmer determined access to agricultural indigenous and exogenous knowledge in the local communities. It can thus be concluded that power relationships and status determine people's motivation to share and the direction of knowledge flows in the community as it was suggested by various KM models (McAdam and McCreedy 2000; Probst, Raub and Romhardt 2000; Nonaka and Takeuchi 1995).

The findings established that the shared context or *ba* enabled farmers to create, share and apply knowledge for farming and marketing purpose in the local communities. The findings illustrated that all four types of *ba* (originating *ba,* dialoguing *ba,* systematizing *ba* and exercising *ba*) of Nonaka, Toyama, and Konno's (2000) knowledge creation model were practiced in the surveyed

communities to create and share knowledge for farming purposes, but the systematic *ba* and exercising *ba* were partially fulfilled. It can thus be concluded that farmers depended on physical space (where originating *ba,* and dialoguing *ba* occurred) to share and create knowledge, while virtual space (systematizing *ba* and exercising *ba*) was used at a minimal rate to share and create knowledge in the local communities.

**7.5.3.5 Conclusions on the preservation of agricultural indigenous knowledge**
The findings established that most of agricultural IK was preserved in human minds. Explicit sources of knowledge and artifacts were used at a low rate to preserve IK in the surveyed local communities. Based on the findings, it can be concluded that IK was limited by knowledge loss due to the lack of awareness, and prescribed structures and rules to facilitate the preservation of knowledge as one would find in the formal organisations. There is thus a need to select knowledge from many events, persons and processes that are worth retaining, preserving and updating as suggested by KM models (Probst, Raub and Romhardt 2000; Rowley 2001).

**7.5.3.6 Conclusions on the application of agricultural indigenous knowledge**
The findings established that the majority of the respondents had applied IK obtained from explicit and tacit sources of knowledge in their farming systems. IK on crop husbandry, new techniques and varieties, and animal husbandry were the most applied agricultural indigenous techniques in the communities. High use of crop husbandry techniques explains why intercropping and random sowing techniques were the dominant techniques applied by farmers despite their ineffectiveness for farming activities. These findings suggest that farmers tended to apply knowledge that they trusted and one which did not challenge their own ideals. The low use of IK to control animal and plant diseases and value added techniques was linked to ignorance because as farmers acquired exogenous knowledge, they also tended to ignore other knowledge modes including their own knowledge system. These findings indicate a need to strike a balance between unhealthy and healthy ignorance for effective flow and utilisation of knowledge as already suggested by Probst, Raub, and Romhardt's (2000) KM model.

The majority of farmers applied IK received from tacit and explicit sources of knowledge because of its effectiveness, availability, affordability, increased productivity, and no other

alternative available. These findings were in line with various KM models (Earl 2001; Probst, Raub and Romhardt 2000; Rowley 2001) which show that the access to relevant knowledge can enhance the performance of business and management processes in the organisations.

Few farmers had not applied IK obtained from explicit and tacit sources of knowledge in their farming systems. When compared to the non-application of exogenous knowledge in the farming systems, the findings established that most farmers had not applied IK 69 (38.1%) in their farming systems as compared to exogenous knowledge 54 (29.8%). Despite the fact that most farmers applied IK into their farming systems, IK loss was prevalent. It is thus important to find ways to preserve IK before it disappears all together.

**7.5.3.7 Conclusions on the role of knowledge intermediaries in managing agricultural IK**
Most knowledge intermediaries captured IK from the local communities, while few of them preserved IK in printed formats. IK was mainly collected through individual and collective face-to-face communication. The major purpose of collecting IK was for extension services, interest in managing IK, and research. More than half of the knowledge intermediaries used oral communication channels to disseminate IK in the communities, while explicit formats were less used. The findings indicated that face to face communication in the local communities was the norm, since it was inherent to the indigenous culture and thus farmers are more likely to acquire and understand knowledge disseminated through this approach than in explicit format. These findings also suggest that not only is IK inadequately preserved by the local communities, but it is also less stored by the knowledge intermediaries. Despite the fact that the role of knowledge managers is well emphasized by various KM models (Davenport 1998; Earl 2001; Nonaka, Toyama and Konno 2000), this principle was partially fulfilled in the sample of this study since the knowledge intermediaries were more involved in capturing IK than disseminating and preserving it, which contributed to IK loss in the rural areas.

**7.5.4 Conclusions on the legal framework relevant for the protection of agricultural indigenous knowledge in Tanzania**
Although IK was covered by various sectoral policies, these policies inadequately addressed IK issues in the country. This finding showed that the Ministry of Trade, Industries and Marketing,

and the IK trust fund (a public and private partnership) were still working on the formulation of IK policy in the country. It is apparent that public and private partnership efforts are needed to foster the establishment of IK policy in the country for effective KM processes as already suggested by various KM models (Davenport 1998; Earl 2001; Kruger and Snyman 2005; Small and Tattalias 2000).

All IK policy makers acknowledged that IPRs were not effective to protect agricultural IK such as genetic resources and expressions of traditional culture. The current IPR system emphasized the protection of individual rights over IK which was derived from western cultures, and thus it ignored the collective ownership of IK in the local communities. In the absence of effective IPR, the findings showed that other people (both local and international) had either commercialized or published some of the IK without any attribution, reciprocity, or benefit sharing with the local communities. It is thus important to improve the existing IPR in order to protect IK from misappropriation. These findings as in line with KM models (Davenport 1998; Earl 2001; Probst, Raub and Romhardt 2000) emphasize that the acquisition of intellectual property is an important way of protecting and exploiting a communities' knowledge or intellectual assets to produce revenue streams. It is thus important to focus on the policies and legalities of knowledge management if IK is to become a valued resource in the communities and effective for farming activities.

Few local communities and knowledge intermediaries were aware of IPR that address IK issues in the local communities. As a matter of fact, the policy makers indicated that few communities had expressed their concerns with regard to the protection of their agricultural IK to the IPR related offices. Although the conventional ways of disclosing tacit IK might present a challenge, the traditional ways of keeping tacit IK through secrecy without documenting it might continue to encourage people to misappropriate IK under the framework of IPR. Even if the local communities are aware of IPR issues, they would not be able to protect their IK because the existing legal regime inadequately recognises and protects IK. It is thus important to improve the existing IK policies and IPR to promote and protect IK for effective KM practices in the

communities as emphasized by various KM models (Davenport 1998; Earl 2001; Probst, Raub and Romhardt 2000).

## 7.5.5 Conclusions on the access to agricultural exogenous knowledge in the local communities

The study findings as in line with various KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub, and Romhardt 2000; Rowley 2001) showed that farmers acquired exogenous knowledge from within and outside their communities for effective KM practices. Local sources such as neighbours/friends were the main sources of agricultural exogenous knowledge in the local communities, followed by public extension officers and parents/family. Explicit sources of exogenous knowledge were less considered by farmers as important sources of exogenous knowledge for the farming activities. The issue here is that farmers try to reduce risk by contacting multiple sources of knowledge in order to trust a certain type of technology. This fact explains why farmers relied more on their neighbours than extension officers. The findings also suggest that farmers will continue to rely on face to face communication than printed materials to access exogenous knowledge in the communities as suggested by Earl's (2001) KM model and Meyer and Boon's (2003) Merger model.

There were variations of tacit and explicit sources of agricultural exogenous knowledge within the surveyed communities and within gender categories that existed within them. The findings suggest that KM strategies should consider gender issues so that women and other vulnerable groups are not left behind in this knowledge era. Further, exogenous knowledge received from various tacit and explicit sources was partially consistent with the farmers' needs. The majority of the respondents obtained exogenous knowledge on new varieties and techniques, crop husbandry and control of animal diseases from tacit and explicit sources of knowledge. Knowledge on markets and credits was accessed at a low rate from the tacit and explicit sources of knowledge, although they were the major farmers' knowledge and information needs. Based on these findings, it can be concluded that there are still gaps in the rural KM strategies since farmers' needs were not fulfilled.

Although farmers had a wider range of sources for accessing exogenous knowledge than IK in the communities, they mainly applied IK in their farming systems as compared to exogenous knowledge in some farming aspects. This finding was in line with the Davenport (1998) KM principle which indicates that effective identification, and sharing and distribution processes of agricultural exogenous knowledge cannot guarantee that knowledge will be utilised for farming activities. The findings also showed that farmers tended to believe in their own knowledge and skills over external knowledge on some aspects of farming techniques. This finding illustrated what Probst, Raub, and Romhardt's (2000) KM model has emphasized that most people tend to over-estimate their own skills for fear of losing their own expert status, which blocks the use of new knowledge.

The majority of the respondents had applied exogenous knowledge and techniques on crop husbandry, and new varieties and techniques. These findings showed that the application of exogenous knowledge in the farming systems was linked to relevancy, increased production and income, and lack of indigenous skills and resources. The findings indicated that the extent to which new knowledge is used depends on the quality, convenience of accessing it, and the media in which it is available as proposed by KM models (Probst, Raub and Romhardt 2000; Rowley 2001).

The findings show that few respondents had not applied conventional knowledge and techniques to control plant diseases and pests, and soil fertilization in their farming systems. High cost of inputs, toxicity and hazardous effects, labour intensiveness, psychological barriers, markets, and land scarcity were the major factors that limited farmers in using exogenous knowledge and techniques in their farming systems. Thus all these factors contributed to farmers' decisions to trust and apply their own knowledge and ignore external knowledge. The findings illustrated what Probst, Raub and Romhardt's (2000) KM model has indicated that new knowledge may not be applied due to the organisational blindness and a general mistrust of outside knowledge.

More than half of the knowledge intermediaries disseminated agricultural exogenous knowledge in the local communities. Face-to-face communication was the dominant method used by

intermediaries to disseminate exogenous knowledge in the communities. The findings showed that most knowledge intermediaries in the surveyed communities were involved with information management rather than KM due to inadequate means to evaluate the use of knowledge in the communities. Personal visits, farmer groups and farmer field schools were the major methods used by knowledge intermediaries to evaluate their knowledge provision strategies. These findings showed that individual and collective face-to-face communication were the major means by which farmers would continue to use more than the print medium to access exogenous knowledge in the local communities.

### 7.5.6 Conclusions on the integration of agricultural exogenous and indigenous knowledge in the local communities

The majority of the respondents indicated that IK was not sufficient to solve their farming problems. High use of exogenous knowledge and techniques in the preservation of planting materials and crops, control of animal and plant diseases and pests, and animal husbandry showed that IK was not sufficient to solve these problems and thus local farmers had to use exogenous techniques to solve these problems. This finding does not mean that exogenous knowledge is superior to IKS, but exogenous knowledge needs to be put into a local context to increase understanding and strengthen IKS instead of replacing it. As a matter of fact, most of the respondents were willing to share their knowledge with the development agencies in order to improve their IKS and farming activities. Thus, the findings of the study were in line with various KM models (Bouthillier and Shearer 2002; Earl 2001; Probst, Raub and Romhardt 2000; Rowley 2001) which emphasize that organisations need access to knowledge from within or outside their organisational environment for effective KM processes.

Most farmers indicated that the rural knowledge intermediaries interacted inadequately with them in an effort to identify and prioritize their agricultural IK in their rural KM strategies. Thus, most of the agricultural technologies were less adopted by farmers because their knowledge was not recognised. Poor linkages between information and knowledge providers and farmers may hinder innovation, better ideas and integration of knowledge between farmers and providers and amongst farmers themselves. These findings explain why farmers applied IK more than

exogenous knowledge gained from tacit and explicit sources of knowledge. It can thus be concluded that farmers' knowledge and that of providers will only be integrated if farmers' knowledge and needs are recognised, identified and prioritized by providers in their KM strategies in the rural areas.

The findings from the local communities also indicated that the participatory approaches were already introduced, however the intermediaries (extension officers, researchers and NGOs) used these approaches at a low rate to identify and prioritize IK in the surveyed communities. It can also be concluded that there is a need to increase the use of participatory approaches in agricultural research and extension services since they can provide a better opportunity for joint learning and sharing of knowledge amongst farmers and knowledge intermediaries in the surveyed regions. There is a need to encourage farmers to join farmer groups, and to form communities of practice since they are useful means for sharing and integrating different knowledge systems.

Further, the study findings from the knowledge intermediaries showed that more than half of the knowledge intermediaries involved farmers when developing agricultural technologies. Almost half of the knowledge intermediaries involved farmers when disseminating agricultural technologies. However, limited number of extension officers and other constraints related to costs and resources inhibited knowledge intermediaries in involving many farmers in technology development and dissemination. Knowledge intermediaries mainly used demonstration plots and farmer groups to involve farmers in technology development and dissemination. Based on the findings, it can also be concluded that participatory approaches were already introduced in the rural areas to determine farmers' knowledge, however the knowledge intermediaries were inhibited by various factors which limited them in reaching many farmers. Thus, farmers thought that their knowledge and needs were not recognised in the rural knowledge provision strategies.

The findings also showed that almost half of the knowledge intermediaries indicated that they prioritized IK in their rural dissemination strategies. These findings correspond with the earlier findings from the local communities which showed that few knowledge intermediaries

prioritized agricultural IK. Based on the findings, it can be concluded that farmers' knowledge was not prioritized in the rural KM strategies which contributed to the low adoption of exogenous technologies in the farming systems in the local communities. Thus, the integration of indigenous and exogenous knowledge in the local communities will not be feasible, unless farmers' knowledge is recognised and prioritized in the rural KM strategies. The recognition and prioritization of farmers' knowledge will increase farmers' confidence that their knowledge is valued, and knowledge intermediaries will be able to incorporate farmers' knowledge into the mainstream knowledge system for further improvement.

While the communities thought that their needs were neither identified nor prioritized by the knowledge intermediaries, most knowledge intermediaries reported that they identified and prioritized farmers' needs. Slightly more than half of the knowledge intermediaries indicated that they satisfied their users' needs. It is thus important for the knowledge intermediaries to coordinate their efforts in an attempt to identify and prioritize farmers' needs for effective KM practices in the local communities. The recognition and prioritization of farmers' needs will enable farmers to accept and utilize new knowledge in their farming system. The findings of the study also agree with Boateng's (2006) circular KM model, which emphasizes that the agricultural extension practice must aspire to bring the communities of extension experts and farmers together in all the KM phases (that is, from knowledge creation to utilisation) in an effort to incorporate farmers' knowledge in the extension system and inform farmers' decisions regarding improved technologies or new ways of farming for effective KM practices

### 7.5.7 Conclusions on the role of ICTs in managing agricultural indigenous knowledge

The study found out that farmers relied more heavily on face to face communication to acquire IK than on ICTs, although ICTs were available in the surveyed villages. The study findings showed that almost half of the farmers had used ICTs to acquire agricultural IK. The study also indicated that farmers are more likely to continue using face to face communication and probably radio and cell phones, while other advanced ICTs such as internet and email will have low use. These findings demonstrated what KM models (Bouthillier and Shearer 2002; Davenport 1998; Earl 2001; Kruger and Snyman 2005; McAdam and McCreedy 2000; Probst, Raub and

Romhardt 2000; Rowley 2001; Small and Tattalias 2000) have emphasized that people should be central to any technological intervention in KM. Thus, it is important to build the capacity of the local people, improve infrastructure and create a knowledge culture for effective KM practices through ICTs in the surveyed communities.

There were no differences with respect to the use of ICTs to access IK in the sampled regions. However, there were remarkable variations with regard to the use of ICTs to acquire agricultural IK by gender and age. It was obvious that the gender digital divide was still prevalent, where the share of female farmers was considerably lower than that of male farmers in the use of ICTs (such as, cell phones and television) to access IK in the local communities. The findings also showed that most farmers who used ICTs to acquire agricultural IK in the areas under investigation were generally young, between 26 to 35 years of age. It is therefore safe to conclude that despite the development of ICTs in the rural areas, there are still disparities among individual farmers in access to ICTs for IK acquisition.

Farmers mainly acquired IK on new varieties and techniques, crop husbandry practices, and soil fertility from ICTs, which did not cater for their major knowledge needs which were: control of plant diseases, marketing and credit. However, there were similarities between IK received from ICTs and that knowledge obtained from tacit and explicit sources of knowledge in the communities. IK on new varieties and techniques, and crop husbandry were the dominant knowledge types received from ICTs and tacit and explicit sources of knowledge in the communities. It can thus be concluded that ICTs were important tools for disseminating agricultural IK in the local communities, although they did not cater for some of the farmers' needs. There were only two community radio stations in the surveyed regions. Thus, most farmers depended on national radio and television broadcasts which did not fulfil their needs because their aim was to cater for the farmers' needs country wide.

ICTs were less used to share agricultural IK in the communities, in spite of their availability in the surveyed communities. Overall, cell phones are increasily becoming an important commmunication medium for sharing knowledge in the surveyed communities. The use of SMSs

has significantly increased the use of cell phones for sharing agricultural IK in the communities. Emails were the second most important channels probably because knowledge intemediaries assisted farmers to use them to acquire and share agricultural IK from research institutes in some communities. These findings show that capacity building is an important aspect to improve use of ICTs especially emails for sharing IK in the local communities.

There was low use of ICTs to preserve agricultural IK in the communities. Despite the fact that the Tanzania ICT policy recognises the importance of documenting local content, few efforts have been made to build the capacity of the local communities to document their own knowledge via ICTs.

The rate of respondents who had applied indigenous techniques obtained through ICTs was low. Farmers mainly applied agricultural IK gained from tacit and explicit sources of knowledge, as compared to IK gained from ICTs. Based on the findings, it can be concluded that farmers are more likely to apply knowledge disseminated through the indigenous communication mechanism that they are familiar with compared to other approaches such as ICTs as suggested by Earl's (2001) KM model and Meyer and Boon's (2003) Merger model.

Further, the research finidngs from the knowledge intermediaries showed that few intermediaries had used ICTs to capture, preserve and disseminate agricultural IK in the communities. Cell phones, digital photographs and internet were the major ICTs used by knowledge intermediaries to capture IK in the communities, while radio was mainly used to disseminate agricultural IK. Personal computers were the major ICTs used by knowledge intermediaries to preserve agricultural IK. Most knowledge intermediaries preferred to use oral communication channels as compared to ICTs, since oral medium is inherent to the indigenous communication approaches. Based on the findings, it can be concluded that not only did few farmers use ICTs to manage their knowledge, but also knowledge intermediaries inadequately used ICTs to manage farmers' IK although they were expected to be major users of ICTs. Various factors constrained the knowledge intermediaries in using ICTs, which included lack of facilities, funds, ICT training and skilled personnel. However, the study findings showed that there is a growing interest in the

use of ICTs to manage IK among the knowledge intermediaries in the surveyed local communities. The effective use of ICTs would prevent the disappearance of IK through IK holders' death or memory lapses which were common in the surveyed communities.

## 7.5.8 Conclusions on the access to agricultural exogenous knowledge through ICT in the local communities

There was high use of ICTs to access agricultural exogenous knowledge as compared to IK in the local communities, which shows the predominance of the exogenous knowledge system over IK. The findings showed that apart from face to face communication, radio was an important ICT for disseminating exogenous knowledge in the rural communities due to its oral nature, low cost and its independency to electricity. Cell phones were also important ICTs used by rural farmers to seek advice regarding their farming problems, while advanced ICTs (such as internet and email) had yet to register high use despite their existence in the areas under investigation. Thus, any KM initiative that needs to invest at the grassroots level should focus on the use of radio and cell phone, while the use of advanced ICTs (such as internet and email) for disseminating agricultural exogenous knowledge is still yet to be realised.

There were no differences with respect to the use of ICTs to access exogenous knowledge in the sampled districts. However, there were gender and age differences on the use of ICT services to access exogenous knowledge in the surveyed regions. Male farmers were more likely to access exogenous knowledge through ICTs (that is, radio, cell phones, and televisions) than female farmers across the surveyed communities. Further, the study indicated that the percentages for the young farmers (aged between 26-35 years) were relatively higher in the use of cell phones, internet and video cassette to access exogenous knowledge than elderly farmers. These findings indicate that the digital divide is still prevalent among individuals in the surveyed communities.

The findings showed that the majority of the respondents accessed exogenous knowledge on new varieties and techniques, and crop husbandry practices from ICTs, which did not cater for their major knowledge needs which were plant disease control, marketing and credit. The inadequate number of community radio services, lack of skills, and relevant content contributed to these

knowledge gaps in the local communities. On the whole, these findings show that ICTs are important in equipping farmers with current and timely knowledge and information to improve their agricultural practices and marketing strategies. Thus, the combination of face-to-face communication and ICTs for KM practices in the rural areas cannot be over-emphasized.

Few farmers had applied exogenous techniques obtained through ICTs. The findings indicated that farmers applied exogenous knowledge gained from tacit and explicit sources of knowledge, as compared to knowledge gained from ICTs. This finding means that oral communication channels are effective ways for delivering exogenous knowledge in the local communities as compared to ICTs. Despite the low use of agricultural exogenous knowledge from ICTs, the results indicated that there were no diferences between the major knowledge types adopted from tacit and explicit sources of knowledge, and those ones adopted from ICTs which were exogenous knowledge on crop husbandry practices and new techniques and varieties. The application of agricultural exogenous knowledge received from ICTs was linked to improved production, control of animal diseases, simplified field operations and increased income. Despite the low rate of adoption, it can be concluded that ICTs can play a key role in disseminating relevant exogenous knowledge which can be used to improve agricultural productivity and increase income of the local communities. However, there is a need to combine ICTs and face-to-face communication channels for effective use of the gained knowledge in the local communities.

The findings showed that few farmers had not applied exogenous techniques which they accessed through ICTs. Most farmers had not applied exogenous techniques on soil fertility and new varieties and techniques. The non-application of agricultural exogenous technologies was associated with high costs of inputs,  irrelevant technologies, lack of skills, land scarcity, and lack of observable improvement from the use of these methods by other farmers. The fact that farmers tended to adopt new technologies when they have seen the improvement of the use of these methods by their fellow farmers, shows that farmer-to-farmer promotion of agricultural technologies is very important even when ICTs are used.

The research findings from the knowledge intermediaries showed that more than half of the intermediaries had used ICTs to disseminate agricultural exogenous knowledge. The internet services through telecentres, cell phone and radio were the main ICTs used by the knowledge intermediaries to disseminate agricultural exogenous knowledge to farmers. Despite the fact that most knowledge intermediaries provided internet services to the rural communities, few farmers used internet directly to access agricultural exogenous knowledge due to high costs to access internet, and lack of awareness, lack of ICT skills and poor local content. It can thus be concluded that the use of ICTs by the intermediaries is still growing and thus they have not yet achieved their full impact in knowledge acquisition in the rural areas. This fact shows that the digital divide is still prevalent in the surveyed regions.

The findings indicated that most knowledge intermediaries ranked ICTs as effective tools for disseminating exogenous knowledge in the local communities. These findings indicate that multiple and a variety of technologies could be identified and used in the future as new technologies emerge since there is increasing awareness and growing interest in the use of ICT to disseminate exogenous knowledge in the rural areas.

**7.5.9 Conclusions on the barriers that hinder the management of agricultural indigenous knowledge and access to exogenous knowledge in the local communities**

The findings indicated that farmers faced various challenges which inhibited them to acquire, share and preserve their agricultural IK. These barriers ranged from the personal, social, and technological to the external environment such as lack of IK records, IK policy, rural knowledge resource centres, and IPR that protects IK. It can thus be concluded that issues related to policies, infrastructure, resources, skills and culture were the major barriers that hindered farmers and knowledge intermediaries in acquiring, sharing and preserving IK in the local communities.

The major barriers which inhibited farmers in accessing agricultural exogenous knowledge in the local communities were related to poor extension services, lack of access to information materials, lack of a knowledge resource centre, and illiteracy. Poor knowledge sharing culture amongst farmers, poor management of farmer groups, lack of inputs, lack of trust, distant

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location; and lack of a bookshop and agricultural shops were other barriers that limited access to exogenous knowledge in the communities. The major problems that inhibited knowledge intermediaries from disseminating exogenous knowledge could be identified in the following categories, which include: funds, infrastructure, staff development, farmers' related problems (that is, illiteracy, management of farmer groups, low adoption rate, and poor reading habits), and poor linkages among knowledge intermediaries. It can thus be concluded that farmers and knowledge intermediaries face various problems, most of which were related to financial and physical resources, skills, and knowledge sharing culture.

The findings show that apart from infrastructural issues, other factors may also limit farmers from accessing indigenous and exogenous knowledge through ICTs, which include relevancy, skills, language, financial, follow up from professionals, and personal barriers. On the other hand, lack of funds, and ICT skills, high level of ICT illiteracy and awareness on the part of farmers, high cost of ICT facilities and poor ICT infrastructure were the major barriers that inhibited knowledge intermediaries from using ICTs to manage IK and disseminate exogenous knowledge in the local communities. It can thus be concluded that issues related to capacity building, infrastructure, facilities, financial constraints, and culture need to be addressed for effective KM activities through ICTs in the local communities.

### 7.5.10 Overall conclusion about the research objectives

The aim of the study was to find out the extent to which KM models and ICTs can be used to manage agricultural IK and appropriately introduce agricultural exogenous knowledge in the selected local communities of Tanzania. The study concluded that KM models can be used to manage IK and appropriately introduce exogenous knowledge in the local communities, and thus the integration of both indigenous and exogenous knowledge can be feasible.

Despite the fact that various KM models (Bouthillier and Shearer 2002; Nonaka, Toyama and Konno 2000; McAdam and McCreedy 1999; Probst, Raub, and Romhardt 2000; Rowley 2001; Small and Tattalias 2000) use different labels to identify KM processes, the study findings showed that farmers managed their knowledge through the following KM processes: knowledge

identification, acquisition, development, sharing, preservation, and application. The study findings showed that farmers possessed an extensive base of agricultural IK. However, this knowledge was acquired and shared within a small, weak and spontaneous network, and thus knowledge loss was prevalent in the surveyed communities. Formal sources of knowledge mainly focused on disseminating exogenous knowledge in the local communities, which showed the predominance of the exogenous knowledge system over IK in the surveyed local communities. The findings demonstrated what KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub, and Romhardt 2000; Rowley 2001) have indicated that knowledge can be constructed within the social and scientific paradigms. The study found that knowledge was mainly created within the social paradigm more than the scientific paradigm in the surveyed communities.

Although there was a predominance of the exogenous knowledge system over IK in the local communities, farmers applied IK gained from tacit and explicit sources of knowledge in their farming systems as compared to exogenous knowledge. Low use of exogenous knowledge was attributed to the fact that few knowledge intermediaries had identified and prioritized farmers' knowledge and needs in the local communities. Participatory approaches were already introduced to integrate farmers' knowledge and exogenous knowledge in the local communities, however, they needed to be strengthened through KM practices. Thus, the study findings were in line with Boateng's (2006) circular KM model which indicates that the agricultural extension practice must aspire to bring the communities of extension experts and farmers together in all the KM phases (that is, from knowledge creation to utilisation) in an effort to incorporate farmers' knowledge in the extension system and inform farmers' decisions regarding improved technologies or new ways of farming for effective KM practices.

The study findings showed that various principles determined access to knowledge in the communities, which included policies, legal framework, ICTs, culture of a certain locality, trust, status, context and space as suggested by various KM models (Davenport 1998; Earl 2001; Nonaka, Toyama and Konno 2000; Probst, Raub and Romhardt 2000; Small and Tattalias 2000). The findings showed that the lack of IK policy and existence of IPR that inadequately recognised

and protected IK, limited acquisition, sharing and preservation of IK in the surveyed communities. With regard to ICTs, the study findings showed that farmers relied more on face to face communication mechanisms than ICTs in the surveyed communities. Further, the study findings showed that most farmers used ICTs especially radio to access exogenous knowledge as compared to IK. There was low use of ICTs to share and preserve agricultural IK in the local communities. Few farmers also applied agricultural knowledge gained from ICTs.

It was established that various KM models (Boisot 1987; Bouthillier and Shearer 2002; Davenport 1998; Earl 2001; Kruger and Snyman 2005; McAdam and McCreedy 1999; Nonaka and Takeuchi 1995; Probst, Raub and Romhardt 1999; Rowley 2001; Small and Tattalias 2000) can be used to manage agricultural IK and to introduce appropriate exogenous knowledge in the local communities. However, all these models focused on the business or organisational settings. Therefore, the study used KM principles that were distilled from the reviewed nine KM models (see Section 3.3.2.1) and the empirical findings of the study to develop a KM model which would be applicable in that social context.

## 7.6 Recommendations

Since knowledge is the collective expertise of everyone in the local community, this study recommends that KM practices should be the responsibility of everyone in the community including village authorities, public and private sectors. According to Noeth (2004:108), KM practices should be embedded in the community and government departments as they currently function in the local communities. The government and private agricultural actors should foster the KM practices in the local communities by engaging the community leaders, and rural people in the whole process. Since IK is site-specific, it can therefore seldom be scaled up without an adaptation, however it can be used to stimulate experimentation and innovation in other communities. With this view, this study recommends that knowledge should not be separated from the individuals who hold it, instead efforts should be made to enable the communities to manage their own knowledge, and to adapt other knowledge systems to suit their local context for effective KM practices and sustainable agricultural development. Ngulube (2002) emphasized that KM approaches can enhance the management of IK without separating it from

its carriers and "containers". Other recommendations are given according to specific study objectives.

**7.6.1 Recommendations on the characteristics of the respondents**

The findings of the study revealed that more male farmers participated in the study than female farmers in the surveyed communities. It is thus important to ensure that rural KM strategies are gender sensitive so that women and other vulnerable groups are not marginalized as suggested in the literature (Batchelor, Scott and Eastwick 2005). Apart from their linkages to gender, rural KM activities need to consider other demographic factors such as age, literacy levels and the extent to which individual farmers are involved in the farming activities, since all these factors affect patterns of access and use of indigenous and exogenous knowledge in the local communities. Despite the fact that about 163 (91.2%) farmers could read and understand simple instructions, the study recommends that there should be continuous adult education for effective KM practices in the local communities.

Although there was limited ownership of some ICTs such as cell phones and television, there were various communal and neighbourly ways and means of accessing these devices in the surveyed communities. The study recommends that government should improve rural telecommunication infrastructure, roads, and access to electricity to increase ownership of ICTs in the local communities. Other studies have shown that rural people are more likely to migrate to other advanced ICTs such as television as soon as they have access to basic infrastructure such as electricity and good broadcast signals (Batchelor, Scott and Eastwick 2005).

**7.6.2 Recommendations on the types of agricultural indigenous knowledge and the role of indigenous and exogenous knowledge in the farming systems in the local communities**

The study recommends that it is important to identify the existing knowledge for effective KM practices and to assess how knowledge can add value to the agricultural activities. It is thus recommended that the knowledge intermediaries carry regular user studies to identify IK in order to determine areas that need intervention, and to enable the local people to locate knowledge they need in their communities. Thus, mapping of the communities' knowledge would also be

feasible as suggested by various KM models (Earl 2001; Noeth 2006; Probst, Raub, and Romhardt 2000). The knowledge intermediaries should involve the local communities at every step of the knowledge identification process to bring the sense of ownership, to empower them to manage their own knowledge, and adapt to other knowledge systems (Boateng 2006; Ngulube 2002).

The findings showed that both indigenous and exogenous knowledge systems play a significant role in various farming aspects to improve agricultural activities in the surveyed communities. The findings also indicated that IK can effectively be applied in different communities with similar agro-ecological conditions, or it can be used to stimulate experimentation and innovation in other communities. It is therefore the recommendation of this study that IK should be recognised, identified and scaled up in the local communities to improve farming activities. It is also important to deploy multiple extension approaches such as face to face communication approaches, participatory approaches, printed materials and ICTs to recognise, identify and share IK and to provide access to relevant exogenous knowledge in the local communities for sustainable agricultural development.

## 7.6.3 Recommendations on the management of agricultural indigenous knowledge in the local communities

This section provides recommendations according to the following KM processes as proposed by various KM models (Bouthillier and Shearer 2002; Nonaka, Toyama and Konno 2000; McAdam and McCreedy 1999; Probst, Raub, and Romhardt 2000; Rowley 2001; Small and Tattalias 2000), which include the following: knowledge identification, acquisition, development, sharing, preservation and application.

### 7.6.3.1 Recommendations on the knowledge and information needs and identification

The study findings and a review of KM models which guided the present study showed that knowledge identification forms an entry point to the KM processes (Probst, Raub, and Romhardt 2000). The study findings showed that there was a huge knowledge gap, despite the fact that the communities possessed an extensive base of IK. This study recommends that the knowledge intermediaries (that is, public and private extension services, researchers, telecentres, input

suppliers, librarians) need to conduct regular studies on information and knowledge needs in order to fulfil communities' needs. The process of identifying and disseminating relevant knowledge should be a continuous process in order to provide access to relevant solutions within a short period of time, and to motivate farmers to seek knowledge in their communities. These studies on needs assessment should also be used to map communities' knowledge in order to help local farmers to locate agricultural experts in their communities. Thus, the integration of indigenous and exogenous knowledge systems would be feasible.

It is also recommended that knowledge intermediaries and village authorities work together to create awareness of the available knowledge sources to help the communities to locate what they need. They should also promote a culture of learning to enable the communities to seek advice when they have a problem and share their knowledge. They should demonstrate the learning benefits of seeking knowledge to increase the perceptions of farmers' personal knowledge growth.

The study also recommends that the government should improve access to public extension services, and the distribution of subsidized agricultural inputs to the rural areas. The study findings showed that inputs were either delivered late or they were not adequate to suit the communities needs, and thus communities were discouraged from seeking knowledge to fulfil their needs. The study also recommends that both public and private sectors, knowledge intermediaries, and local communities should unite to establish knowledge resource centres which would be owned by the communities for effective KM practices.

It is also recommended that multiple sources of knowledge should be used to equip farmers with relevant knowledge. Although, the oral format was the dominant medium in the surveyed communities, other formats in the form of print and ICTs would help to supplement and reinforce what was shared at a verbal level. Apart from radio, cell phones can also play a great role in identifying knowledge sources through the use of SMS technology which is cheap and a faster way to locate knowledge holders. SMSs can also be referred back to and help farmers have something permanent to reinforce what was discussed verbally.

**7.6.3.2 Recommendations on the acquisition of agricultural indigenous knowledge**

It is recommended that knowledge creation and sharing activities through face-to-face interactions between individuals and groups, as well as demonstration and observation should be encouraged in the communities to enhance knowledge acquisition as described by Earl's (2001) KM model and Meyer and Boon's (2003) merger model. Print materials should be used as something permanent for future reference. Knowledge intermediaries and village leaders should play a key role in this. Knowledge intermediaries should also capture and disseminate IK in the communities to enhance access to IK and increase farmers' confidence in adapting new knowledge. Knowledge intermediaries should also consider the differences in access to IK according to location and gender so that women and other vulnerable groups are not marginalized in the rural KM strategies.

**7.6.3.3 Recommendations on the development of agricultural knowledge**

The findings as in line with KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub, and Romhardt 2000; Rowley 2001) showed that knowledge can be constructed within the social and scientific paradigms. It is thus recommended that a conducive environment should be created in the communities to enable individual farmers and groups to share their knowledge, and conduct their local experiments or try out new knowledge as a way to create new knowledge in the social paradigm. The village leaders, knowledge intermediaries, and government officers of a particular locality can create a conducive environment by using the following factors as proposed by Noeth (2004:110): to reward the communities when they take risks and try out new ideas; to promote a positive attitude towards change; and tolerance to mistakes to encourage the communities to try out new things. These factors will encourage individual farmers and groups to innovate and generate new knowledge.

Despite the fact that the knowledge intermediaries have become so responsive of farmer demands through the use of participatory approaches in the surveyed communities, the findings showed that the public extension and research services were characterised by inadequate funds and fewer researchers and extension agents were available to engage in participatory research with smallholder farmers. It is thus recommended that the government should increase the number of extension officers, and they should be equipped with adequate resources for effective

extension services in the country. Further, the extension and research officers should identify local innovators, and involve them in participatory research for joint learning as a way to create knowledge in the scientific paradigm.

**7.6.3.4 Recommendations on the sharing of agricultural indigenous knowledge**

The study findings showed that culture, status and trust, and context and space (*ba*) enabled sharing of agricultural knowledge in the communities. This study recommends that the communities in the rural areas should strive to create a knowledge sharing culture to enable the communities to share their knowledge that is being safeguarded in secrecy. The village leaders, knowledge intermediaries, and private and government institutions in the rural areas should play a key role in this aspect. They should encourage farmers to build relationships, and to carry out collaborative work to create mutual trust which is an important factor for enabling knowledge sharing. Local farmers should be motivated to accept new knowledge and to share their knowledge to prevent knowledge hoarding which is an inhibitor to knowledge sharing. Knowledge intermediaries should conduct capacity building programs on KM issues to village authorities and opinion leaders, in order to empower these leaders to foster knowledge sharing culture in the communities.

The findings showed that traditional cultures were location specific and they either enabled or disabled knowledge sharing activities in the communities. Thus, a culture that influences knowledge sharing activities should be identified and promoted to foster knowledge sharing activities in the communities. For instance, the existing structures and networks such as farmer groups, folklore, storytelling, apprenticeships and initiation rites should be promoted, and strengthened for effective knowledge sharing activities in the communities. These structures should be used to encourage innovation and continuous learning in the communities.

Farmer groups should be encouraged to enhance communities of practices (CoPs). This study showed that CoPs already existed in the sampled districts, but they needed to be strengthened for effective knowledge creation and sharing in the communities. Thus, village leaders, knowledge intermediaries, and private and government institutions in the rural areas should play a key role in nurturing these CoPs and existing cultural structures (such as folklore) in the following ways:

encourage active participation in the existing structures and networks such as farmer groups; motivate the communities, individual farmers and groups to establish links with other communities to enable learning and sharing of new agricultural knowledge; create time and space for communities to share and create new knowledge; and to identify IK holders and motivate them to share their knowledge through farmer forums, and other social networks in the local communities. Story telling should also be used more often to share and distribute knowledge in the individual and collective interactions such as CoPs.

### 7.6.3.5 Recommendations on the preservation of agricultural indigenous knowledge

The findings established that most IK was preserved in human minds because there was no structure to preserve IK in the communities. It is recommended that the communities should continuously share (thus creating new knowledge), and preserve knowledge in tacit and explicit formats in their communities. This technique will enable the communities to prevent knowledge loss and to make knowledge readily available in their communities and outside their communities' boundaries. Tacit knowledge can be preserved through oral demonstrations such as folklore, initiation rites, apprenticeships, and various social networks such as farmer groups, communities of practices, and seminars. On the other hand, explicit formats can include print and electronic formats which can be accessed from the rural knowledge centres or libraries. Carvings and artifacts can also be used to preserve explicit knowledge. Public and private partnerships would be needed to facilitate the establishment of rural knowledge centres, conduct capacity building on KM issues, and nurture knowledge culture to enable the communities to preserve their knowledge.

Knowledge maps can be used to show where knowledge experts are located in a certain locality. Noeth (2004:122) proposed that knowledge maps in the form of brochures and booklets can be used to help the communities to keep in touch with individuals who possess specific types of knowledge. More importantly, the communities should make sure that the knowledge maps and knowledge repositories (either print or electronic) are updated. Outdated maps will limit local people in locating knowledge bearers in order to access and share knowledge.

**7.6.3.6 Recommendations on the application of agricultural indigenous knowledge**

The study findings showed that most farmers applied IK received from explicit and tacit sources of knowledge in their farming systems as compared to exogenous knowledge received from the same sources. These findings suggest that farmers tend to apply knowledge that does not challenge their own ideals. At the same time, low use of IK on the control of animal and plant diseases and post-harvest techniques was linked to ignorance because as farmers acquired exogenous knowledge, they also tended to ignore other knowledge modes including their own knowledge system in some farming aspects. These findings indicate a need to strike a balance between unhealthy and healthy ignorance for effective flow and utilisation of knowledge as already suggested by Probst, Raub, and Romhardt (2000). Communities and village leaders should be encouraged to sustain their knowledge system as well as to accept and apply new knowledge to improve their farming systems.

**7.6.4 Recommendations on the legal framework relevant for the protection of agricultural indigenous knowledge in Tanzania**

It is recommended that the Ministries responsible for establishing IK policy should speed up the process of formulating IK policy to enhance the management of IK in the local communities. The findings showed that there were initiatives on the ground to review the current IPR laws. However, IK was not going to receive adequate attention even in the review process. There is thus a need to improve the existing IPR system in an attempt to recognise and protect IK and genetic resources from biopiracy. The incorporation of the *sui generis* concept into the IPR has been suggested by policy makers as an important factor to enhance the protection of IK in the country. Capacity building programs should be initiated by the knowledge intermediaries, government institutions and other civil societies to enable the communities to recognise their ownership rights such as plant breeders' rights and enable them to register for benefit sharing of their local innovations. Communities (both women and men) should be involved in the policy formulation and review in order to include their needs and knowledge in the existing policies. Other recommendations as suggested by Kabudi (2003) include the following:

- Review existing IPR framework in an effort to protect IK and access genetic resources;

- Enact legislation requiring approval of and benefit sharing with local communities through appropriate government institutions;

- OAU model law should be used to domesticate IPR laws that recognise IK in the country; and

- Establish together with national research institutes and professional associations ethical guidelines and codes of conduct for the collection and dissemination, and benefit sharing for, indigenous knowledge, innovations and practices.

## 7.6.5 Recommendations on the access to agricultural exogenous knowledge in the local communities

The study recommends that individual and collective interactions should be used to enable access to and use of new agricultural technologies. Farmers are more likely to accept and use a new technology once they have seen the consequential improvement in their fellow farmers' farming activities. A combination of indigenous communication mechanism (such as drama, dance, and proverbs) and conventional approaches (such as seminars, print formats) should also be used to transfer agricultural knowledge to farmers. KM approaches such as storytelling, and community of practices should also be used to disseminate knowledge to farmers. The intermediaries should conduct needs assessments in order to fulfil farmers' needs in the different locations. The rural knowledge provision strategies should be gender sensitive, so that women and other vulnerable groups are not marginalized in KM activities.

The study findings showed that most farmers applied IK received from explicit and tacit sources of knowledge in their farming systems as compared to exogenous knowledge received from the same sources. The findings showed that farmers tended to have faith in their own knowledge and skills over external knowledge. Based on the findings, this study recommends that knowledge intermediaries should recognise farmers' knowledge, and involve them in the design and development of agricultural technologies to increase the adoption rate of exogenous technologies. Awareness creation programs should be conducted to enhance farmers' decisions to accept new technologies. Other factors should also be considered to enhance the application of

exogenous knowledge in the communities such as, provision of inputs at the appropriate farming season, dissemination of relevant technology, and reliable markets.

### 7.6.6 Recommendations on the integration of agricultural exogenous and indigenous knowledge in the local communities

The findings established that IK cannot solve all farming problems. Thus, most farmers were willing to share their knowledge with the development agencies for the improvement of their IKS and farming activities in the surveyed communities. Thus, the need to integrate exogenous and indigenous knowledge cannot be over-emphasized. However, the findings showed that few intermediaries interacted with farmers in an attempt to identify and prioritize their knowledge and needs. Various factors inhibited intermediaries to identify and prioritize farmers' knowledge and needs which included limited resources and skilled labour. This study recommends that the government should increase the number of extension officers, and they should be equipped with adequate resources for effective extension services in the country. Both public and private extension officers should coordinate their efforts in their rural KM strategies for effective integration of indigenous and exogenous knowledge systems.

It is also recommended that knowledge intermediaries/providers should combine KM practices (such as communities of practice, storytelling) with their participatory approaches to enhance learning, sharing and distribution of knowledge in the communities. KM approaches would enable both the communities and knowledge intermediaries to understand each other's knowledge systems, and thus the integration of knowledge would be possible.

The knowledge intermediaries should nurture a knowledge culture to influence farmers' decisions to accept new knowledge, and in enabling agricultural experts to understand and accept IK. Farmers are more likely to be motivated in adopting technologies from agricultural experts once they realise that their own inputs are incorporated in the design and development of such technologies as described in Boateng's (2006) circular KM model. New knowledge will only be accepted in the communities if there is respect, trust, positive attitude, and commitment towards learning (Hess 2006). For effective integration of indigenous and exogenous knowledge in the

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communities, this study suggests that the knowledge intermediaries and communities should work together to establish the following as proposed by Hess (2006): build up mutual trust and respect; develop a common language; create a shared knowledge base; welcome and appreciate others knowledge system; show a learning attitude; spend time together for exchanging ideas; and spend time together working and investigating.

The findings showed that most knowledge intermediaries in the surveyed communities were more involved with information management than knowledge management due to inadequate means to evaluate knowledge use in the surveyed communities. There is thus a need to conduct the capacity building programmes on KM issues to individual farmers, community leaders and knowledge intermediaries for effective KM practices in the local communities.

**7.6.7 Recommendations on the role of ICTs in managing agricultural indigenous knowledge**

The study recommends that people should be central to any ICT intervention in KM as described by various KM models (Bouthillier and Shearer 2002; Davenport 1998; Earl 2001; Kruger and Snyman 2005; McAdam and McCreedy 2000; Probst, Raub and Romhardt 2000; Rowley 2001; Small and Tattalias 2000). The study findings showed that farmers relied more on face to face communication mechanisms than print formats and ICTs in the surveyed communities. The findings also showed that there was high use of ICTs to access agricultural exogenous knowledge as compared to IK in the local communities. Thus, this study recommends that the knowledge intermediaries should also identify, recognise and manage IK since farmers are more likely to accept new knowledge once they realise that their own inputs are incorporated in the development of those technologies. The use of ICTs and KM practices can help to bridge gaps between farmers and agricultural knowledge intermediaries.

Radio can be used to equip farmers with relevant IK since the ownership of radio was high in the surveyed communities. Both public and private sectors should be sensitized to establish rural radio services since they are effective in fulfilling communities' needs. Volunteers can be used to run these rural radio services, and thus lowering the operational costs. Communities should be

involved in the establishment of these community radio services, and in the preparation of radio programs to enhance the incorporation of IK into the radio programmes. A format that combines indigenous communication approaches such as storytelling, dance and drama specific to a local context with corresponding thematic discussions amongst farmers listening to agricultural radio programmes can improve learning and sharing of IK in the communities (Chapman *et al.,* 2003). The knowledge intermediaries and village leaders should therefore motivate farmer groups to listen to the radio agricultural programs and to discuss issues raised at the radio program to enhance learning and sharing of IK in the communities. A combination of video and audio and use of other video and interactive media (mobile cinema, outdoor media, Internet) can add value to whatever the radio or television is broadcasting to communities (Development Associates Ltd 2004). Thus, the integration of indigenous and exogenous knowledge would be possible.

The study also recommends that the knowledge intermediaries should supplement their extension services with the use of cell phones. They should also encourage farmers to use cell phones to communicate amongst each others and with farmers in different communities to acquire and share IK. Further, the findings showed that there was low use of television to acquire IK due to limited programs on agriculture, lack of electricity and TV sets. This study recommends that the government should improve the electricity supply in the rural areas to enable farmers to access IK through a wide range of ICTs such as TV.

Knowledge intermediaries should also create awareness, conduct training and nurture knowledge culture to enhance learning and sharing of knowledge through ICTs in the communities. The knowledge intermediaries should also consider the remarkable differences on access to ICT according to age and gender so that women, elderly and other vulnerable groups are not left behind in the developmental projects. Thus, institutional efforts are needed to equip knowledge intermediaries with adequate ICT facilities and skills to improve rural KM activities. The findings showed that there was a growing interest in the use of ICTs to manage IK amongst knowledge intermediaries. Thus the responsible institutions such as public and private research and extension services should take this opportunity to facilitate the use of ICTs for effective rural KM strategies.

**7.6.8 Recommendations on the access to agricultural exogenous knowledge through ICT in the local communities**

It is recommended that KM projects which need to invest at the grassroots level should combine face-to-face communication and ICTs such as radio, and cell phone to disseminate agricultural exogenous knowledge in the local communities. The establishment of community radio that uses vernacular languages, and indigenous communication mechanisms (such as drama, storytelling) should be encouraged in the local communities in order to disseminate relevant knowledge to farmers. Knowledge intermediaries should also encourage farmer groups to listen to radio programs and discuss the issues that are raised from the radio programs afterwards to enhance learning and acceptance of new technologies in the local communities.

Knowledge intermediaries should encourage knowledge sharing activities via cell phones since they are popular ICTs in the rural areas. The current findings showed that middlemen used cell phone to disseminate incorrect market prices to farmer in order to gain cheap offers. Thus, the Ministry of Industry, Trade and Marketing should promote its marketing information system to equip farmers with relevant marketing information in the country. If possible, this marketing information should be specific to different regions and districts in order to fulfil farmers' needs.

Despite the fact that internet services were available in the rural communities, few farmers used internet directly to access agricultural exogenous knowledge. Telecentres should provide more value added services such as agricultural, health and other related services. More focus should be put on awareness creation and training programmes to enable the communities to use advanced ICTs such as internet and email to access agricultural exogenous knowledge. Farmer groups should be encouraged to use these advanced ICTs to acquire and share their knowledge through discussion forums. Issues relating to gender disparities and age should be considered and integrated in the ICT projects. Telecentre staff should constantly assist users who do not have enough skills to use ICTs.

**7.6.9 Recommendations on the barriers that hinder the management of agricultural indigenous knowledge and access to exogenous knowledge in the local communities**

The findings showed that farmers faced various barriers in the management of agricultural IK, access to exogenous knowledge and use of ICTs. These barriers ranged from the personal and social barriers, financial, skills, resources, policy, to the infrastructure problems such as a lack of basic roads, electricity, telecentre and knowledge resource centres. This study recommends that the following issues should be addressed for effective KM practices, which are related to policies, knowledge culture, leadership, capacity building, content, networking, language, infrastructure, and sustainability.

The government policy directives should be used to guide the planning and implementation of KM services in the rural areas. The mechanisms for implementation should be put in place with adequate funds and skilled human resources. KM practices should be guided with key policies in the country, which may include policies that deal with IK, rural development, agriculture, ICTs, education and various sectoral policies. Issues related to the capacity building, culture, content, infrastructure, and leadership should be addressed in the planning and implementation of KM services. Issues related to linkages between KM practices and gender should be addressed at this level. The education policies and strategies should address issues related to the inclusion of agricultural subjects and IK into the curriculum of the primary and secondary education in the country. The incorporation of agricultural subjects and IK in the formal education will foster recognition and use of IK for farming activities in the rural areas.

Policy issues will need both public and private efforts to foster the establishment of IK policy in the country for effective protection and management of IK in the local communities. The government should also institute mechanisms for the implementation of IK policy which should address the protection of IK, management of IK, incorporation of IK into the mainstream knowledge systems, and the capacity building issues for both the communities and knowledge intermediaries. Women's empowerment and equal participation in issues related to KM practices and IK have to be recognised in the key policies. The current IPR system should be reviewed to address issues related to the protection of IK and genetic resources.

The creation of a knowledge culture should involve awareness creation on the value of knowledge since IK was poorly recognised in the surveyed communities. Individuals and existing social networks should value their own knowledge base and attempt to accept and use new knowledge. Knowledge culture will enable the communities to realise that they can learn new concepts, share their knowledge, and consider themselves that they are part of the same learning communities. Thus, knowledge culture will induce change of attitudes towards indigenous and exogenous knowledge in the communities which will be a basis for effective knowledge integration and KM practices. It is also recommended that culture should not only ensure change of attitudes towards knowledge, but it should also involve desire and willingness of individuals and groups to enhance learning and sharing of knowledge in the communities.

Based on the findings, farmers indicated that there was a lack of leadership commitment to KM practices in the communities. For effective KM practices in the local communities, this study recommends that village leaders, knowledge intermediaries, and other public and private sectors need to encourage and facilitate knowledge creation and sharing activities. Village leaders, knowledge intermediaries, and other public and private sectors should be active enough to link different pools of knowledge and various types of communities such as individual farmers, families, informal and formal networks that exist in their communities. They should nurture a knowledge culture to enable farmers to be receptive, committed and supportive of KM practices in the local communities. The village leaders, knowledge intermediaries, and other public and private sectors in the local communities should take the responsibility of the following as suggested by Noeth (2004): identify the central objectives, scope and levels of KM, and roles and responsibility for individuals, groups and organisations involved in KM. The basic foundation of the leaders should be to create opportunities for farmers to share their innovations, promote relationship building, collaborative works, mutual trust and facilitate learning to create a learning community that will be responsive to change and progress. Thus, these leaders should nurture the community of practice, storytelling, and knowledge sharing forums by creating space and time for farmers to meet and share their knowledge, thus creating new knowledge in return.

Capacity building programmes should include both the demand and supply sides (that is, farmers and knowledge intermediaries). The government should improve its extension and research services by increasing the number of extension officers, and providing adequate training programs to update their skills in the farming activities and KM practices. On the other hand, both public and private sector should conduct continuous capacity building exercised for local leaders and the communities (especially vulnerable groups) to improve the management of IK and access of exogenous knowledge and use of ICTs in the local communities. The social capital of the local leaders should be strengthened and their roles in KM activities should be properly defined. There should be active participation and involvement of farmers in various processes that deal with knowledge production and dissemination for effective KM practices and knowledge integration in the local communities as described by Boateng's (2006) circular KM model.

The establishment of basic infrastructure in the rural communities should be one of the major priorities of the government and local communities. The government should focus on the improvement of rural electrification, telecommunication signals, and road infrastructure. Both public and private sectors should also increase access to affordable power sources such as solar power in the local communities to enable use of low cost ICTs such radio. The local communities and public and private sectors should also establish knowledge resource centres in their localities to enhance learning, sharing and preservation of agricultural knowledge.

Inadequate access to local and relevant content was among the major barriers that limited farmers to manage their IK, and access exogenous in the communities. This study recommends that knowledge maps should be used to identify IK holders so that the local people can easily locate knowledge sources in their communities. The knowledge intermediaries should incorporate IK in their extension services and disseminate knowledge that is relevant to farmers' needs. Telecentres operators should scout for relevant content and ensure easy access of that content to farmers to increase their user base. The rural radio broadcasts should generate and disseminate relevant agricultural knowledge to farmers. Radio broadcasts should also ensure that issues that are related to timing, sustainability and continuity of their radio programmes are taken

into consideration for future developmental work. The dissemination of local content via cell phones should also be addressed. The findings indicated that middlemen used cell phones to disseminate incorrect market prices to farmers. There is thus a need for the Ministry of Industry, trade and Marketing to promote its marketing information system that delivers correct market prices via cell phone to the communities. Further, the findings indicated that most of the local content on the internet was in English which discouraged most users from continuing using the internet. There is thus a need to create relevant content in local languages in order to motivate farmers to use ICTs to access knowledge. Knowledge intermediaries and other private and government sectors should involve the communities in the design and development of this content in order to include their needs and knowledge. In this sense, the linkages of indigenous and exogenous knowledge would be feasible.

There is also a need for agricultural actors (such as telecentres, community radio, extension and research officers, NGOs) in the local communities to network and collaborate in content generation, dissemination and preservation for effective KM practices in the local communities. These agricultural actors can explore the possibility of establishing linkages such an association of rural agricultural actors in order to build their capacities and promote exchange of knowledge, experiences and sharing of resources where possible for effective KM practices in the rural areas.

To ensure sustainability of ICT investment in the rural areas, the government should play an important role in financing and maintaining rural ICT projects such as telecentres, community radio and TV. The communities, public extension officers and researchers should also be involved in the production of radio/TV programs, and the agricultural related services provided by the telecentres. An adequate budget should be allocated by the government for KM activities in the rural areas.

## 7.7 A proposed KM model for rural communities

This section presents a KM model for rural farmers in order to fulfil the last objective of the study that is to recommend a KM model for effective management of IK and access to

exogenous knowledge on farming systems in the rural areas of Tanzania. The model is based on the survey results and the theoretical framework as presented in section 3.3.2 of Chapter Three.

A review of nine KM models which guided the present study showed that these models were focused on serving the needs of the organisations. However, the need for the KM approaches in the local communities is becoming more apparent. Certain concepts related to KM models in the corporate environment can be adapted to manage knowledge in the local communities. Such a model is presented in Figure 7.1.

The KM model for rural communities indicates that the potential of knowledge for agricultural development should be conceptualised within the framework of the targeted community. Since most of the farmer's knowledge is tacit, and it is embedded in oral culture and demonstrations, the focus should be on farmers (at the center of the model) rather than on ICTs. The study showed that farmers mainly identified, acquired, shared and preserved indigenous and exogenous knowledge through face-to-face communication, both in individual and collective interactions in the local communities. Thus, farmers (at the center of the model) do not only manage their knowledge, but they are also capable of integrating their knowledge system with exogenous knowledge to improve their farming activities.

The knowledge intermediaries (at the center of the model) interact with farmers in an effort to understand and incorporate farmers' knowledge into the mainstream knowledge system, while farmers (at the center of the model) interact with knowledge intermediaries in an attempt to understand and learn new capabilities to improve their farming activities. Thus, knowledge integration becomes possible. The knowledge intermediaries (that is, public and private extension services, researchers, telecentres, input suppliers, librarians) should therefore play a key role in facilitating knowledge creation activities in the local communities. According to Merger's model, intermediaries can facilitate access and translation of exogenous knowledge, where possible they can draw on IK to ensure adoption and implementation of new practices (Meyer and Boon 2003).

**TARGETED COMMUNITY**



**Figure 7.1: The knowledge management model for rural communities**

In the present study, knowledge intermediaries played a key role in facilitating the formation of farmer groups, encouraging farmers to share knowledge through participatory approaches, providing space and setting time for knowledge sharing activities through farmer groups, and learning by doing through training and demonstration plots. Thus, knowledge intermediaries are

not only involved in the management of IK in the communities, but also they form an entry point where exogenous knowledge can be integrated in the local communities' knowledge system.

Based on the findings and the theoretical framework, this model (at the bottom of the model) presents KM processes in a sequence of a cycle where each stage in the model can embrace either indigenous or exogenous knowledge which may result into a blend of indigenous and exogenous knowledge. Further, each stage of the cycle embraces both tacit and explicit knowledge. There is also a recognition that the KM processes move back and forth between different phases. The KM processes of this model share common ground with other works of Bouthillier and Shearer (2002), Probst, Raub, and Romhardt (2000), McAdam and McCreedy (1999), Small and Tattalias (2000), Earl (2001), and Rowley (2001). These KM processes include: knowledge identification, knowledge acquisition, knowledge development, knowledge sharing and distribution, knowledge preservation, knowledge application, and knowledge validation.

The KM model for rural communities (Figure 7.1) emphasizes that the principles (at the top of the model) should first be determined in order to influence or enable the KM processes in the local communities as highlighted by various authors (Davenport 1998; Kruger and Snyman 2005; Probst, Raub, and Romhardt 2000; Small and Tattalias 2000; Earl 2001). In this study, these principles or enablers may positively or negatively influence KM and knowledge integration processes. Figure 7.1 (at the top of the model) indicates that knowledge may be managed and integrated if there are policies that recognise IK and emphasize the management and integration of indigenous and exogenous knowledge, committed leadership for KM activities, knowledge culture, appropriate ICTs, IPR laws to protect the existing knowledge, favourable context and space, and mapping to locate knowledge bearers and knowledge resources. However, the absence of ICTs should not constitute a barrier for KM and knowledge integration processes, since the findings showed that communities are more likely to understand, acquire and use knowledge that is shared through indigenous communication channels which are oral in nature than in other approaches such as ICTs.

This model expands on what Hess (2006) suggested that indigenous and exogenous knowledge may be integrated, if local farmers and knowledge intermediaries spend more time together, share knowledge in an open and respectful way and omit judging the others knowledge as true or false. Thus, the absence of enablers may affect KM processes and the integration of indigenous and exogenous knowledge in the local communities. This means that the larger the intersection, the easier the communities are able to identify, acquire, develop, share, preserve, apply and validate new knowledge amongst theirselves, and together with agricultural knowledge intermediaries. While, the smaller the intersection, the more difficult it is for the communities to identify, acquire, develop, share, preserve, apply and validate new knowledge amongst theirselves and together with agricultural knowledge intermediaries.

Overall, all these KM practices build a learning community which is skilled at identifying, acquiring, generating, preserving and sharing knowledge as well as adapting its actions to reflect new insight and innovation. This entails that KM practices may improve agricultural productivity since the existing knowledge would be managed and new skills and innovation would be created to develop a learning community in the process. The communities would also be able to create their knowledge from within and outside their environment, and thus the integration of indigenous and exogenous knowledge systems would be possible.

### 7.7.1 Knowledge management enablers

Various KM enablers which may influence KM processes and knowledge integration are described in this section, which include policies, leadership, culture, ICTs, protection, mapping, and context and space.

### 7.7.1.1 Policy

KM practices should be guided with key policies in the country, which may include policies that deal with IK, rural development, agriculture, ICTs, education and various sectoral policies. These policies should comprise a shared definition of and vision for KM in the country. They should aim at providing clear goals/strategies for the innovation initiatives to take place in the rural areas. They should provide guidance with regard to prioritizing, deciding upon, and taking

action to institutionalize KM processes. This will enable the communities and agricultural actors (such as research, extension, NGOs, libraries) to establish KM practices and a culture that is conducive for KM activities in their localities. The policies should be gender sensitive to increase active participation of women and other vulnerable groups in KM activities in the rural areas.

### 7.7.1.2 Leadership

Leaders facilitate the development of a strategy to build, maintain and utilize KM practices in the local communities. Thus, public and private officers in the rural areas, and the village and cultural leaders should be empowered with adequate KM skills in order to lead and nurture KM activities in the communities. These leaders can facilitate KM practices by establishing knowledge sharing forums. They should also set time and space for farmers to meet and share knowledge, such as through knowledge sharing forums and other KM practices in the local communities. Leaders should also encourage farmers to attend meetings, join farmer groups, establish CoPs, and use storytelling to share agricultural knowledge amongst each others. Thus, leaders are not only involved in the management of IK in the communities, but also they form an entry point where exogenous knowledge can be integrated in the communities' knowledge system.

### 7.7.1.3 Culture

Culture is important to create an environment that can facilitate knowledge creation and sharing in the local communities. The findings revealed that the communities did not have a culture to share and learn from each other. Similar to various KM models (Probst, Raub, and Romhardt 2000; Rowley 2001; Small and Tattalias 2000), this study suggests a need to create a culture in the communities to ensure that knowledge is valued and shared, and to emphasize the role of knowledge in supporting individual and community learning. This culture can be cultivated through the deployment of certain artifacts, the promotion of certain norms, values such as care, and healthy dialectic between cooperative and competitive cultures (Jashapara 2004:187). The concept of care as suggested by Von Krogh, Ichijo and Nonaka (2000) is characterised by mutual trust, active empathy, access to help, lenience in judgment, and courage. Thus, care should be

cultivated amongst farmers to create an enabling context for knowledge creation and sharing that encourages cooperation, sharing, loyalty and creativity.

Care should also be nurtured to express a culture of respect, trust, and moral commitment between the intermediaries and farmers in spite of their cultural differences in order to create a fertile ground for the linkages between indigenous and exogenous knowledge. According Spallek (2007:5), only if participants and stakeholders trust each others, openness and transparency can arise and "real" knowledge be shared. Recognition of and respect for each other's competence are the basis of trust (Spallek 2007:5). Policies and programs should also encourage greater openness in the local communities among farmers and knowledge intermediaries to create an environment that is conducive for knowledge sharing and integration.

Certain norms that encourage innovations in the communities should also be promoted. According to Jashapara (2004), these norms include risk taking, rewards for change, and transparency. In risk taking, the communities should be encouraged to take risks to try out new practices, technologies and knowledge, and thus there should be acceptance to mistakes if ones' trial fails. In rewards for change, the communities' ideas should be valued, and they should receive total support and attention from farmer group's leaders and village leaders when they try out something new. In transparency, lateral thinking in the communities should be encouraged to promote creation and access to knowledge.

Artifacts can include storytelling, narratives and other culture specifics in a certain locality which need to be encouraged and promoted to enhance KM and knowledge integration processes. Such traditional culture can include team working in the agricultural fields, apprenticeships, initiation rites in the adolescent age, and folklore such as songs, drama and traditional dances. Existing structures and norms should also be promoted such as age-set system. Storytelling and narratives should also be used to share knowledge in the individual and collective interactions in the community. Stories are a powerful way of understanding what happened in a sequence of events, and the causes of why they happened (Brown and Duguid 2000). Thus, stories are important in enabling local farmers to remember what was shared in the communities. That is why Stoll

(2007) concluded that KM needs to be embedded in local cultures and in a social fabric of the local communities.

The existing social networks such as farmer groups should be used to nurture communities of practices (CoPs) in the rural areas. CoPs can facilitate the creation of a knowledge culture and environment for cultural change that is conducive for the generation and sharing of ideas and knowledge. They can also nurture a sense of belonging and trust which are important factors for facilitating knowledge sharing. CoPs can enable learning and knowledge sharing among members through storytelling and social networks. Communities of practices can be used to strengthen close social embeddedness and intercommunity linkages which are important in facilitating KM and knowledge integration in the local communities as suggested by Lang (2004). Members belonging to more than one CoPs can enable knowledge sharing among different CoPs and thus, knowledge integration would be feasible.

Active participation in the community of practices, farmer groups, village meetings, and other informal networks in the communities should be encouraged to enable learning and sharing of knowledge in the communities. Farmers should be encouraged to participate in every stage of the knowledge production activities that exist in their local communities such as production of radio and TV programs, and research and extension services. This fact will enable farmers to be both creators and disseminators of agricultural knowledge in the local communities.

Inter-community linkages should be encouraged for effective knowledge exchange which would enable KM and knowledge integration in the local communities. Lang (2004) suggested that organisations need to have tightly coupled collaborations which are characterised by high level of mutual commitment between partners for effective KM practices. Thus, communities should be encouraged to establish tight coupling collaborations with other communities which can be characterised with exchange visits, regular group training, demonstrations and meetings. Farmer groups should establish linkages with other farmer groups that exist in other communities for effective knowledge acquisition and integration. Knowledge bearers need to be identified and participate in different farmer groups in an attempt to redeploy their tacit knowledge through

face to face interactions, demonstrations, apprenticeships, communities of practices and storytelling.

### 7.7.1.4 Mapping

This enabler can enable the communities to identify where and how particular IK is stored within and outside their communities. This enabler will enable the scientists and extension agents to value farmers' capacities, and to see farmers' knowledge and innovation as being complementary to their own knowledge and skills (Waters-Bayer *et al.,* 2006). It is thus important to encourage scientists and extension agents to identify IK holders as a means to change their own attitudes towards farmers' knowledge, and to help them recognise how they can complement and strengthen farmers' creativity (Waters-Bayer *et al.,* 2006). The recognition of IK holders will raise farmers-self esteem and confidence and thus they would be more likely to respect and adopt knowledge disseminated by the scientists and extension agents. Thus, the integration of exogenous and indigenous knowledge would be feasible since the identification of IK holders would change both farmers and intermediaries' images of each others, which sets a fertile ground for knowledge creation through equal partnership. In the local communities, face to face communication, print media (such as notice boards at the village office, registers, brochures, newsletters) and ICTs such as cell phones through SMS, and community radio can also be used as directories to provide information about the knowledge experts, and their location in the communities.

### 7.7.1.5 ICTs

The findings suggest that ICTs such as radio, TV and cell phones may enable local communities to manage knowledge from within and outside their communities. Thus, the linkages between indigenous and exogenous systems would be possible. However, the digital divide still exists in most developing countries, and thus it is important to improve ICT infrastructure, electricity supply, awareness and literacy, and nurture knowledge culture to increase use of ICTs in the rural areas for successful KM practices.

### 7.7.1.6 Protection

The presence of legal enactment, rules and regulations concerning IK can ensure that IK is shared and protected from misappropriation in the local communities. The ownership of knowledge will also strengthen trust and guarding against the disadvantages resulting from openness. Participants can rely on KM to address issues relating to the theft of intellectual property and the misuse of knowledge and experience (Spallek 2007:5). Actually, the ownership of the created knowledge is essential for motivation (Herberg and Haeusler 2007). However, the findings of the present study indicated that existing IPRs in Tanzania are based on the classical approaches which inadequately protect agricultural IK. This approach protects the individual rights based on the western models, instead of collective rights which are still relevant and common in Africa including Tanzania's communities. There is thus a need to review the existing IPR framework to protect farmers' knowledge. These laws should enable the registration of grassroots innovations, and certification of their products for the authentication. Capacity building programs should be initiated to enable the communities to legally protect their knowledge and their genetic resources, as well as to negotiate benefit sharing agreements.

### 7.7.1.7 Context and space

These enablers were also added to the KM enablers of this study because knowledge is space and context dependent. The present findings showed that village leaders were important in facilitating shared context for emerging relationships or "ba" such as by providing a physical place (for example, village offices, village leaders' houses), or a mental space such as commitment in green revolution. On the other hand, knowledge intermediaries provided physical spaces such as telecentres, and NGO offices which were used for village meetings, virtual spaces such as computer networks, and mental spaces such as common goals for improving farming activities. It is thus important to build the capacity of the village leaders and knowledge intermediaries so that they can facilitate the shared context that is conducive for knowledge creation in the local communities.

**7.7.2 Knowledge management processes**

Overall, all these enablers may influence KM processes in the local communities if nurtured well. These KM processes are now presented in the subsequent sections, which include: knowledge identification, knowledge acquisition, knowledge development, knowledge sharing and distribution, knowledge preservation, knowledge application and knowledge validation.

**7.7.2.1 Identification**

Knowledge identification involves analyzing and describing what communities know, and what they should know in order to identify their knowledge gaps, and to help the communities to locate knowledge they need (Probst, Raub, and Romhardt 2000). Identification of knowledge bearers is important in improving both the capacity and opportunity to learn in the communities. It is at this stage that mapping of knowledge holders and their expertise becomes feasible. The integration of indigenous and exogenous knowledge would be possible because knowledge bearers may either possess indigenous, or exogenous knowledge, or a blend of the two knowledge systems. The study findings showed that farmers mainly relied on the local and informal networks of families and friends, while public extension officers, district authorities, and input suppliers were important sources of knowledge. There is also a need for awareness creation of the available knowledge sources in the local communities, which can include individual farmers, knowledge intermediaries, and other private and public institutions.

**7.7.2.2 Acquisition**

Knowledge can be brought from internal and external sources of the community. Rural people's knowledge is mostly tacit, and thus knowledge can easily be created and acquired through individual and social interactions in the local communities. Person-to-person communication and other social networks such as storytelling, community of practices, demonstrations, and indigenous communication channels such as folklore, apprenticeships, and initiation rites can facilitate acquisition of knowledge in the local communities. According to the Meyer and Boon's (2003) Merger model, the utilisation of communication mechanisms inherent in the IKS can enable the translation of outside information to rural communities where oral tradition still prevails. Thus, the integration of indigenous and exogenous knowledge would be possible in the

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local communities. Print formats and ICTs especially radio and cell phone can be used to supplement what was gained in the oral channels. Further, the communities of practice and other social networks such as collaborative works can be used to bridge the knowledge gap between farmers and extension and research services, and thus the fusion of indigenous and exogenous knowledge systems would be possible. Farmer groups, communities of practice and individual farmers also need to strengthen linkages with other communities and farmer groups in different communities in order to acquire knowledge from within and outside their communities for effective knowledge acquisition and knowledge integration processes.

### 7.7.2.3 Development

The acquisition of knowledge allows internal knowledge of an individual to be combined with other internal or external knowledge to create new knowledge, better ideas, new products and new efficient processes (Probst, Raub, and Romhardt 2000:130). Information may be analyzed to create new knowledge. This phase is also referred by Mostert and Snyman (2007) as 'sense making', where understanding and problem solving occur. Apart from problem solving, Probst, Raub, and Romhardt (2000) added that creativity occurs at this stage which is the ability to produce new ideas and solutions. It includes processes of evaluation and judgment based on previous experience and values. The findings of the present study showed that farmers created knowledge by carrying out local experiments driven by personal curiosity, seeking for solutions and as an adaptation to new knowledge. Farmers' knowledge was also constructed within social and scientific paradigms as suggested by various KM models (Earl 2001; McAdam and McCreedy 1999; 2000; Probst, Raub and Romhardt 2000).

In the local communities, the social paradigm involves the creation of new knowledge through individual and collective interactions or socialization process as referred to by Nonaka (1994), or social interchange as referred to by McAdam and McCreedy (1999:2000). The scientific paradigm occurs when local people (either individual or collectives) actively participate in extension and research activities in the local communities. In this phase, the knowledge intermediaries involve farmers in participatory research and extension activities in order to understand their knowledge and incorporate it in the mainstream knowledge system, while farmers participate in research in order to gain new knowledge to improve their farming

activities. This phase may also result in the fusion of indigenous and exogenous knowledge systems.

**7.7.2.4 Sharing and distribution**

Knowledge sharing involves exchange and transfer of knowledge through individual and collective interactions amongst farmers, and between communities and knowledge intermediaries. The aim of this process is to enable the communities to find what they are looking for and be able to use and reuse knowledge. More emphasis should be put on face-to-face communication because local communities depend on informal networks of family, friends and neighbours to share their knowledge. It is also important to strengthen indigenous communication channels to share knowledge in the communities, since farmers are more likely to understand and accept new knowledge when the sharing mechanisms are familiar to their oral culture. Print formats and ICTs such as radio and cell phones can be used to share and distribute knowledge among farming communities to supplement what was gained verbally. As the countries establish connectivity, other advanced ICTs such as internet and email will become a powerful enabler for the exchange of IK.

KM practices such as communities of practice should be strengthened to enhance knowledge sharing activities in the communities. Through communities of practice, farmers would be able to share their knowledge within their groups, and between different groups they belong to, and thus integrating their knowledge with external knowledge. Further, individual with external contacts can also bring new knowledge to the groups (Buchel 2007). Brown and Duguid (2001) suggested that knowledge may be shared and integrated between CoPs through brokering by participation, translation, and boundary objects. Brokering by participation occurs because some farmers may belong to several communities, and thus they will be in a position to broker knowledge between different communities to which they belong. Knowledge intermediaries can play the role of translators who can broker knowledge to different communities since they are knowledgeable about work of various communities that exist in the rural areas. Boundary objects are objects of interest to each community involved, but which are viewed or used differently by each, which may be ICTs (such as radio, cell phones, TV), print materials, farm inputs and tools, extension services, information services such as libraries, and physical spaces such as village

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offices. As a result each community would be able to understand what is common and what is distinct about another community, which may help to engage in mutual negotiations, and sharing of resources and knowledge.

Cabero and van Immerzeel (2007) emphasized that tacit knowledge is essential for agricultural activities, but farmers are frequently trained almost exclusively on the basis of explicit knowledge. The present findings showed that few knowledge intermediaries involved farmers in an attempt to understand farmers' knowledge and learn from them. There is thus a need to change from teaching to learning among local people. Knowledge intermediaries should learn from farmers' own experience and farmers should learn from the intermediaries and their fellow farmers in order to share and create new knowledge. Thus, the integration of indigenous and exogenous knowledge systems would be feasible in the local communities.

### 7.7.2.5 Preservation

Knowledge preservation ensures that relevant knowledge is selected and stored in individual or collective memories and regularly updated for potential future value in the local communities. The communities should continuously share (thus creating new knowledge), and preserve knowledge in tacit and explicit formats in their communities. The preservation of knowledge should be a continuous process in the communities to prevent knowledge loss in the local community. Tacit knowledge can be preserved through oral demonstrations such as folklore, initiation rites, apprenticeships, and various social networks such as farmer groups, communities of practice, and seminars. Further, as individual members in social networks recognise their common interests, individual needs and different areas of expertise, the more their social knowledge becomes explicit knowledge, which can easily be described to others (Von Krogh, Ichijo and Nonaka 2000:14). On the other hand, explicit knowledge can be preserved in the collective memories which can either be print or electronic format or both. Explicit knowledge should be retained in the local communities to ensure continuous use and updating. Noeth (2006) suggested that not only should knowledge be preserved, but also methods used in the KM practices, and the results obtained during the transformation of knowledge enablers should be documented and preserved. Thus, the KM practices in the local communities will be improved since both KM practices and knowledge will be preserved.

### 7.7.2.6 Application

Knowledge application ensures that the acquired knowledge is applied productively for the benefit of the local community. The application of knowledge may lead to the development of new knowledge through integration, creation, innovation and extension of existing knowledge (Noeth 2006; Probst, Raub, and Romhardt 2000; Rowley 2001). This stage is also referred to as internalization which is closely related to `learning by doing' (Nonaka, Toyama, and Konno 2000). The present findings showed that most farmers applied agricultural knowledge gained from tacit sources of knowledge as compared to the agricultural knowledge gained from ICTs. It is thus important to use face-to-face communication to share knowledge in the local communities rather than other communication media. It is also important to combine participatory approaches with KM processes such as story tellings and CoPs to enable farmers to accept and use exogenous knowledge together with their own knowledge.

### 7.7.2.7 Validation

This enabler assesses the value of the entire KM process and validates the newly created knowledge. The study findings showed that few farmers were involved by the intermediaries in the research activities in an effort to understand farmers' knowledge system and increase adoption rates of new technologies in the communities. Apart from integrating indigenous and exogenous knowledge systems, these research activities were also used to validate and improve farmers' knowledge system. It is thus important to involve farmers in the validation process at the original site of application of IK. According to Sen (2005), validation ensures the significance, relevance, reliability, functionality, effectiveness and transferability of IK. Charyulu (1999) suggested that IK needs to be validated for scientific background and relevance (in solving problems), reliability, functionality (how well does it work?), effectiveness and transferability. The results from this phase may lead to the development of a new knowledge that can be used to build the knowledge base of the local communities and improve KM activities in the communities. Thus, the integration of indigenous and exogenous knowledge would be feasible.

**7.8 Suggestions for further research**

This study analyzed how farmers manage their knowledge and how exogenous knowledge can be integrated into the rural knowledge system for agricultural development. The study identified several issues that require further research in order to provide in-depth understanding of the issues that are of critical importance for the application of KM approaches in the rural areas of developing countries.

Statistics show that some 80 percent of the world's population depends on IK to meet their medicinal needs, and at least half rely on IK for crops and food supplies (CSOPP 2001; Hart and Vorster 2006). The current study investigated the management of indigenous and exogenous knowledge in the agriculture sector. It is recommended that studies be conducted to establish the current state of knowledge management in other sectors in the rural areas, especially the health sector since most of the developing world's population depends upon it. Other sectors include natural resource management, education and finance.

The current study investigated how the existing policies and IPRs affected the management and use of IK in the local communities. It is recommended that more studies be conducted to establish the link between the current IPR systems, existing policies and the management and protection of IK. Issues related to the dynamic state of knowledge, secrecy, trust, and power relationships and how they are linked to the current legal framework in the country needs to be investigated.

Despite the fact that the study was carried out in the rural areas where ICTs were available, the findings showed that the local communities mainly used radio and cell phones, while advanced ICTs such as internet and email had low use. It recommended that research be undertaken to establish the role of community radio, cell phones and television in managing indigenous and exogenous knowledge for effective KM practices in the local communities. The linkages between KM processes (that is, acquisition, development, sharing, preservation, application and validation), ICTs and other KM enablers such as culture, leadership, context and space, ownership, and policies need to be investigated.

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This study investigated the current state of KM practices in the rural areas, and thus it did not test the applicability of KM models in the management of indigenous and exogenous knowledge in the local communities. Thus, further studies should be conducted to test how the KM model developed in this study can be used to manage farmers' knowledge and integrate it with exogenous knowledge for improved agricultural performances in the developing countries. The model proposed in this study is expected to stimulate discussions and further theoretical and empirical studies, with the aim of constructing a comprehensive and universal model of KM for rural communities in developing countries.

**7.9 In conclusion**

The study attempted to assess the linkages between indigenous and exogenous knowledge and how they can be managed and integrated for effective agricultural activities in the selected rural areas of Tanzania. Its aims in assessing how local people manage their knowledge, access exogenous knowledge, and how KM approaches can be used to enhance the management and integration of indigenous and exogenous knowledge systems have been achieved. The study found that the management of IK and its integration to exogenous knowledge is important to ensure sustainable agricultural development in developing countries. However, farmers do not only lack opportunities to share and preserve their own indigenous knowledge, but they are also deprived from accessing exogenous knowledge. Given adequate and appropriate resources, the local communities can effectively manage their IK and integrate it with relevant exogenous knowledge in order to improve their farming activities. Therefore, recommendations based on the study's findings were made and areas for further research were identified.

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| | | |
|---|---|---|
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| AFDF | see | African Women's Development Fund |
| ALIN-EA | see | Arid Land Information Network-Eastern Africa |
| AU | see | African Union |
| BRELA | see | Business Registrations and Licensing Agency |
| CIA | see | Central Intelligence Agency |
| CIDA | see | Canadian International Development Agency |
| COSOTA | see | Copyright Society of Tanzania |
| COSTECH | see | Tanzania Commission for Science and Technology |
| CSOPP | see | Civil Society Organisations and Participation Programme |
| CTO | see | Commonwealth Telecommunications Organisations |
| CWF | see | Canadian Wildlife Federation |
| ECA | see | Economic Commission for Africa |
| ESRF | see | Economic and Social Research Foundation |
| FADECO | see | Family Alliance for Development and Cooperation |
| FAO | see | Food and Agriculture Organisation |
| HSRC | see | Human Science Research Council of South Africa |
| IDRC | see | International Development Research Centre |
| IDS | see | Institute of Development Studies, University of Sussex |
| IICD | see | International Institute for Communications and  Development |
| IIRR | see | International Institute of Rural Reconstruction |
| ILO | see | International Labour Organisation Convention |
| ITU | see | International Telecommunication Union |
| KAMEA | see | Karagwe Media Association |
| KIRSEC | see | Kilosa Rural Services and Electronic Communication |
| MAFS | see | Ministry of Agriculture and Food Security in Tanzania |
| MISA | see | Media Institute of Southern Africa |
| NBS | see | National Bureau of Statistics of Tanzania |
| NUFFIC | see | Netherlands Universities Foundation for International Cooperation |
| OECD | see | Organisation for Economic Cooperation and Development |
| PROLINNOVA | see | Promoting Local Innovations in Sustainable Agriculture in Tanzania |
| SRISTI | see | Society for Research and Initiatives for Sustainable Technologies and Institution |
| SUA | see | Sokoine University Of Agriculture |
| TCCA | see | Tanzania Chamber of Commerce, Industry and Agriculture |
| TCRA | see | Tanzania Communications Regulatory Authority |
| TLA | see | Tanzania Library Association |
| TLSB | see | Tanzania Library Service Board |
| UN | see | United Nations |

| UNDP | see | United Nations Development Programme |
|------|-----|--------------------------------------|
| UKZN | see | University of KwaZulu-Natal |
| UNEP | see | United Nations Environment Programme |
| UNESCO | see | United Nations Educational, Scientific and Cultural Organisation |
| UNU-IAS | see | United Nations University Institute of Advanced Studies |
| UPOV | see | International Union for the Protection of New Varieties of Plants |
| URT | see | United Republic of Tanzania |
| WIPO | see | World Intellectual Property Organisation |
| WSIS | see | World Summit on The Information Society |
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## Appendix 1: A guide for interviews with local communities

**Section A: Personal information**
1.  Ethnic group:………………………………………………………………………
2.  Sex: 1=[ ] Female          2=[ ] Male
3.  Age (years): …………………………………………………………………………
4.  Highest education level
    1=[ ] Informal schooling          4=[ ] Secondary          education
    2=[ ] Primary education          5=[ ] Illiterate
    3=[ ] Post secondary (specify)…………………………………………………
5.  Occupation:……………………………………………………………………………
6.  Region:…………………………………………………………………………..
7.  District:…………………………………………………………………………….
8.  Division:…………………………………………………………………………
9.  Ward:……………………………………………………………………………
10. Village:…………………………………………………………………………...
11. Date of interview:……………………………………………………………

**Section B: Indigenous knowledge management**
**1. Various types of agricultural indigenous knowledge and the integration of both indigenous and exogenous knowledge in the farming systems**
**1.1 Types of crops**
12. What is the size of your farm?
13. What crops do you grow?
14. What benefits do different types of crops provide to your household?
    1=[ ] Food          3=[ ] Fuel          5=[ ] Sale
    2=[ ] Veterinary medicine          4=[ ] Human medicine      6=[ ] Ornaments
15. What benefits do different types of crops provide to your farm?
    1=[ ] Soil conditioner          2=[ ] Manure          3=[ ] Others:…………

**1. 2 Planting materials**
16. How do you acquire your planting materials?

|   | Crop | How is it acquired? | Seeds | Roots | Cuttings |
|---|------|---------------------|-------|-------|----------|
| 1 |      |                     |       |       |          |
| 2 |      |                     |       |       |          |

17. What methods are used for seed storage?
18. Which methods do you prefer for storing your seeds? 1=[ ] Indigenous 2=[ ] Exogenous

**1. 3 Farming practices**
19. What criteria do you use for selecting land for planting crops?
    1=[ ] Plot's suitability for specific crops  3=[ ] Fertile lands      5=[ ] Type of soil
    2=[ ] Good water holding capacity          4=[ ] Weather          6=[ ] Others:…………
20. How are crops planted?
21. What types of crops are being intercropped? What types of crops are being mono-cropped?

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| | Crop | Intercropped | Mono-cropped |
|---|------|--------------|--------------|
| 1 | | | |
| 2 | | | |

22. Why are crops being intercropped?
23. Why are crops being mono-cropped?
24. What methods do you use to control weeds?
   1=[ ] Long-term fallow (over 4 years)        5=[ ] Selective weeding
   2=[ ] Short-term fallow (1-3 years)          6=[ ] Dry grasses
   3=[ ] Seasonal organic matter from planted crops   7=[ ] Intercropping
   4=[ ] use of herbicides                      8=[ ] Dry leaves
   [ ] Others:…………………………………………………………………………
25. What methods do you use to improve the quality of soil?
   1=[ ] Mineral fertilizers        5=[ ] Rotation of crops      9=[ ] Animal manure
   2=[ ] Nitrogen-fixing crops      6=[ ] Ash from burning      10=[ ] Protecting trees
   3=[ ] long-term fallow (over 4 years)   7=[ ] Laying of crop stalks 11=[ ] Tree leaves
   4=[ ] Short-term fallow (1-3 years)   8=[ ] Organic materials    12=[ ] Others:……….
26. What indicators do you use to determine the changes in the quality of a soil?
27. What methods do you use for preserving crops?
28. Do you irrigate your crops? 1=[ ] Yes        2=[ ] No           3=[ ] Don't know
29. Which plants are irrigated? ……………………………………………………………
30. How are plants irrigated? ……………………………………………………………

**1. 4 Pest and disease management**
31. What are the common plant diseases?

| | Crop | Disease |
|---|------|---------|
| 1 | | |

32. What are the common pests?

| | Crop | Pests |
|---|------|-------|
| 1 | | |
| 2 | | |

33. What types of pesticides do you use to control plant diseases?

| | Plant disease | Pesticide |
|---|---------------|-----------|
| 1 | | |

34. What types of pesticides do you use to control plant pests?

| | Plant pest | Pesticide |
|---|------------|-----------|
| 1 | | |

35. Do you grow plants to repel insects? 1=[ ] Yes        2=[ ] No
36. Which plants do you grow to repel insects?…………………………… …………
37. What are the common plant predators? …………………………………………………
38. How do you control predators?…………………………………………………………
39. Which methods do you prefer for controlling plant diseases?
   1=[ ] Indigenous 2=[ ] Exogenous

**1.5 Livestock varieties**
40. What animal species do you keep in the community? How many are they?

41. Why do you keep a particular livestock species?
42. How are animals procured?

    1=[ ] Exchange          3=[ ] Gift               5=[ ] Purchase

    2=[ ] Family            4=[ ] Government agent     6=[ ] From neighbours

## 1.6 Animal feeding

43. How do you feed your animals?
44. Do you grow fodder? 1=[ ] Yes               2=[ ] No     3=[ ] Don't know
45. What type of special feeds do you provide?..............……………………………………

## 1.7 Animal reproduction

46. What criteria are used for selecting male and female animals for breeding?
47. Do you control breeding? 1=[ ] Yes      2=[ ] No     3=[ ] Don't know
48. When do you control breeding? ………………………………………………………………
49. Why do you control breeding? ………..………………………………………………………
50. How do you control breeding? ………..………………………………………………………

## 1.8 Animal health

51. What animal diseases do you observe in your community? How are diseases diagnosed?

| | Disease name | How are diseases diagnosed? |
|---|---|---|
| 1 | | |
| 2 | | |

52. What solutions do you use to deal with animals in poor condition?

| | Disease name | Solutions |
|---|---|---|
| 1 | | |
| 2 | | |

53. Do you use any prevention mechanism to protect your animals from diseases?

    1=[ ] Yes      2=[ ] No     3=[ ] Don't know

54. If yes, what kinds of prevention mechanisms do you use to protect your animals from the diseases?…………………………………………………………………………………
55. Which animal treatments do you prefer? 1=[ ] Indigenous   2=[ ] Exogenous
56. Do you cultivate medicinal plants for controlling animal diseases?

    1=[ ] Yes              2=[ ] No            3=[ ] Don't know

57. If yes, what medicinal plants do you cultivate for controlling animal diseases? ………………………………………………………………………………………………
58. Do you use wild medicinal plants for controlling animal diseases?

    1=[ ] Yes              2=[ ] No            3=[ ] Don't know

59. If yes, what wild medicinal plants do you use for controlling animal diseases? ………………………………………………………………………………………………
60. Do you cultivate medicinal plants for controlling plant diseases?

    1=[ ] Yes              2=[ ] No            3=[ ] Don't know

61. If yes, what medicinal plants do you cultivate for controlling plant diseases? ………………………………………………………………………………………………
62. Do you use wild medicinal plants for controlling plant diseases?

    1=[ ] Yes              2=[ ] No            3=[ ] Don't know

63. If yes, what wild medicinal plants do you use for controlling plant diseases? ……………………………………………………………………………………………

64. Do you use wild medicinal plants for preserving crops?
    1=[ ] Yes                2=[ ] No                3=[ ] Don't know

65. If yes, what wild medicinal plants do you use for preserving crops? ……………………………………………………………………………………………

**1.9 Labour**

66. Are there any differences in the roles of men and of women in farming?
    1=[ ] Yes                2=[ ] No                3=[ ] Don't know

67. If yes, what are those roles?......................………………………………………………

68. What are the labour arrangements for farming?
    1=[ ] Family labour    2=[ ] Hired labour    2=[ ] Both hired and family labour

69. What tools are used for cultivation?
    1=[ ] Handheld implements   2=[ ] Mechanical traction        3=[ ] Oxen-drawn plow

**2. Information and knowledge needs and information seeking patterns**

70. What type of knowledge required for your farming activities has been difficult for you to obtain?

    1=[ ] Soil classification               2=[ ] Crops varieties
    3=[ ] Crop husbandry                   4=[ ] Irrigation
    5=[ ] Agricultural tools                6=[ ] Animal feeding
    7=[ ] Animal breeds                    8=[ ] Credit/ loan facilities
    9=[ ] Land preparations                10=[ ] Soil fertilization
    11=[ ] Value added                     12=[ ] Agricultural marketing
    13=[ ] Animal husbandry                14=[ ] Animal diseases
    15=[ ] Plant diseases and pests        16=[ ] Others:………………………

71. Have you tried to find this knowledge?
    1=[ ] Yes              2=[ ] No              3=[ ] Don't know

72. If "yes": what happened when you tried to find this knowledge?…………………………

73. What source did you consult to access this knowledge?…………………………………

74. If "no" in 73: why have you not tried to find it? …………………………………

75. What problems did you encounter when you tried to access this knowledge? ……………………………………………………………………………………………

**3. The current status of managing agricultural indigenous knowledge in the local communities**

**3.1 Sources of indigenous knowledge**

76. Where do you obtain knowledge with regards to indigenous farming?

    1=[ ] Personal experience          10=[ ] Church/mosque
    2=[ ] Parents/ guardian/family     11=[ ] Social group gatherings
    3=[ ] Neighbour/Friends            12=[ ] Village leaders
    4=[ ] Women meetings               13=[ ] Farmers' groups
    5=[ ] Herding livestock            14=[ ] Village meetings
    6=[ ] Demonstration and observation   15=[ ] Newspapers

7=[ ] Magazines                  16=[ ] Books
8=[ ] Newsletters               17=[ ] Conference/workshops/seminars
9=[ ] Posters                    18=[ ] Agricultural shows

77. How frequently are you in contact with the sources of agricultural indigenous knowledge?

| | Source | Very often | Often | Neither often nor seldom | Seldom | Very seldom |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |

78. What type of agricultural indigenous knowledge do you obtain from these sources?

| Type of indigenous knowledge | Source |
|---|---|
| Local crop variety | |
| Crop planting | |
| Crop harvesting, processing and storage | |
| Crop disease or pest problem | |
| Crop husbandry | |
| Animal husbandry | |
| How to solve animal diseases | |
| How to improve soil fertility | |

79. What types of agricultural indigenous technologies did you adopt for your farming activities? What are the reasons for adopting these technologies?
80. What types of agricultural indigenous technologies did you reject for your farming activities? What are the reasons for rejecting these technologies?
81. Do the information providers interact with you to inquire about your agricultural indigenous knowledge before disseminating agricultural technologies in the village?
   1=[ ] Yes               2=[ ] No              3=[ ] Don't know
82. If yes, how do they inquire about your agricultural indigenous knowledge?
   ………………………………………………………………………………………………
83. Do the information providers prioritize your indigenous knowledge into the agricultural technologies that they disseminate in the village?
   1=[ ] Yes               2=[ ] No              3=[ ] Don't know
84. If yes, please give an example: ……………….……………………………………………
85. Would be willing to provide your indigenous knowledge to the development agencies so that they can combine it with exogenous knowledge for improved farming activities?
   1=[ ] Yes               2=[ ] No              3=[ ] Don't know
86. Does the existing agricultural indigenous knowledge in the local community meet your farming requirements?
   1=[ ] Yes               2=[ ] No              3=[ ] Don't know
87. If yes, please give an example ………………………………………………………………….
88. Are you aware of any national intellectual property rights that address issues with regard to the ownership of agricultural indigenous knowledge in the local communities?
   1=[ ] Yes               2=[ ] No              3=[ ] Don't know

89. If yes, are the intellectual property rights effective in protecting agricultural IK of the local communities?

1=[ ] Very effective  2=[ ] Effective    3=[ ]Probably 4=[ ]ineffective 5=[ ]Very ineffective

90. If the intellectual property right is effective or very effective, please explain what are those?...........................................................................................................................

91. Do you think it is important to have a specific policy on indigenous knowledge within the country?

1=[ ]Very important 2=[ ]Important 3=[ ]Probably 4=[ ]Least important 5=[ ]Not important

92. Why do you think it is important to have a specific policy on indigenous knowledge?

## 3.2 Sharing of indigenous knowledge
### 3.2.1 Folklore

93. What types of folklore are practiced in the village?

1=[ ] Drama        3=[ ] Plays  5=[ ] Puppet shows      7=[ ] Proverbs          9=[ ] Dance
2=[ ] Song        4=[ ] Poetry 6=[ ] Story telling      8=[ ] Debates

94. On what occasions are the folklore performed? ……………………………………………….
95. On what topics are the folklore performed? …………………………………………………….
96. Who attends in these occasions when folklore is performed? ……………………………
97. Who performs the entertainments? …………………………………………………………………

### 3.2.2 Indigenous organisations

98. Are you a member of any associations that exist in the village?

1=[ ] Yes                        2=[ ] No                3=[ ] Don't know

99. What groups are you involved with? What are the types of those groups? What are the activities of these groups?
100. Where does each group that you are a member meet? How frequent do you meet?
101. How do members find out about the organisations decisions?
102. What relationships exist between the different groupings?…………………………………

### 3.2.3 Indigenous education

103. Are initiation rites during adolescent age used for sharing agricultural indigenous knowledge?    1=[ ] Yes                    2=[ ] No                3=[ ] Don't know
104. If yes: what kinds of agricultural indigenous knowledge are shared through initiation rites?
    1=[ ] Crop production  2=[ ] Animal production  3=[ ] Selling produce
105. What apprenticeships arrangements exist in your community?…………………………
106. Which subjects are taught in these apprenticeships? ……………………………………
107. Who can become an apprentice? ……..………………………………………………………
108. Who teaches the apprentice? …………………………………………………………………
109. How long are apprenticeships? …………………………………………………………..

### 3.2.4 Other ways of sharing indigenous knowledge

110. Where do people in the village meet? For what reasons do people meet in the village

|   | Purpose | Meeting place |
|---|---------|---------------|
| 1 |         |               |
| 2 |         |               |

**3.3 Preservation of indigenous knowledge**

111. Do you use any non-ICT based tools to preserve agricultural indigenous knowledge (Example, written, carvings)?    1=[ ] Yes          2=[ ] No        3=[ ] Don't know

112. If it is yes, what non-ICT based tools do you use when preserving agricultural indigenous knowledge?
  1=[ ] Written 2=[ ] Carvings  3=[ ] Rock painting 4=[ ] Others:………

**4. Access to exogenous knowledge in the local communities**

113. What are the main sources of the exogenous tacit knowledge on farming systems in the local community?
 1=[ ] Parent/Children/family  8=[ ] Neighbours/ friends
 2=[ ] Extension officers  9=[ ] Village meetings
 3=[ ] Agricultural shows  10=[ ] Farmers' groups
 4=[ ] Agricultural researchers  11=[ ] Non-governmental organisation
 5=[ ] Cooperative societies  12=[ ] Agro-based industries salesman
 6=[ ] Individual traders  13=[ ] School teachers
 7=[ ] Religious leader  14=[ ] Others…………………………

114. What are the main sources of the exogenous explicit knowledge on farming systems in the local community?
 1=[ ] Books  3=[ ] Magazines  5=[ ] Brochures 7=[ ] Newsletters
 2=[ ] Posters  4=[ ] Training modules 6=[ ] Newspapers 8=[ ] Others:………

115. How often do you obtain exogenous knowledge on farming activities?

|   | Source | Very often | Often | Neither often nor seldom | Seldom | Very seldom |
|---|--------|------------|-------|--------------------------|--------|-------------|
| 1 |        |            |       |                          |        |             |
| 2 |        |            |       |                          |        |             |

116. What type of agricultural exogenous knowledge do you obtain from these external sources?

| Type of exogenous knowledge | Source |
|-----------------------------|--------|
| New crop variety and technique |  |
| Crop planting |  |
| Crop harvesting, processing and storage |  |
| Crop disease or pest problem |  |
| Crop husbandry |  |
| How to solve animal diseases |  |
| Animal husbandry |  |
| How to improve soil fertility |  |
| Market prices of agricultural products |  |
| How to get credit |  |

117. What types of exogenous agricultural technologies did you adopt for your farming activities? What are the reasons for adopting these technologies?

118. What types of exogenous agricultural technologies did you reject for your farming activities? What are the reasons for rejecting these technologies?

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119. Do the information providers interact with you to determine your agricultural information needs before disseminating agricultural technologies in the village?
   1=[ ] Yes 2=[ ] No 3=[ ] Don't know
120. If yes, how do they determine your agricultural information needs?
   ………………………………………………………………………………………………
121. Do the information providers prioritize your information needs in the disseminated agricultural technologies in the village?
   1=[ ] Yes 2=[ ] No 3=[ ] Don't know
122. If yes, please give an example…………………………..………………………………

**5. The role of ICT in managing indigenous and exogenous knowledge on farming systems**

123. What types of ICTs do you or any other member of the household own?
   1=[ ] Radio 3=[ ] Television 5=[ ] Cellular phone
   2=[ ] Audio cassettes 4=[ ] Video cassette 6=[ ] Personal Computer
124. For those ICTs that you do not have, which ones do you have to travel to access them?
125. For those ICTs that you do not have, how long do you have to travel to access them?

|   | ICTs | Within one km | 5 km | 10 km | More than 20 km |
|---|------|---------------|------|-------|-----------------|
| 1 |      |               |      |       |                 |
| 2 |      |               |      |       |                 |

126. What ICTs do you use to acquire, share and preserve indigenous knowledge (IK) and accessing external knowledge on farming activities?

|   | ICTs | Acquiring IK | Sharing IK | Preserving IK | Accessing external knowledge |
|---|------|--------------|------------|---------------|------------------------------|
| 1 |      |              |            |               |                              |

127. How frequently are you in contact with the ICTs as a source of indigenous knowledge on farming activities?

|   | ICTs | Very often | Often | Neither often nor seldom | Seldom | Very seldom |
|---|------|-----------|-------|--------------------------|--------|-------------|
| 1 |      |           |       |                          |        |             |

128. How frequently are you in contact with the ICTs as a source of external knowledge on farming activities?

|   | ICTs | Very often | Often | Neither often nor seldom | Seldom | Very seldom |
|---|------|-----------|-------|--------------------------|--------|-------------|
| 1 |      |           |       |                          |        |             |
| 2 |      |           |       |                          |        |             |

129. What type of indigenous knowledge do you obtain from these ICTs?

|   | ICT | Type of indigenous knowledge |
|---|-----|------------------------------|
| 1 |     |                              |
| 2 |     |                              |
| 3 |     |                              |

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130. What type of exogenous knowledge do you obtain from these ICTs?

| | ICT | Type of exogenous knowledge |
|---|---|---|
| 1 | | |
| 2 | | |

131.  Of those agricultural knowledge disseminated through ICTs, what types of those technologies did you adopt for your farming activities? What are the reasons for adopting these technologies?

132.  Of those agricultural knowledge disseminated through ICTs, what types of technologies did you reject for your farming activities? What are the reasons for rejecting these technologies?

## 6. Barriers that hinder the effective management of indigenous and exogenous knowledge on farming systems in the local communities

133.  What problems do you face in acquiring, sharing and preserving agricultural indigenous knowledge?

| | Problem | Acquisition | Sharing | Preserving |
|---|---|---|---|---|
| 1 | Poor knowledge sharing culture | | | |
| 2 | Lack of trusts | | | |
| 3 | Political dimensions or social status | | | |
| 4 | Poor recognition of IK | | | |
| 5 | Lack of information materials on IK | | | |
| 6 | Lack of a nearby library | | | |
| 7 | Lack of appropriate intellectual property rights to govern IK | | | |

134.  What problems do you face in accessing exogenous agricultural knowledge?

1=[ ] Low level of literacy                          3=[ ] Lack of extension services

2=[ ] Lack of information materials in local language   4=[ ] Lack of a nearby library

[ ] Others ……………………………………………………………………….

135.  What problems do you face when using ICT in acquiring, sharing and preserving agricultural indigenous knowledge and in accessing external agricultural knowledge?

| | Problem | Acquisition | Sharing | Preserving | Accessing exogenous knowledge |
|---|---|---|---|---|---|
| 1 | Low level of ICT literacy | | | | |
| 2 | Lack of awareness about ICTs | | | | |
| 3 | Poor ICT infrastructure | | | | |
| 4 | Lack of local contents in local languages | | | | |
| 5 | Lack of funds | | | | |
| 6 | Lack of nearby telecentre | | | | |
| 7 | Lack of electricity | | | | |

**Appendix 2*: A guide for interviews with indigenous knowledge intermediaries**

**Section A: Information about respondent**
1. Designation
   [ ] Extension officers                       [ ] District agricultural officers
   [ ] Agricultural researchers                  [ ] IK trainees
   [ ] Non-governmental organisation (NGO) officer     [ ] School teachers
   [ ] Agro-based private company officer           [ ] Individual trader
   [ ] Librarian/ information specialist             [ ] Telecentre staff
   [ ] Others: …………………………………………………………………………………
2. Organisation:…………………………………………………………………….
3. Sex:       [ ] Female           [ ] Male
4. Age (years): …………………………………………………………………
5. Highest education level
   [ ] PhD[ ] Masters       [ ] Bachelor    [ ] Diploma    [ ] Certificate   [ ] High school
6. Region:…………………………………………………………………………….
7. District:…………………………………………………………………………….
8. Division:…………………………………………………………………………
9. Ward:…………………………………………………………………………….
10. Village:…………………………………………………………………………...
11. Date of the interview:…………………………………………………………..

**Section B: Indigenous knowledge management**

**1. The management of agricultural indigenous knowledge in the local communities**
12. Are you aware about any farmers who possess agricultural indigenous knowledge?
    [ ] Yes                [ ] No         [ ] Don't know
13. Do you capture agricultural indigenous knowledge from the local communities?
    [ ] Yes                [ ] No         [ ] Don't know
14. What strategies do you use for collecting agricultural indigenous knowledge in the local communities?.......................................……………………………………………………
15. What type of agricultural indigenous knowledge do you capture from the local communities? …………………………..……………………………………………………
16. What is the purpose of collecting agricultural indigenous knowledge?
    1= [ ] Raise the profile of IK      3= [ ] Interest in managing IK       5= [ ] Research
    2= [ ] Extension services         4=[ ] Marketing agricultural inputs   6= [ ] Teaching
17. What strategies do you use for preserving agricultural indigenous knowledge?
    …………………………………………………………………………………………
18. What strategies do you use for disseminating agricultural indigenous knowledge in the local communities?
    1= [ ] Training            3= [ ] Conference/meeting        4= [ ] Face-to-face
    2= [ ] Agricultural shows     [ ] Others: …………………..……………………
19. What ICTs do you use when collecting agricultural indigenous knowledge?
    1=[ ] Computers    5=[ ] Internet          8=[ ] Email           11=[ ] Television
    2=[ ] Film shows   6=[ ] Microfiche       9=[ ] Cell phone       12=[ ] CDs

3=[ ] Audio cassettes  7=[ ] Database    10=[ ] Video cassettes    13=[ ] Radio

4=[ ] Land-line phone            [ ] Others: ………………………………………

20. Are ICTs effective in acquiring agricultural indigenous knowledge?

[ ] Very effective  [ ] Effective  [ ] Probably effective [ ] Ineffective [ ] Very ineffective

21. What ICTs do you use for preserving agricultural indigenous knowledge?

1=[ ] Personal Computer                4=[ ] Internet              7=[ ] Cellular phone

2=[ ] Audio cassettes                  5=[ ] Microfiche        8=[ ] CDs

3=[ ] Video cassette                   6=[ ] Email             9=[ ] Database

[ ] Others: ……………………………………………

22. Are ICTs effective in preserving agricultural indigenous knowledge?

[ ] Very effective  [ ] Effective  [ ] Probably effective [ ] Ineffective [ ] Very ineffective

23. What ICTs do you use for disseminating agricultural indigenous knowledge?

1=[ ] Personal Computer   5=[ ] Internet        8=[ ] Email            11=[ ] Television

2=[ ] Film shows             6=[ ] Microfiche   9=[ ] Cellular phone      12=[ ] CDs

3=[ ] Audio cassettes         7=[ ] Database    10=[ ] Video cassettes    13=[ ] Radio

4=[ ] Land-line phone          [ ] Others: ……………………………………………

24. Are ICTs effective in disseminating agricultural indigenous knowledge?

[ ] Very effective  [ ] Effective  [ ] Probably effective [ ] Ineffective [ ] Very ineffective

25. What print materials do you use for disseminating agricultural indigenous knowledge?

1=[ ] Newspapers          4=[ ] Books          6=[ ] Pamphlets         8=[ ] Magazines

2=[ ] Brochures           5=[ ] Newsletters     7=[ ] Leaflets          9=[ ] Posters

3=[ ] Training modules    [ ] Others:……………...…………………………………

26. Are the print materials effective in disseminating agricultural IK?

[ ] Very effective  [ ] Effective  [ ] Probably effective [ ] Ineffective [ ] Very ineffective

27. Is the traditional oral communication system (face-to-face interaction) effective in disseminating agricultural IK?

[ ] Very effective  [ ] Effective  [ ] Probably effective [ ] Ineffective  [ ] Very ineffective

28. Are you aware of any national intellectual property rights that address issues with regard to the ownership of agricultural indigenous knowledge in the local communities?

[ ] Yes                  [ ] No            [ ] Don't know

29. If yes, are the intellectual property rights useful in protecting agricultural IK of the local communities?

[ ] Very useful      [ ] Useful      [ ] Probably  [ ] Useless   [ ] Very useless

30. Do you think it is important to have a specific policy on indigenous knowledge within the country?

[ ] Very important [ ] Important [ ] Probably important [ ] Least important [ ] Not important

31. Why do you think it is important to have a specific policy on indigenous knowledge?

…………………………………………………………………………………………………

32. What should the indigenous knowledge policy address with regards to the ownership of agricultural indigenous knowledge?....................……………………………………………

33. How do you perceive your contribution to the management (acquisition, processing, preservation and dissemination) of agricultural indigenous knowledge in the local communities?.........................................……………………………………………………

**2. Dissemination of exogenous knowledge in the local communities**

34. Are farmers aware about the agricultural knowledge services provided by your organisation?

[ ] Yes                [ ] No         [ ] Don't know

35. Do you determine what farmers needs before sharing new knowledge to them?

[ ] Yes                [ ] No         [ ] Don't know

36. How do you seek what farmers' needs before disseminating new knowledge to them?

………………………………………………………………………………………

37. Do you think it is important to seek first what farmers need?

[ ] Yes                [ ] No         [ ] Don't know

38. If yes, why?...................………………………………………………………………

39. Do you think your institution satisfies most of the users' needs?

[ ] Yes                [ ] No         [ ] Don't know

40. Do you prioritize farmers' information needs in the disseminated agricultural technologies in the village?

[ ] Yes                [ ] No         [ ] Don't know

41. If yes, please specify…………………………………………………………………

42. Do you involve farmers when developing agricultural technologies?

[ ] Yes                [ ] No         [ ] Don't know

43. If yes, please specify?...................………………………………………………………

44. If no, why not?...................………………………………………………………………

45. Do you involve farmers when disseminating agricultural technologies?

[ ] Yes                [ ] No         [ ] Don't know

46. If yes, please specify?...................………………………………………………………

47. If no, why not?...................………………………………………………………………

48. Do you prioritize farmers' indigenous knowledge in your knowledge and information provision strategies?

1= [ ] Yes         2= [ ] No         3= [ ] Don't know

49. If yes, please specify……………………………………………………………………

50. What ICTs do you use for disseminating agricultural knowledge to the farmers?

1=[ ] Personal Computer  5=[ ] Internet     8=[ ] Email         11=[ ] Television

2=[ ] Film shows        6=[ ] Microfiche  9=[ ] Cellular phone  12=[ ] CDs

3=[ ] Audio cassettes     7=[ ] Database    10=[ ] Video cassette  13=[ ] Radio

4=[ ] Land-line phone     [ ] Others: ……………………………………………

51. Are ICTs effective in disseminating agricultural knowledge?

[ ] Very effective  [ ] Effective  [ ] Probably [ ] Ineffective [ ] Very ineffective

52. What print materials do you use for disseminating agricultural knowledge?

1=[ ] Newspapers        4=[ ] Books              6=[ ] Pamphlets

8=[ ] Magazines         2=[ ] Posters           5=[ ] Newsletters

7=[ ] Leaflets           9=[ ] Brochures       3=[ ] Training modules

53. Are the print materials effective in disseminating agricultural technologies?

[ ] Very effective  [ ] Effective  [ ] Probably [ ] Ineffective  [ ] Very ineffective

54. What other strategies do you use for disseminating agricultural technologies to the farmers?

1=[ ] Training            3=[ ] Conference/meeting    5=[ ] Exchange visits

2=[ ] Agricultural shows    4=[ ] Personal visits      [ ]Others:……………

55. Do you have a follow up mechanisms to ensure that farmers adopt the agricultural technologies that you disseminate to them?
   [ ] Yes                    [ ] No              [ ] Don't know
56. If yes, please specify…………………………………………………………………………
57. If no, why not?.........................…………………………………………………………………

**3. Barriers that hinder the effective management of indigenous knowledge and external knowledge on farming systems in the local communities**
58. What problems do you face in acquiring, preserving and disseminating agricultural indigenous knowledge?

| Problem | Acquisition | Sharing | Preserving |
|---|---|---|---|
| Poor knowledge sharing culture in the local communities | | | |
| Long distances to the communities | | | |
| Inadequate number of staff | | | |
| Lack of appropriate intellectual property rights to govern IK | | | |
| Lack of a specific indigenous knowledge policy | | | |
| Lack of training to manage indigenous knowledge | | | |
| | | | |

59. What problems do you face in disseminating external agricultural knowledge?
   [ ] Lack of facilities                                    [ ] Long distance
   [ ] High illiteracy on the part of farmers        [ ] Inadequate        trained personnel
   [ ] Financial constraints                              [ ] Others:…………………
60. What problems do you face when using ICT in managing (acquiring, sharing and preserving) agricultural indigenous knowledge and in disseminating agricultural knowledge in the local communities?

| Problem | Acquiring IK | Sharing IK | Preserving IK | Disseminating agricultural technologies |
|---|---|---|---|---|
| Lack of the institutional ICT policy | | | | |
| Inadequate ICT skills | | | | |
| Inadequate personnel with adequate ICT skills | | | | |
| Financial constraints | | | | |

**Appendix 3: Observation checklist for local communities**

**Section A: Information about the local community**
1. Region:…………………………………………………………………………………
2. District:………………………………………………………………………………
3. Division:………………………………………………………………………………
4. Ward:………………………………………………………………………….......
5. Village:………………………………………………………………………............
6. Date of observation:…………………………………………………………............

**Section B: Indigenous knowledge management**

**1. Various types of agricultural indigenous knowledge and the integration of indigenous knowledge and exogenous knowledge in the farming systems**
**1.1 Crop planting and production**
7.     What crops are grown in the village? ……...…………………………………………
8.      How are crops planted?  …………………………………………………………….
9.      What type of cropping system do farmers use in their farms? ………………………
10.     What types of crops are being mono-cropped?..........………………………………….
11.     What types of crops are being inter-cropped?...…………………………………….…
12.     Do farmers irrigate their farms?  …………………………………………………….
13.     Which plants are irrigated? …………..…...………………………………………..
14.     How are plants irrigated? ..………………………………………………………….
15.     What tools are used for cultivation? ..………………………………………………..

**1.2        Animal husbandry**
16.     What animal species do farmers keep in the community? ………………………………..
17.     How do farmers feed their animals? …………………………………………………

**2. The current status of managing agricultural indigenous knowledge in the local communities**
**2.1 Sources of indigenous knowledge**
18.     Where do farmers obtain knowledge with regards to indigenous farming activities?
        …………………………………………………………………………………………

**2.2 Sharing of indigenous knowledge**
19.     What types of folklore are practiced in the village? …………………………………
20.     Are there any cultures that influence sharing of agricultural indigenous knowledge in the community?...................………………………………………………………………
21.     How do they influence sharing of agricultural knowledge?
22.     How does status enable sharing of agricultural knowledge in the communities?
23.     How does status inhibit sharing of agricultural knowledge in the communities?
24.     Where do people in the village meet? For what reasons do people meet in the village?

**2.3 Preservation of indigenous knowledge**

25.     What non-ICT based tools do farmers use for preserving indigenous knowledge on farming systems? …………………………………………………………………………..

**3. Dissemination and access of external knowledge in the local communities**

26.     What are the main sources of the external tacit knowledge on farming systems in the local community? …………………………………………………………………………..

27.     What are the main sources of the external explicit knowledge on farming systems in the local community? …………………………………………………………………………..

**4. The role of ICT in managing indigenous and exogenous knowledge on farming systems**

28.     What ICTs do farmers use to acquire indigenous knowledge (IK) on farming activities?

29.     What ICTs do farmers use to share indigenous knowledge (IK) on farming activities?

30.     What ICTs do farmers use to preserve indigenous knowledge (IK) on farming activities?

**31.**     What ICTs do farmers use for accessing exogenous knowledge on farming activities?

**5. Barriers that hinder the effective management of agricultural indigenous knowledge and accessibility of exogenous knowledge in the local communities**

32.     What problems do farmers face when acquiring, sharing and preserving agricultural indigenous knowledge? …………………………………………………………………

33.     What problems do farmers face when accessing external agricultural knowledge?

34.     What problems do farmers face when using ICT in acquiring, sharing and preserving agricultural indigenous knowledge and in accessing external agricultural knowledge?

**Appendix 4: A guide for focus group interviews with local communities**

**Section A: Information about the local community**

- Region:…………………………………………………………………………………
- District:………………………………………………………………………………
- Division:………………………………………………………………………………
- Ward:…………………………………………………………………………………......
- Village:………………………………………………………………………............
- Date of observation:…………………………………………………………............

**1. Various types of agricultural indigenous knowledge and the integration of both indigenous and exogenous knowledge in the farming systems**

**1. 2 Planting materials**

1. How do you acquire your planting materials?

|  | Crop | How is it acquired? | Seeds | Roots | Cuttings |
|---|---|---|---|---|---|
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |

2. What methods are used for seed storage?
3. Which methods do you prefer for storing your seeds?
   1=[ ] Indigenous ……………………………………………………………………..
   2=[ ] Exogenous ……………………………………………………………………

**1. 3 Farming practices**

4. What criteria do you use for selecting land for planting crops?
   1=[ ] Plot's suitability for specific crops  3=[ ] Fertile lands       5=[ ] Type of soil
   2=[ ] Good water holding capacity        4=[ ] Weather
   [ ] Others:………………………
5. How are crops planted?

|  | Crop | Methods that are used for planting |
|---|---|---|
| 1 |  |  |
| 2 |  |  |

6. What types of crops are being intercropped? What types of crops are being mono-cropped?
7. Why are crops being intercropped?.................……………………………………….
8. Why are crops being mono-cropped?.................……………………………………
9. What methods do you use to control weeds?………………………………………
10. What methods do you use to improve the quality of soil?…………………………
11. What indicators do you use to determine the changes in the quality of a soil? …………………………………………………………………………………………
12. What methods do you use for preserving crops?
13. Do you irrigate your crops?   1=[ ] Yes            2=[ ] No        3=[ ] Don't know
14. Which plants are irrigated? ………………………………………………….……
15. How are plants irrigated? …………………………………………………………

**1. 4 Pest and disease management**

16. What are the common plant diseases?

|   | Crop | Disease |
|---|------|---------|
| 1 |      |         |
| 2 |      |         |

17. What are the common pests?

|   | Crop | Pests |
|---|------|-------|
| 1 |      |       |
| 2 |      |       |

18. What types of pesticides do you use to control plant diseases?

|   | Plant disease | Pesticide |
|---|---------------|-----------|
| 1 |               |           |
| 2 |               |           |
| 3 |               |           |

19. What types of pesticides do you use to control plant pests?

|   | Plant pest | Pesticide |
|---|------------|-----------|
| 1 |            |           |
| 2 |            |           |

20. What are the common plant predators? …………………………………………………
21. How do you control predators?…………………………………………………………
22. Which methods do you prefer for controlling plant diseases?
    1=[ ] Indigenous …………………………………………………………………..
    2=[ ] Exogenous …………………………………………………………………

**1.7        Animal feeding**
23. How do you feed your animals?
24. Do you grow fodder?     1=[ ] Yes   2=[ ] No       3=[ ] Don't know
25. What type of special feeds do you provide?..........……………………………………

**1.8 Animal reproduction**
26. What criteria are used for selecting male and female animals for breeding?
27. Do you control breeding?   1=[ ] Yes          2=[ ] No        3=[ ] Don't know
28. When do you control breeding? ……………………………………………………
29. Why do you control breeding? ……………………………………………………
30. How do you control breeding? …………….……………………………………

**1.9 Animal health**
31. What animal diseases do you observe in your community? How are diseases diagnosed?
32. What solutions do you use to deal with animals in poor condition?
33. Do you use any prevention mechanism to protect your animals from diseases?
34. If yes, what kinds of prevention mechanisms do you use to protect your animals from the diseases?…………………………………………………………….………………
35. Which animal treatments do you prefer?
        1=[ ] Indigenous        2=[ ] Exogenous

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**Appendix 5: Participatory rural appraisal**

**1. Information mapping and linkage diagram**

**Procedure**
1. Gather a group of participants representative of a particular category of farmers
2. Draw a circle representing the farmers in the middle of the "local area" section.
3. Ask participants where they get agricultural exogenous knowledge from within or outside their communities (that is, local or formal or informal institutions and ICTs), and who they share their knowledge with.
4. Draw a circle for each one they identify, and draw a line between each circle and the circle representing the farmers. The size of the line will denote the importance of the knowledge source
5. For each of these sources or contacts, ask participants to describe (and make notes against the lines on the paper, or on a separate piece of paper, or on this paper):
   - What type of agricultural knowledge is obtained from the source
   - How frequently are they in contact with them? (e.g. are they always available, or is it difficult to find them?)
   - How reliable are the sources of knowledge? (very reliable; 2=moderately reliable; 3=not reliable)
   - How satisfied are they with the source of knowledge on agriculture?
   - What types of agricultural knowledge did they adopt in their farming activities? What are the reasons for adopting such knowledge in their farming systems?
   - What types of agricultural knowledge did they reject in their farming activities? What are the reasons for rejecting such knowledge in their farming systems?

**B.** Once the information mapping is complete, the researcher will ask participants the following questions in order to solicit their knowledge needs**:**
   - What types of knowledge required for your farming activities have been most difficult for you to obtain?
   - Have they tried to access this knowledge?
   - What happened when they tried to access the knowledge?
   - What source did you consult to access this knowledge?
   - What problems did you encounter when you tried to access this knowledge?

**2.        Problem tree**

**Procedure:**
- Explain the purpose of the exercise to the participants
- Use the brainstorming technique to get a list of problems of the people in the following areas and tell them to write them on separate cards
    - Managing agricultural indigenous knowledge
    - Access to agricultural exogenous knowledge
    - The use of ICTs in managing agricultural indigenous knowledge and accessing agricultural exogenous knowledge
- Facilitate a discussion to identify the most serious or important problem
- Place the main problem in the centre of a large piece of paper, or on the ground
- Ask farmers what causes the problem, and what the effects are
- Write each of these causes and effects on a separate card and place them on the paper or on the ground to show how they are linked to the main problem. Place the causes below the main problem, and the effects above it
- For each cause, ask what causes it; for each effect, ask what the consequences are. Continue this process until no further causes and effects are mentioned
- Move the cards around until participants agree they are in the correct position in relation to the main problem. Draw lines between the cards to indicate the patterns of causes and effects

**Appendix 6: A guide for interviews with indigenous knowledge policy makers**

**Section A: Information about respondent**

1. Designation:………………………………………………………………………..
2. Organisation: …………………………………………………………………………
3. Sex:  [ ] Female            [ ] Male
4.  Age (years): …………………………………………………………………………
5. Highest education level
   [ ] PhD              [ ] Masters      [ ] Bachelor    [ ] Diploma    [ ] Certificate
   [ ] High school
6. Date of the interview:…………………………………………………………………

**Section B: The existing policies with regards to the management of agricultural indigenous knowledge in Tanzania**

**1. Current policies on indigenous knowledge**
7. Are you aware of the existence of any policies that address the utilisation of indigenous knowledge for development purposes? ……………………………………………………
8. If yes, what are these policies? What does each of the policy address?..............................
9. Are the current policies effective in addressing the utilisation of indigenous knowledge for development purposes? …………………………………………………………………..
10. If yes, please specify?.................................................................................................
11. If no, what do you think should be done?…………………………………………………
12. Are you aware of the existence of any intellectual property rights that addresses the protection of genetic resources and expressions of traditional culture? ……………………
13. If yes, what are these intellectual property rights? What does each of the intellectual property right address with regards to safeguarding the genetic resources and expressions of traditional culture? …………………………………………………………………………
14. Are the current intellectual property rights effective in protecting genetic resources and expressions of traditional culture?  …………………………………………………………..
15. If yes, please specify?…………………………………………………………………………
16. If no, what do you think should be done?…………………………………………………
17.  Have there been any concerns raised by the communities in relation to the protection of their indigenous knowledge?  …………………………………………………………………
18. If yes, please give examples? ……………………………………………………………

**2. Problems faced with the current indigenous knowledge policies**
19. What problems do you face with regards to the current intellectual property right in protecting agricultural indigenous knowledge?...................................................................
20. What problems do you face with regards to the current policies on agricultural indigenous knowledge?.................................................…………………………………………………

**Appendix 7: Introductory letter from office of vice chancellor at the Sokoine University of Agriculture for Kilosa District, Morogoro Region**

KIBALI CHA KUFANYA UTAFITI NCHINI TANZANIA

## CHUO KIKUU CHA SOKOINE CHA KILIMO
OFISI YA MAKAMU WA MKUU WA CHUO
S.L.P. 3000, MOROGORO, TANZANIA

*Simu:023-2604523/2603511-4; Fax:023-2604651; TELEX NO. 55308 UNIVMOG; MOROGORO*
_____

Kumb. Zetu : SUA/ADM/R.1/8            Tarehe 08/1/2008

Mkuu wa Wilaya,
Kilosa,
Morogoro

### UTAFITI WA WAALIMU NA WANAFUNZI WA CHUO KIKUU

Madhumuni ya barua hii ni kumtambulisha kwako Edda Tandi Lwoga mtafiti wa Chuo Kikuu cha Sokoine cha Kilimo. Huyo hivi sasa yuko katika shughuli za utafiti.

Kufuatana na waraka wa Serikali Kumb. Na. MPEC/R/10/1 wa tarehe 7 Julai 1980 na Kifungu Na. 8 cha Sheria Namba 6 ya 1984 (iliyokianzisha Chuo Kikuu), Makamu wa Mkuu wa Chuo alipewa madaraka ya kutoa vibali vya kufanya utafiti Nchini kwa Waalimu, Wanafunzi na Watafiti wake kwa niaba ya Serikali na Tume ya Sayansi na Teknolojia.

Hivyo basi tunaomba umpatie Mtaalamu aliyetajwa hapo juu msaada atakaohitaji ili kufanikisha uchunguzi wake. Gharama za malazi na chakula chake pamoja na usafiri wake atalipia mwenyewe kutokana na fedha alizopewa Chuo Kikuu. Msaada anaouhitaji zaidi ni kuruhusiwa kuonana na viongozi na wananchi ili aweze kuzungumza nao na kuwauliza maswali aliyo nayo.

Kiini cha Utafiti wa Mtaalamu aliyetajwa hapo juu ni: Utumiaji wa mbinu za menejimenti ya maarifa pamoja na teknolojia ya habari na mawasiliano katika usimamiaji wa maarifa ya asili katika sekta ya kilimo kwenye baadhi ya mikoa, Tanzania

Sehemu anazofanyia huo utafiti ni: Kilosa, Morogoro.

Ikiwa kuna baadhi ya sehemu ambazo zinazuiliwa, ni wajibu wako kuzuia zisitembelewe.

Muda wa Utafiti huo ni kuanzia tarehe 20/1/2008 hadi tarehe 20/8/2008

Ikiwa utahitaji maelezo zaidi wasiliana nami.

Wasalaam,

Prof. Gerald C. Monela
**MAKAMU WA MKUU WA CHUO**

MAKAMU WA MKUU WA CHUO
CHUO KIKUU CHA SOKOINE CHA KILIMO
S.L.P. 3000
MOROGORO

Nakala:Mtafiti

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**Appendix 8: Introductory letter from office of vice chancellor at the Sokoine University of Agriculture for Karagwe District, Kagera Region**

KIBALI CHA KUFANYA UTAFITI NCHINI TANZANIA

**CHUO KIKUU CHA SOKOINE CHA KILIMO**
OFISI YA MAKAMU WA MKUU WA CHUO
S.L.P. 3000, MOROGORO, TANZANIA

*Simu:023-2604523/2603511-4; Fax:023-2604651; TELEX NO. 55308 UNIVMOG; MOROGORO*

_____

Kumb. Zetu : SUA/ADM/R.1/8                    Tarehe 08/1/2008

Mkuu wa Wilaya,
Karagwe,
Kagera.

### UTAFITI WA WAALIMU NA WANAFUNZI WA CHUO KIKUU

Madhumuni ya barua hii ni kumtambulisha kwako Edda Tandi Lwoga mtafiti wa Chuo Kikuu cha Sokoine cha Kilimo. Huyo hivi sasa yuko katika shughuli za utafiti.

Kufuatana na waraka wa Serikali Kumb. Na. MPEC/R/10/1 wa tarehe 7 Julai 1980 na Kifungu Na. 8 cha Sheria Namba 6 ya 1984 (iliyokianzisha Chuo Kikuu), Makamu wa Mkuu wa Chuo alipewa madaraka ya kutoa vibali vya kufanya utafiti Nchini kwa Waalimu, Wanafunzi na Watafiti wake kwa niaba ya Serikali na Tume ya Sayansi na Teknolojia.

Hivyo basi tunaomba umpatie Mtaalamu aliyetajwa hapo juu msaada atakaohitaji ili kufanikisha uchunguzi wake. Gharama za malazi na chakula chake pamoja na usafiri wake atalipia mwenyewe kutokana na fedha alizopewa Chuo Kikuu. Msaada anaouhitaji zaidi ni kuruhusiwa kuonana na viongozi na wananchi ili aweze kuzungumza nao na kuwauliza maswali aliyo nayo.

Kiini cha Utafiti wa Mtaalamu aliyetajwa hapo juu ni: Utumiaji wa mbinu za menejimenti ya maarifa pamoja na teknolojia ya habari na mawasiliano katika usimamiaji wa maarifa ya asili katika sekta ya kilimo kwenye baadhi ya mikoa, Tanzania.

Sehemu anazofanyia huo utafiti ni: Karagwe, Kagera

Ikiwa kuna baadhi ya sehemu ambazo zinazuiliwa, ni wajibu wako kuzuia zisitembelewe.

Muda wa Utafiti huo ni kuanzia tarehe 20/1/2008 hadi tarehe 20/8/2008

Ikiwa utahitaji maelezo zaidi wasiliana nami.

Wasalaam,

Prof. Gerald C. Monela
**MAKAMU WA MKUU WA CHUO**

MAKAMU WA MKUU NA CHUO
CHUO KIKUU CHA SOKOINE CHA KILIMO
S.L.P 3000
MOROGORO

Nakala: Mtafiti

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**Appendix 9: Introductory letter from office of vice chancellor at the Sokoine University of Agriculture for Kasulu District, Kigoma Region**

KIBALI CHA KUFANYA UTAFITI NCHINI TANZANIA

**CHUO KIKUU CHA SOKOINE CHA KILIMO**
OFISI YA MAKAMU WA MKUU WA CHUO
S.L.P. 3000, MOROGORO, TANZANIA

*Simu:023-2604523/2603511-4; Fax:023-2604651; TELEX NO. 55308*
*UNIVMOG; MOROGORO*

_____

Kumb. Zetu : SUA/ADM/R.1/8                                Tarehe 08/1/2008

Mkuu wa Wilaya,
Kasulu,
Kigoma.

### UTAFITI WA WAALIMU NA WANAFUNZI WA CHUO KIKUU

Madhumuni ya barua hii ni kumtambulisha kwako Edda Tandi Lwoga mtafiti wa Chuo Kikuu cha Sokoine cha Kilimo. Huyo hivi sasa yuko katika shughuli za utafiti.

Kufuatana na waraka wa Serikali Kumb. Na. MPEC/R/10/1 wa tarehe 7 Julai 1980 na Kifungu Na. 8 cha Sheria Namba 6 ya 1984 (iliyokianzisha Chuo Kikuu), Makamu wa Mkuu wa Chuo alipewa madaraka ya kutoa vibali vya kufanya utafiti Nchini kwa Waalimu, Wanafunzi na Watafiti wake kwa niaba ya Serikali na Tume ya Sayansi na Teknolojia.

Hivyo basi tunaomba umpatie Mtaalamu aliyetajwa hapo juu msaada atakaohitaji ili kufanikisha uchunguzi wake. Gharama za malazi na chakula chake pamoja na usafiri wake atalipia mwenyewe kutokana na fedha alizopewa Chuo Kikuu. Msaada anaouhitaji zaidi ni kuruhusiwa kuonana na viongozi na wananchi ili aweze kuzungumza nao na kuwauliza maswali aliyo nayo.

Kiini cha Utafiti wa Mtaalamu aliyetajwa hapo juu ni: Utumiaji wa mbinu za menejimenti ya maarifa pamoja na teknolojia ya habari na mawasiliano katika usimamizi wa maarifa ya asili katika sekta ya kilimo kwenye baadhi ya mikoa, Tanzania.

Sehemu anazofanyia huo utafiti ni: Kasulu, Kigoma.

Ikiwa kuna baadhi ya sehemu ambazo zinazuiliwa, ni wajibu wako kuzuia zisitembelewe.

Muda wa Utafiti huo ni kuanzia tarehe 20/1/2008 hadi tarehe 20/8/2008

Ikiwa utahitaji maelezo zaidi wasiliana nami.

Wasalaam,

Prof. Gerald C. Monela
**MAKAMU WA MKUU WA CHUO**

MAKAMU WA MKUU NA CHUO
CHUO KIKUU ... SOKOINE CHA KILIMO
S. L. P. 3000
MOROGORO

Nakala: Mtafiti

**Appendix 10: Introductory letter from office of vice chancellor at the Sokoine University of Agriculture for Mpwapwa District, Dodoma Region**

KIBALI CHA KUFANYA UTAFITI NCHINI TANZANIA

**CHUO KIKUU CHA SOKOINE CHA KILIMO**
OFISI YA MAKAMU WA MKUU WA CHUO
S.L.P. 3000, MOROGORO, TANZANIA

*Simu:023-2604523/2603511-4; Fax:023-2604651; TELEX NO. 55308 UNIVMOG; MOROGORO*

Kumb. Zetu : SUA/ADM/R.1/8                    Tarehe 08/1/2008

Mkuu wa Wilaya,
Mpwapwa,
Dodoma.

**UTAFITI WA WAALIMU NA WANAFUNZI WA CHUO KIKUU**

Madhumuni ya barua hii ni kumtambulisha kwako Edda Tandi Lwoga mtafiti wa Chuo Kikuu cha Sokoine cha Kilimo. Huyo hivi sasa yuko katika shughuli za utafiti.

Kufuatana na waraka wa Serikali Kumb. Na. MPEC/R/10/1 wa tarehe 7 Julai 1980 na Kifungu Na. 8 cha Sheria Namba 6 ya 1984 (iliyokianzisha Chuo Kikuu), Makamu wa Mkuu wa Chuo alipewa madaraka ya kutoa vibali vya kufanya utafiti Nchini kwa Waalimu, Wanafunzi na Watafiti wake kwa niaba ya Serikali na Tume ya Sayansi na Teknolojia.

Hivyo basi tunaomba umpatie Mtaalamu aliyetajwa hapo juu msaada atakaohitaji ili kufanikisha uchunguzi wake. Gharama za malazi na chakula chake pamoja na usafiri wake atalipia mwenyewe kutokana na fedha alizopewa Chuo Kikuu. Msaada anaouhitaji zaidi ni kuruhusiwa kuonana na viongozi na wananchi ili aweze kuzungumza nao na kuwauliza maswali aliyo nayo.

Kiini cha Utafiti wa Mtaalamu aliyetajwa hapo juu ni: Utumiaji wa mbinu za menejimenti ya maarifa pamoja na teknolojia ya habari na mawasiliano katika usimamiaji wa maarifa ya asili katika sekta ya kilimo kwenye baadhi ya mikoa, Tanzania.

Sehemu anazofanyia huo utafiti ni: Mpwapwa, Dodoma

Ikiwa kuna baadhi ya sehemu ambazo zinazuiliwa, ni wajibu wako kuzuia zisitembelewe.

Muda wa Utafiti huo ni kuanzia tarehe 20/1/2008 hadi tarehe 20/8/2008

Ikiwa utahitaji maelezo zaidi wasiliana nami.

Wasalaam,

Prof. Gerald C. Monela
**MAKAMU WA MKUU WA CHUO**

Nakala: Mtafiti

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**Appendix 11: Introductory letter from office of vice chancellor at the Sokoine University of Agriculture for Moshi Rural District, Kilimanjaro Region**

KIBALI CHA KUFANYA UTAFITI NCHINI TANZANIA

## CHUO KIKUU CHA SOKOINE CHA KILIMO
### OFISI YA MAKAMU WA MKUU WA CHUO
S.L.P. 3000, MOROGORO, TANZANIA

*Simu:023-2604523/2603511-4; Fax:023-2604651; TELEX NO. 55308 UNIVMOG; MOROGORO*

Kumb. Zetu : SUA/ADM/R.1/8                    Tarehe 08/1/2008

Mkuu wa Wilaya,
Moshi Vijijini,
Kilimanjaro.

### UTAFITI WA WAALIMU NA WANAFUNZI WA CHUO KIKUU

Madhumuni ya barua hii ni kumtambulisha kwako Edda Tandi Lwoga mtafiti wa Chuo Kikuu cha Sokoine cha Kilimo. Huyo hivi sasa yuko katika shughuli za utafiti.

Kufuatana na waraka wa Serikali Kumb. Na. MPEC/R/10/1 wa tarehe 7 Julai 1980 na Kifungu Na. 8 cha Sheria Namba 6 ya 1984 (iliyokianzisha Chuo Kikuu), Makamu wa Mkuu wa Chuo alipewa madaraka ya kutoa vibali vya kufanya utafiti Nchini kwa Waalimu, Wanafunzi na Watafiti wake kwa niaba ya Serikali na Tume ya Sayansi na Teknolojia.

Hivyo basi tunaomba umpatie Mtaalamu aliyetajwa hapo juu msaada atakaohitaji ili kufanikisha uchunguzi wake. Gharama za malazi na chakula chake pamoja na usafiri wake atalipia mwenyewe kutokana na fedha alizopewa Chuo Kikuu. Msaada anaouhitaji zaidi ni kuruhusiwa kuonana na viongozi na wananchi ili aweze kuzungumza nao na kuwauliza maswali aliyo nayo.

Kiini cha Utafiti wa Mtaalamu aliyetajwa hapo juu ni: Utumiaji wa mbinu za menejimenti ya maarifa pamoja na teknolojia ya habari na mawasiliano katika usimamiaji wa maarifa ya asili katika sekta ya kilimo kwenye baadhi ya mikoa, Tanzania.

Sehemu anazofanyia huo utafiti ni: Moshi Vijijini, Kilimanjaro.

Ikiwa kuna baadhi ya sehemu ambazo zinazuiliwa, ni wajibu wako kuzuia zisitembelewe.

Muda wa Utafiti huo ni kuanzia tarehe 20/1/2008 hadi tarehe 20/8/2008

Ikiwa utahitaji maelezo zaidi wasiliana nami.

Wasalaam,

Prof. Gerald C. Monela
**MAKAMU WA MKUU WA CHUO**

Nakala: Mtafiti

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**Appendix 12: Introductory letter from office of vice chancellor at the Sokoine University of Agriculture for Songea Rural District, Ruvuma Region**

KIBALI CHA KUFANYA UTAFITI NCHINI TANZANIA

**CHUO KIKUU CHA SOKOINE CHA KILIMO**
OFISI YA MAKAMU WA MKUU WA CHUO
S.L.P. 3000, MOROGORO, TANZANIA

*Simu:023-2604523/2603511-4; Fax:023-2604651; TELEX NO. 55308 UNIVMOG; MOROGORO*
_____

Kumb. Zetu : SUA/ADM/R.1/8                     Tarehe 08/1/2008

Mkuu wa Wilaya,
Songea Vijijini,
Ruvuma

### UTAFITI WA WAALIMU NA WANAFUNZI WA CHUO KIKUU

Madhumuni ya barua hii ni kumtambulisha kwako Edda Tandi Lwoga mtafiti wa Chuo Kikuu cha Sokoine cha Kilimo. Huyo hivi sasa yuko katika shughuli za utafiti.

Kufuatana na waraka wa Serikali Kumb. Na. MPEC/R/10/1 wa tarehe 7 Julai 1980 na Kifungu Na. 8 cha Sheria Namba 6 ya 1984 (iliyokianzisha Chuo Kikuu), Makamu wa Mkuu wa Chuo alipewa madaraka ya kutoa vibali vya kufanya utafiti Nchini kwa Waalimu, Wanafunzi na Watafiti wake kwa niaba ya Serikali na Tume ya Sayansi na Teknolojia.

Hivyo basi tunaomba umpatie Mtaalamu aliyetajwa hapo juu msaada atakaohitaji ili kufanikisha uchunguzi wake. Gharama za malazi na chakula chake pamoja na usafiri wake atalipia mwenyewe kutokana na fedha alizopewa Chuo Kikuu. Msaada anaouhitaji zaidi ni kuruhusiwa kuonana na viongozi na wananchi ili aweze kuzungumza nao na kuwauliza maswali aliyo nayo.

Kiini cha Utafiti wa Mtaalamu aliyetajwa hapo juu ni: Utumiaji wa mbinu za menejimenti ya maarifa pamoja na teknolojia ya habari na mawasiliano katika usimamizi wa maarifa ya asili katika sekta ya kilimo kwenye baadhi ya mikoa, Tanzania

Sehemu anazofanyia huo utafiti ni: Songea vijijini, Ruvuma.

Ikiwa kuna baadhi ya sehemu ambazo zinazuiliwa, ni wajibu wako kuzuia zisitembelewe.

Muda wa Utafiti huo ni kuanzia tarehe 20/1/2008 hadi tarehe 20/8/2008

Ikiwa utahitaji maelezo zaidi wasiliana nami.

Wasalaam,

Prof. Gerald C. Monela
**MAKAMU WA MKUU WA CHUO**

MAKAMU WA MKUU WA CHUO
CHUO KIKUU CHA SOKOINE CHA KILIMO
S.L.P 3000
MOROGORO

Nakala: Mtafiti

# Appendix 13: Introductory letter from the University of KwaZulu-Natal



UNIVERSITY OF
KWAZULU-NATAL

School of Sociology and Social
Studies
University of KwaZulu-Natal
Private Bag X01
Scottsville 3209
South Africa
Tel: +27 (0) 33 2605972
Fax: +27 (0) 33 2605092
ngulubep@ukzn.ac.za

11 December 2007

**TO WHOM IT MAY CONCERN**

**Letter of introduction: Ms. Edda Lwoga Student No. 207521242 (Information Studies Programme)**

This letter serves to introduce Ms. Edda Lwoga who is registered as a PhD student at the University of KwaZulu-Natal. Ms Lwoga is currently carrying out a study on the application of knowledge management approaches and information and communication technologies to manage indigenous knowledge in the agricultural sector in selected regions of Tanzania. The study seeks to find out the extent to which knowledge management principles and information and communication technology can be used to manage agricultural indigenous knowledge in some local communities of Tanzania. The information obtained and the resultant recommendations could assist in decision-making.

In order to undertake the study, Ms. Lwoga will need to conduct observations in selected local communities. In addition to that, she will carry out some interviews among *local communities* such as farmers, traditional leaders, village leaders and traditional entertainers, *indigenous knowledge intermediaries* such as extension officers, district agricultural officers, agriculture information specialists/librarians, telecenter staff, agricultural researchers, indigenous knowledge trainees, non-governmental organization officers, school teachers, individual trader and agro-based private companies officers seed and livestock suppliers, agrochemical and veterinary goods suppliers, transporters, tractor and oxen rental suppliers, providers of artificial insemination and bull schemes, pest control groups and consultants, and *indigenous knowledge policy makers* such as officers from the Business Registration and Licensing Agency (BRELA), Copyrights Society of Tanzania (COSOTA), Intellectual Property Advisory Service and Information Centre (IPASIC), Tanzania IK Trust Fund and Ministry of Agriculture and Food Security in Tanzania. In that light, the Information Studies Programme kindly requests you to render any possible assistance to Ms Lwoga in order to facilitate the conduct of the study.

If you require any clarification pertaining to the study, please, feel free to contact Prof. Patrick Ngulube, who is the supervisor of the research, on telephone 27332605972 or email ngulubep@ukzn.ac.za.

Thank you in advance in anticipation.

Yours faithfully

Prof Patrick Ngulube (Supervisor)
Academic Coordinator
Information Studies Programme
School of Sociology and Social Studies
University of KwaZulu-Natal
Pietermaritzburg
South Africa

**Appendix 14: Informal consent form for collecting data in the local communities**

**Consent form for collecting data in the local communities**

Dear Participant,

My name is Edda Lwoga. I am a PhD candidate in the Information Studies Programme at the University of KwaZulu-Natal, South Africa. I am conducting a study titled "Application of knowledge management approaches and information and communication technologies to manage indigenous knowledge in the agricultural sector in selected regions of Tanzania". The study seeks to examine the extent to which knowledge management principles and information and communication technologies can be used to manage agricultural indigenous knowledge in some local communities of Tanzania.

The study includes everyone who is involved in farming activities in your village. Participation is voluntary. You can withdraw from participating in the interview at any time during the process. The interview is going to take 30 minutes of your time. The information you give will help to enhance the management of agricultural indigenous knowledge in Tanzania. You will not incur any expenses by being involved in the research.

Electronic data will be protected by a password and preserved in electronic devices such as flash disks, CDROM and computer in order to provide backups for the data collected. Printed versions of the data will be properly filed and stored in a safe place for a period of five years. The notes and recording will be transcribed by using a word processor. The notebooks and the tape recordings will be destroyed after transcription.

The information you provide will be strictly kept confidential and will only be used for this study. Your credentials will not be included in the final report. Failure to participate in the research will not prejudice you in any way.

**AUTHORIZATION:** I have read the above and understand the nature of this study. I agree to participate in this study and I understand that my participation in this study is voluntary. I understand that if there is a need for any clarification about this study, I may contact the student's supervisors, Prof. Patrick Ngulube, (ngulubep@ukzn.ac.za), Prof. Christine Stilwell (stilwell@ukzn,.ac.za) or the researcher, Edda Lwoga (207521242@ukzn.ac.za).

Participants signature:_____          Date:_____
Researchers signature:_____          Date:_____

**Appendix 15: Tacit and explicit sources of knowledge for various types of agricultural indigenous knowledge (N=181)**

| Knowledge sources | New varieties & techniques | | Livestock husbandry | | Plant diseases | | Crop husbandry | | Value added | | Soil fertility | | Animal diseases | | Agricultural tool | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % | No | % | No | % | No | % | No | % |
| Agricultural shows | 1 | 0.6 | 1 | 0.6 | - | - | - | - | - | - | - | - | - | - | - | - |
| Books | 5 | 2.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Church | - | - | 2 | 1.1 | 1 | 0.6 | 5 | 2.8 | 1 | 0.6 | - | - | - | - | - | - |
| Cooperatives | 2 | 1.1 | - | - | - | - | 1 | 0.6 | - | - | - | - | - | - | - | - |
| Extension officer | 3 | 1.7 | 2 | 1.1 | 1 | 0.6 | - | - | - | - | 3 | 1.7 | - | - | - | - |
| Farmer groups | 6 | 3.3 | 7 | 3.9 | 4 | 2.2 | 10 | 5.5 | 4 | 2.2 | 3 | 1.7 | 5 | 2.8 | - | - |
| Livestock headers | 3 | 1.7 | 11 | 6.1 | 3 | 1.7 | 9 | 5 | 5 | 2.8 | 3 | 1.7 | 6 | 3.3 | - | - |
| Neighbours | 47 | 26 | 41 | 22.7 | 38 | 21.0 | 73 | 40.3 | 40 | 22.1 | 33 | 18.2 | 43 | 23.8 | - | - |
| Newsletters | 4 | 2.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Newspapers | 4 | 2.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| NGOs | 9 | 5 | 1 | 0.6 | 2 | 1.1 | - | - | 2 | 1.1 | 1 | 0.6 | 2 | 1.1 | - | - |
| Observation | 25 | 13.8 | 8 | 4.4 | 3 | 1.7 | 9 | 5 | 25 | 13.8 | 3 | 1.7 | 6 | 3.3 | - | - |
| Parents | 55 | 30.4 | 55 | 30.4 | 54 | 29.8 | 100 | 55.2 | 86 | 47.5 | 38 | 21 | 69 | 38.1 | 5 | 2.8 |
| Posters | - | - | 2 | 1.1 | | | - | - | - | - | - | - | - | - | - | - |
| Researchers | 3 | 1.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| School | 3 | 1.7 | - | - | - | - | - | - | 1 | 0.6 | - | - | - | - | - | - |
| Seminars | 4 | 2.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Social groups | 18 | 9.9 | 19 | 10.5 | 10 | 5.5 | 21 | 11.6 | 13 | 7.2 | 9 | 5 | 16 | 8.8 | - | - |
| Village leaders | - | - | 6 | 3.3 | 2 | 1.1 | 4 | 2.2 | 2 | 1.1 | 3 | 1.7 | 4 | 2.2 | - | - |
| Village meetings | - | - | 1 | 0.6 | 2 | 1.1 | 3 | 1.7 | - | - | - | - | 1 | 0.6 | - | - |
| Women meetings | 2 | 1.1 | - | - | - | - | 2 | 1.1 | 1 | 0.6 | - | - | - | - | - | - |

**Appendix 16: Tacit and explicit sources of knowledge for various types of agricultural exogenous knowledge in the local communities (N=181)**

| Exogenous Knowledge sources | Knowledge Types | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agricultural tool | | Animal disease | | New varieties & techniques | | Crop husbandry | | Financial | | Animal husbandry | | Marketing | | Plant diseases | | Soil fertility | | Value added | |
| | No | % | No | % | No | % | No | % | No | % | No | % | No | % | No | % | No | % | No | % |
| Agricultural shows | 1 | 0.6 | 2 | 1.1 | 10 | 5.5 | 3 | 1.7 | - | - | 3 | 1.7 | - | - | 2 | 1.1 | 2 | 1.1 | 1 | 0.6 |
| Input suppliers | 9 | 5.0 | 34 | 18.8 | 30 | 16.6 | 23 | 12.7 | - | - | 35 | 19.3 | - | - | 33 | 18.2 | 20 | 11.0 | 2 | 1.1 |
| Books | - | - | 6 | 3.3 | 7 | 3.9 | 7 | 3.9 | - | - | 1 | 0.6 | - | - | 5 | 2.8 | 1 | 0.6 | 1 | 0.6 |
| Church | - | - | 1 | 0.6 | 19 | 10.5 | 2 | 1.1 | 1 | 0.6 | - | - | 1 | 0.6 | 2 | 1.1 | 1 | 0.6 | 1 | 0.6 |
| Cooperatives | - | - | - | - | 6 | 3.3 | 6 | 3.3 | - | - | - | - | 23 | 12.7 | - | - | - | - | - | - |
| Extension officers | 10 | 5.5 | 49 | 27.1 | 79 | 43.6 | 86 | 47.5 | 11 | 6.1 | 50 | 27.6 | 12 | 6.6 | 43 | 23.8 | 22 | 12.2 | 25 | 13.8 |
| Farmer groups | - | - | 21 | 11.6 | 23 | 12.7 | 17 | 9.4 | 19 | 10.5 | 22 | 12.2 | 16 | 8.8 | 18 | 9.9 | 7 | 3.9 | 8 | 4.4 |
| Livestock headers | - | - | 7 | 3.9 | 6 | 3.3 | 6 | 3.3 | - | - | 11 | 6.1 | - | - | 3 | 1.7 | - | - | 5 | 2.8 |
| Individual traders | - | - | 6 | 3.3 | 6 | 3.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Neighbours | - | - | 36 | 19.9 | 66 | 36.5 | 60 | 33.1 | 6 | 3.3 | 36 | 19.9 | 14 | 7.7 | 28 | 15.5 | 15 | 8.3 | 10 | 5.5 |
| Newsletters | - | - | 1 | 0.6 | 12 | 6.6 | 10 | 5.5 | - | - | 1 | 0.6 | 1 | 0.6 | 2 | 1.1 | 1 | 0.6 | - | - |
| Newspapers | - | - | - | - | 2 | 1.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| NGO | - | - | 21 | 11.6 | 28 | 15.5 | 26 | 14.4 | 23 | 12.7 | 23 | 12.7 | 13 | 7.2 | 15 | 8.3 | 7 | 3.9 | 12 | 6.6 |
| Observation | - | - | - | - | 20 | 11.0 | 17 | 9.4 | - | - | - | - | - | - | - | - | - | - | - | - |
| Parents | - | - | 27 | 14.9 | 16 | 8.8 | 41 | 22.7 | 2 | 1.1 | 25 | 13.8 | 3 | 1.7 | 22 | 12.2 | 11 | 6.1 | 18 | 9.9 |
| Posters | - | - | - | - | 4 | 2.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Public agency | - | - | - | - | 1 | 0.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Researchers | - | - | 4 | 2.2 | 6 | 3.3 | 7 | 3.9 | - | - | 4 | 2.2 | 1 | 0.6 | - | - | - | - | - | - |
| Schools | - | - | 2 | 1.1 | - | - | 9 | 5.0 | - | - | 2 | 1.1 | - | - | 5 | 2.8 | 3 | 1.7 | 4 | 2.2 |
| Seminars | - | - | 7 | 3.9 | 8 | 4.4 | 9 | 5.0 | - | - | 7 | 3.9 | - | - | 5 | 2.8 | 4 | 2.2 | 2 | 1.1 |
| Social groups | - | - | - | - | 9 | 5.0 | 9 | 5.0 | - | - | - | - | - | - | - | - | - | - | - | - |
| Training module | - | - | 1 | 0.6 | 1 | 0.6 | 1 | 0.6 | - | - | 1 | 0.6 | - | - | 1 | 0.6 | - | - | - | - |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Village leaders | - | - | - | - | 7 | 3.9 | 6 | 3.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| Village meetings | - | - | 9 | 5.0 | 14 | 7.7 | 14 | 7.7 | 3 | 1.7 | 9 | 5.0 | 3 | 1.7 | 9 | 5.0 | 1 | 0.6 | 3 | 1.7 |
| Women meetings | - | - | - | - | 1 | 0.6 | 1 | 0.6 | - | - | - | - | - | - | - | - | - | - | - | - |

**Appendix 17: ICTs used to access various types of agricultural exogenous knowledge in the local communities (N=161)**

| ICT | Knowledge types | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agricultural tools | | Animal diseases | | New varieties & techniques | | Crop husbandry | | Financial | | Livestock husbandry | | Marketing | | Plant diseases | | Soil fertility | | Value added | |
| | No | % | No | % | No | % | No | % | No | % | No | % | No | % | No | % | No | % | No | % |
| Cell phone | 1 | 0.6 | 11 | 6.8 | 11 | 6.8 | 14 | 8.7 | - | - | 10 | 6.2 | 13 | 8.1 | 1 | 0.6 | 1 | 0.6 | - | - |
| Email | - | - | - | - | - | - | 5 | 3.1 | - | - | 1 | 0.6 | 3 | 1.9 | - | - | - | - | 1 | 0.6 |
| Internet | - | - | - | - | - | - | 5 | 3.1 | - | - | 1 | 0.6 | 2 | 1.2 | - | - | - | - | 1 | 0.6 |
| Radio | 5 | 3.1 | 5 | 3.1 | 86 | 53.4 | 51 | 31.7 | 2 | 1.2 | 11 | 6.8 | 5 | 3.1 | 7 | 4.3 | 12 | 7.5 | 3 | 1.9 |
| Audio cassettes | - | - | - | - | - | - | 1 | 0.6 | - | - | - | - | - | - | - | - | - | - | - | - |
| Television | - | - | 3 | 1.9 | 29 | 18 | 13 | 8.1 | - | - | 8 | 5.0 | 2 | 1.2 | - | - | - | - | - | - |
| Film shows | - | - | - | - | 2 | 1.2 | 1 | 0.6 | - | - | - | - | - | - | - | - | - | - | - | - |
| Video cassette | - | - | - | - | - | - | 2 | 1.2 | - | - | - | - | - | - | - | - | - | - | - | - |

*(Multiple responses were possible)*

**Appendix 18: Problem tree depicting the barriers that hinder the management of organic farming knowledge at Lyasongoro Village, Moshi Rural District**

**EFFECTS**

Low income

High level of poverty

Low adoption of organic farming

POOR GROWTH OF EDUCATION ON ORGANIC FARMING

Farmers who attended organic farming training don't teach others because they are not empowered

People are selfish to share their knowledge on organic farming

Organic farming techniques reaches few farmers

Extension agents lack skills on organic farming

Farmers are not motivated to attend training

Farmers don't adopt because they lack a specific market for organic products

Lack of information materials on organic farming e.g books, TV/radio programmes

**CAUSES**

**Appendix 19: Problem tree depicting the barriers that hinder the management of IK in Moshi Rural District (Lyasongoro and Mshiri Villages)**

**EFFECTS**

Brings human diseases and death

Expensive to buy agricultural inputs

Land destruction / soil infertility

Loss of labour

High use of pesticides

High use of mineral fertilizers

Youth migrate to urban areas

Poverty

Disappearance of indigenous seeds

Hunger

Low income

Inability to meet family expenses

**POOR UTILISATION OF IK**

IK is not recorded

Poor knowledge sharing culture

IK holders die because of old age

Herb medicine is suspected to be linked to witchcraft

Youth ignore IK

Agriculture is not an income earning sector

Use of exogenous knowledge replaces IK

IK holders require payments for their knowledge

Lack of trust and selfishness

IK is shared in clans e.g. blacksmith shared in specific clans

Government does not recognize IK, they concentrate more on exogenous knowledge

Poverty

**CAUSES**

587

**Appendix 20: Problem tree depicting the barriers that hinder the management of IK in Karagwe District (Katwe and Iteera Villages)**

EFFECTS

Low income and productivity

Dominance of unimproved IK in farming systems

Failure to utilize IK in farming systems

Shortage of food

Reliance on external knowledge which is not suitable for local farming system

Lack of access to IK

**LOSS OF IK**

Lack of recorded IK

IK susceptible to witchcraft

IK holders are dying

Difficult to know IK holders

Neglected by government

IK takes time to be prepared

Poor knowledge sharing culture

IK holders are not empowered

Extension officers do not encourage use of IK

Lack of trust

Scared to share because it will be stolen due to lack of policies to protect IK

IK is ignored by young people and others

Reluctance to change

Village leaders do not encourage sharing

People who are not careful may overdose so they are not taught

Selfishness

Personal attitudes and negligence

Culture and customs

CAUSES

588

**Appendix 21: Problem tree depicting the barriers that hinder the management of IK in Kasulu District (Kidyama and Nyansha Villages)**

**EFFECTS**

Continuation of bad farming practices e.g. field burning

High level of poverty

Increasing unethical conducts to youth

IK is not improved because it is not used

Hunger

Low agricultural yield

Food insecurity

**LOSS OF IK**

Youth are not ready to learn IK

High level of ignorance of IK

Lack of knowledge sharing culture

Lack of documented IK

Modernization

Formal education

Difficult to know IK holders

**CAUSES**

**Appendix 22: Problem tree depicting the barriers that hinder the management of IK in Kilosa District (Kasiki and Twatwatwa Villages)**

**EFFECTS**

Disappearance of effective traditional agricultural techniques

Disappearance of traditional culture

Lack of labour because most youth are educated and thus they migrate to work to town

Youth end with habits that are different from their traditions

Shortage of food

Low agricultural yields

**DISAPPEARANCE OF IK**

Inter-cultural changes

Difficult to know who has IK, or where to get IK

Lack of an approach to record IK

Poor knowledge sharing culture

Government does not recognize IK,

Migration of IK holders from one place to another

Use of exogenous knowledge affects the application of IK

Self-centeredness

Youth ignore IK

Formal education

ICTs development e.g. radio, cell phones, TV

Elders (IK holders) die because of old age

Culture and customs

**CAUSES**

590

**Appendix 23: Problem tree depicting the barriers that hinder the management of IK in Songea Rural District (Lilondo and Materereka Villages)**

**EFFECTS**

Disappearance of useful culture and customs

Failure of youth to work because of bad morals

Disappearance of local methods for disease and pest control

IK is not utilised and replicated

Moral degradation

**LACK OF ACCESS TO INDIGENOUS KNOWLEDGE**

IK is based on belief, it is not researched knowledge

Use of IK contributes to low agricultural production

Youth are not receptive of IK

Difficult to know who has IK and where to get it

IK is not documented

Illiteracy of early IK custodians

Poor recognition of IK value by government

Formal school

Modernization

Lack of knowledge sharing culture

Individual communities are not encouraged to share knowledge

Jealousy

self-centeredness

**CAUSES**

**Appendix 24: Problem tree depicting the barriers that hinder access to exogenous knowledge in Moshi Rural District (Lyasongoro and Mshiri Villages)**



EFFECTS

Can not afford to take children to school

Loss of labour

Inadequate animal feeds

Farmers shift from agriculture to other activities

high level of migration from rural to urban

Poverty

High level of crime

Human diseases and death

Loss of agricultural produce

Low income in agriculture

Lack of confidence in government

Lack of access to markets, inputs and credit

Traditional farming is not improved

Low adoption of technologies

**AGRICULTURE CONTINUE TO BE POOR AND A FARMER REMAINS TO BE POOR**

Few printed materials on agricultural information

Lack of inputs

Poor extension services

Public Extension agents do not encourage farmers to use modern techniques

Farmers exposed to extension services do not share their knowledge

Public Extension officers do not visit frequently

Few Public extension officers

Non use of participatory approaches

Public extension officers shift to livestock because they are paid by farmers

CAUSES

592

**Appendix 25: Problem tree depicting the barriers that hinder access to exogenous knowledge in Karagwe District (Iteera and Katwe Villages)**



**EFFECTS**

- Inability to meet necessary expenses
- Dominance of unimproved knowledge system
- Low production and food insecurity
- Lack of inputs
- Poverty at family and Village levels
- Animal and plant diseases
- Lack of reliable markets
- Low income

**LOW ADOPTION OF IMPROVED TECHNOLOGIES**

- Farmers who are exposed to extension services do not teach others
- Many farmers do not like to attend seminars or meetings
- Resistant to change
- Lack of access to printed information
- Poor extension services
- Lack of agricultural and veterinary shops to acquire inputs and knowledge
- Selfishness
- Infrequent visit and training by extension due to lack of transport
- Farmers are not empowered to disseminate knowledge to others
- Few seminars
- Inadequate practical & participatory orientation
- Inadequate extension staff
- Irrelevant technologies

**CAUSES**

593

**Appendix 26: Problem tree depicting the barriers that hinder access to exogenous knowledge in Kasulu District (Nyansha and Kidyama Villages)**

EFFECTS

Increased incidences of crime

Continuation of bad farming practices e.g. field burning

Selling crops at low prices

Crops damage because they are not sold

Unreliable markets

Failure to meet family expenses

Low adoption of new techniques

Poverty

Low production and income

Hunger

**LACK OF ACCESS TO EXOGENOUS KNOWLEDGE**

Lack of adequate extension officers

Extension officers do not frequently visit

Lack of culture to share knowledge

Lack of adequate seminars

Lack of access to printed information

Neighbours may not tell the truth due to selfishness and jealousness

Poor extension services

Lack of libraries

Lack of funds to purchase printed information

Village meeting not regularly organised

CAUSES

594

**Appendix 27: Problem tree depicting the barriers that hinder access to exogenous knowledge in Kilosa District (Kasiki and Twatwatwa Villages)**

EFFECTS

| | |
|---|---|
| Low production | Not able to access credits |
| | Low rate of technology adoption |
| Food shortage | Continued to use unimproved inputs and techniques |
| Increasing number of plant pests and diseases | Lack of confidence to the government |
| | Unreliable markets |
| | IK knowledge is not improved |
| | Do not know which inputs to use |

**LOW LEVEL OF AGRICULTURAL EDUCATION**

Low awareness on the part of farmers to demand their rights

Agriculture is not prioritized by the District authority

High illiteracy

Extension officer is there but not available to advise farmers

Few extension officers

Library charges high fees

Village leaders are unreliable

Educated farmers do not teach others

District administration does not supervise well the extension services

Inadequate and irrelevant printed materials

Unreliable agro-shops because inputs are inadequate, expensive and not available at appropriate time

People do not like to join FFS because they think they will be paid and yet there are no payments

**CAUSES**

**Appendix 28: Problem tree depicting the barriers that hinder access to exogenous knowledge in Mpwapwa District (Mazae and Vinghawe Villages)**



EFFECTS

Poor use of crop animal husbandry improved technologies

Shortage of food

Low agricultural production

Damaged produce due to poor use of postharvest techniques

High incidences of animal and plant diseases

Unreliable markets

**LACK OF ACCESS TO KNOWLEDGE IN AGRICULTURE**

Illiteracy

Farmer groups are not well distributed

Poor extension officers

Lack of funds to purchase newspapers, books

Inadequate extension officers

Extension officers are not always available e.g. NGO, public extension services

Few seminars

Lacks of transport to enable extension to reach farmers

Inadequate access to printed information

Ignore knowledge disseminated by other farmers because they are not specialist

CAUSES

596

**Appendix 29: Problem tree depicting the barriers that hinder access to exogenous knowledge in Songea Rural District (Lilondo and Materereka Villages)**

**Appendix 30: Problem tree depicting the barriers that hinder the management of indigenous knowledge and access to exogenous knowledge through ICTs in Moshi Rural District (Mshiri and Lyasongoro Villages)**

**EFFECTS**

Unreliable markets

Lack of access to agricultural inputs

Loss of labour

Poverty

Low production

Hunger

Migration from rural to urban areas

**LACK OF ACCESS TO AGRICULTURAL KNOWLEDGE AND INFORMATION**

Lack of awareness on ICT - internet

ICTs are expensive to maintain

Lack of knowledge on the use of ICTs

Programmes are not frequently aired and their schedule is not known by farmers

Unreliable and lack of electricity

Programmes need to localized according to the specific areas

Few agricultural programmes

Poor coverage of cell phones network

Lack of ICTs geared into farmers e.g. lack of community radio

Poor agricultural programmes in TV and radio broadcasts

**CAUSES**

598

**Appendix 31: Problem tree depicting the barriers that hinder the management of indigenous knowledge and access to exogenous knowledge through ICTs in Karagwe District (Iteera and Katwe Villages)**

**EFFECTS**

High incidence of plant pests and diseases

Continued reliance on traditional means of information access

Lack of access to inputs

IK system is not improved

Lack of access to new techniques

Low adoption of improved technologies

Low production

**FAILURE TO USE ICTS IN FARMING SYSTEMS**

Poor reception of some radio broadcasts and cell phone network

Few agricultural programmes on TV

Difficult to recharge batteries for cell phones

Low awareness of ICT

Expensive ICTs, example batteries, TV

Lack of electricity

**CAUSES**

**Appendix 32: Problem tree depicting the barriers that hinder the management of indigenous knowledge and access to exogenous knowledge through ICTs in Kasulu District (Kidyama and Nyansha Villages)**



**EFFECTS**

Agricultural performances are not improved

Continued use of poor farming practices

Low adoption of new techniques

Reliance on sources of information from the Village which are not enough to improve agriculture

Lack of reliable markets

**LACK OF ACCESS TO AGRICULTURAL KNOWLEDGE**

High cost of ICTs

Lack of electricity

Lack of nearby telecentre

Low awareness of ICTs

Few programmes on TV and radio

Short time allotted for radio programm

Lack of practical in radio so they can not understand

Cell phones may provide wrong information e.g. crop prices

Inappropriate time for radio & TV programmes

Irrelevant knowledge on radio and TV

Poor quality of TV and radio agricultural programmes

**CAUSES**

600

**Appendix 33: Problem tree depicting the barriers that hinder the management of indigenous knowledge and access to exogenous knowledge through ICTs in Kilosa District (Twatwatwa and Kasiki Villages)**

**EFFECTS**

Low income

Farmers remain uneducated

Increasing number of livestock diseases

Food insecurity

Low agricultural yield

Poverty

**INADEQUATE ACCESS TO LOCAL CONTENT**

High cost of ICTs

Lack of power

Customs rules restrict livestock herders to listen to radio

High level of illiteracy

Few agricultural programmes

Most radio stations broadcast commercials rather than educative programmes

Middle men use cell phones to deceive livestock keepers on prices to gain cheap offers

Short time allotted to programmes

Irrelevant knowledge

Poor infrastructure

Poor agricultural radio programmes

**CAUSES**

**Appendix 34: Problem tree depicting the barriers that hinder the management of indigenous knowledge and access to exogenous knowledge through ICTs in Mpwapwa District (Vinghawe and Mazae Villages)**

**EFFECTS**

Unreliable markets

Low production

Low adoption of crop and animal husbandry technologies

Animal and plant diseases

Poverty

**USE OF INAPPROPRIATE AGRICULTURAL PRACTICES**

Cell phones may not be reliable

Lack of cheap technology e.g. solar power

High costs to purchase ICTs and airtime for cell phones

Lack of access to adequate knowledge – radio and TV programmes

High cost of electricity and batteries

Radio programmes are not continuously aired

Bad timing of radio programme

Few agricultural radio and TV programmes

Lack of funds

**CAUSES**

**Appendix 35: Problem tree depicting the barriers that hinder the management of indigenous knowledge and access to exogenous knowledge through ICTs in Songea Rural District (Matetereka and Lilondo Villages)**

**EFFECTS**

| | |
|---|---|
| Low production | |
| | Misbehaviour of youth |
| Low income | Failure to cope with changes |
| | Continue to use ineffective techniques |
| Unreliable markets | |

**POOR USE OF ICTS TO ACCESS KNOWLEDGE ON FARMING TECHNIQUES**

Lack of nearby Telecentre

Cell phone may provide unreliable market information

Lack of electricity

Ineffective TV and radio programmes

Low awareness of ICTs

High cost of ICTs example airtime for cell phones

Low number of agricultural TV and radio programmes

Bad timing of farming programmes when most farmers are not

**CAUSES**

Lack of funds

603