INTERNAL TECHNOLOGY TRANSFER IN THE SUDAN: THE DICHOTOMY BETWEEN AGRICULTURAL RESEARCH AND AGRICULTURAL PRACTICE

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A thesis submitted in partial fulfilment of the requirements of Napier University for the degree of Doctor of Philosophy

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DECLARATION

I hereby declare that the work presented in this thesis was carried out by myself at Napier University, except where quoted or otherwise indicated in the text. Parts of the work have been presented at conferences and these are listed below:

1.Work based on Chapters 6 and 7 was presented at the *Faculty of Arts and Social Science Postgraduate Conference* held at Edinburgh on 01 June 2000 (Ahmed 2000).

2. Work based on Chapters 4 and 5 was presented at the *Fifth International Conference of the UK Based 'Third World Science Technology and Development Forum' on: Technology and Development in the New Millennium* held at Karachi during 24-28 April 2000 (Ahmed and Adams 2000). See Appendix-G.

3. Work based on Chapter 1 was presented at the *British Council International Links in the Classroom Seminar* held at Edinburgh on 20 May 1999 (Ahmed 1999a)

4. Work based on Chapters 1 and 2 was presented at the *Development Studies Association - Scotland Study Group Conference* held at Edinburgh on 24 April 1999 (Ahmed 1999b).

5. Work based on Chapters 1, 2 and 3 was presented at the *Scottish Economic Society Annual Conference* held at Edinburgh during 8-9 April 1999 (Ahmed 1999c).

This thesis has not been submitted in part or whole for any other degree.

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ABSTRACT

Sudan is the 'largest country in Africa' and boasts the 'largest farm in the world'. Sudan is a predominately agricultural economy, agriculture employs more than eighty percent of the country's labour force and its industry.

The national agricultural research institutions are charged with the key responsibility of implementing sustainable agricultural growth and development in Sudan. By adoption of demonstrable benefit farms, the research institutions view their contribution as providing improvements to traditional Sudanese practices rather than focusing on developing new techniques. Any research institution must have methods of improving farming practices and the pertinent test of their relevance is improved management practices.

Crop productivity is extremely low and does not exceed thirty percent of the level attained in research or demonstration fields; the difficult economic position of the country has adversely affected the activities of the agricultural research institutions; technology generation is greatly hampered; the extension service is fragmented and its efforts are confined to a small number of farmers; the research institutions are weakened due to frequent staff turnover, lack of continuity in the research agenda and inadequacies in management and hence their impact is limited.

The main purpose of this study is to critically evaluate the implementation capacity constraints which exist in formal agricultural research and the impact this has on the development of the agricultural sector of the Sudanese economy. The study also attempts to provide a better understanding of the relationships between low productivity in Sudan and the determinants of this.

The data for this research were obtained from a field survey carried out in 1999. In the survey, a total of 120 farmers from the Gezira Scheme, 84 researchers from the Agricultural Research Corporation, 33 academic staff from the Gezira University as well as extensionists from the Central State were successfully interviewed.

The research explores various aspects of the internal technology transfer system and the productivity gap in traditional agriculture. A critical review of the theoretical and empirical literature on technology transfer has been conducted in the study.

It is obvious that economic analysis alone will not provide a satisfactory solution to the type of problems investigated in the study as these issues and problems also have political and socio-cultural dimensions.

Therefore, the proposed solutions simply seek to change the behaviours of both individuals and institutions. To do this it is necessary to recognise all the dimensions of the technology transfer problem.

This study provides insights into the influence of demographic, socio-economic, cultural, technical and decision-making factors on technology transfer and productivity in Sudan. The thesis concludes with discussion of key policy implications and areas for further research. The findings of this research should assist in guiding planners and policy-makers in improving the internal technology transfer system and perhaps in enabling agricultural productivity to improve in the Sudan.

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LIST OF ABBREVIATIONS

Abbreviation	Name
AARINENA	Association of Agricultural Research Institutions in the Near East and North Africa
ACSAD	Arab Centre for Studies of Arid Zones and Dry Lands
AFANRUG	Abu Haraz Faculty of Agriculture and Natural Resources, University of Gezira
AGDP	Agricultural Domestic Product
AGTECHP	Agricultural Technology and Training Project
AOAD	Arab Organisation for Agricultural Development
APCs	Agricultural Production Corporations
APRA	Animal Production Research Administration
ARC	Agricultural Research Corporation
ARETP	Agricultural Research Extension and Training Project
ARRC	Animal Resources Research Corporation
ARS	Assistant Research Scientist
ASARECA	Association of Agricultural Research in East and Central Africa
CASSU	College of Agricultural Studies, Sudan University

CGIAR	Consultative Group on International Agricultural Research
CIHEAM	Centre international de hautes etudes agronomique Mediterraneennes
CIMMYT	Centro International de Mejoramiento de Maiz y Trigo
CVRA	Central Veterinary Research Administration
ENRRI	Environmental and Natural Resources Research Institute
FAO	Food and Agriculture Organisation of the United Nations
FAPUoK	Faculty of Animal Production, University of Khartoum
FASUG	Faculty of Agricultural Sciences, University of Gezira
FAUoK	Faculty of Agriculture, University of Khartoum
FFSs	Farmers Field Schools
FNRESUJ	Faculty of Natural Resources and Environmental Studies, University of Juba
FSR	Farming Systems Research
FTCs	Farmer Training Centres
FVSUoK	Faculty of Veterinary Science, University of Khartoum
GDP	Gross Domestic Product
GRS	Gezira Research Station

GU	Gezira University
HYV	High Yield Varieties
ICARDA	International Centre for Agricultural Research in Dry Areas
ICIPE	International Centre for Insect Physiology and Ecology
ICISAESA	Informal Consultation of the International Supporters of Agricultural Extension Systems in Africa
ICRISAT	International Crops Research Institute for the Semiarid Tropics
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGADD	Inter-Governmental Authority on Drought and Development
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
INTERPAKS	International Program for Agricultural Knowledge Systems
INTSORMIL	International Sorghum and Millet Research Programme
IPM	Integrated Pest Management
IPR	Internal Rates of Return
ISNAR	International Service for National Agricultural Research

LDCs	Lesser Developed Countries
MHESR	Ministry of Higher Education and Scientific Research
MNCs	Multinational Corporations
MOA	Ministry of Agriculture
NARIs	National Agricultural Research Institutions
NARS	National Agricultural Research Systems
NCR	National Centre for Research
PSERU	Planning and Socio-Economic Research Unit, Gezira Scheme.
SGB	Sudan Gezira Board
SSA	Sub-Saharan Africa
SSLM	Southern Sudan Liberation Movement
TA	Teaching Assistant
TOT	Transfer-Of-Technology
T&V	Training and Visit Extension System (Approach)
UNDP	United Nations Development Programme
WANA	West Asian and North African Countries

CHAPTER ONE

Introduction

CHAPTER –1
INTRODUCTION

In this thesis an investigation of the determinants of productivity gap and technology transfer in Sudan is conducted. This investigation has been carried out in different Chapters of the thesis. This Chapter focus on the background to the study and gives a brief review of the general characteristics of Sudan. The structure of the thesis is outlined at the end of this Chapter.

1.1 Background to the Study

In its study; African Agriculture: The Next 25 Years (1986) the FAO concluded that Sub-Saharan Africa (SSA) has the potential to increase agricultural production. If the potential is properly mobilised, a number of SSA countries could become self-reliant and their economic situation would then be more manageable. One proven approach to mobilisation is through agricultural research. Strategies for raising productivity of land and labour include, in the short term, wider local application of existing technologies, and in the long term, development or adaptation of new technologies for identified agricultural production systems.

Past development and research strategies have emphasised export and staple food commodities. Indigenous non-staple food and export commodities offer an opportunity for SSA countries to broaden their food resource base and to regain some of the lost share of the export markets. Therefore, research strategies and master plans will have to include the development of technologies for indigenous food crops and non-traditional export commodities. To date agricultural research has been concentrated on rainfed production in relatively high potential environments. But production at current levels of output is already low and will be inadequate to meet increasing demands for food and agricultural products for domestic consumption and export. New and better production and resource management technologies are required to optimise and improve the use of lands and environments having high, intermediate or marginal potential for production.

In Sudan, the institutional bodies responsible for implementing modern and traditional approaches to agriculture are the national agricultural research institutions (NARIs) which are charged with the key responsibility of implementing sustainable agricultural growth and development (ARC, 1994). By adoption of demonstrable benefit farms, NARIs view their contribution as providing improvements on traditional Sudanese practices (WANA, 1997) rather than focusing on developing *new* techniques. Enabling the research capacities of NARIs requires sustained political will, support and commitment, together with appropriate and defined policies, priorities and objectives, and effective co-ordination (Ahmed, 1998). Any research institution must have pertinent institutional structures, well-trained and motivated research and technical support staff, sustained adequate funding and adequate research facilities (FAO, 1988). In addition to that, they should have methods of improving farming practices and the pertinent test of relevance in improved management practices.

Improved cultivars with resistance to the prevailing diseases were developed and adopted, improved cultural practices pertaining to crop nutrition, water requirement, weed control and integrated pest management and techniques to improve the quality were recommended and implemented, and improved technologies for a wide range of crops (Ahmed, 1999b), with focus on the Gezira Scheme.

However, crop productivity is extremely low and does not exceed thirty percent of the level attained in research or demonstration fields (ISNAR, 1994); the difficult economic position of the country has adversely affected the activities of NARIs; technology generation is greatly hampered; the extension services are fragmented and their efforts are confined to a small number of farmers; NARIs are weakened due to frequent staff turnover, lack of continuity in the research agenda and inadequacies in management and hence their impact is limited (Ahmed, 1999c).

These are the key problems facing Sudanese agriculture and represent the core source of the criticism levelled by Grawert[1] (1998). There is clearly a need for further research into the linkages between agricultural research and farming practices in

[1] This criticism comes in Grawert's latest book entitled 'Making Living in Rural Sudan', where the author referred to Sudan as "A country without hope" based on different international development and wealth scales.

Sudan since future development in this area can only be improved if the underlying reasons for the current policy 'failure' are clearly understood.

1.2 General Background of Sudan

> *"Sudan appears to be a country without hope. Whether considered from the economic, the social or the political perspective, it is down at the bottom of the list"*.

Grawert, 1998:1

With an area of 2.5 million square kilometres, Sudan is the 'largest country in Africa' and '9th largest in the world' (IMF, 1999:7), with the 'longest river in the world'. See the map of Sudan in Figure 1.1. Sudan extends between latitudes 3° N and 22° N and longitudes 22° E and 39° E. It borders on nine countries: Libya, Egypt, Eritrea, Ethiopia, Kenya, Uganda, Zaire, Central Africa Republic and Chad.

Sudan has boasted the 'largest farm in the world' in the Gezira irrigated Cotton scheme (Yousif, 1997), and the 'world's largest Sugar-producing complex' in the Kenana project (Food Matters Worldwide, 1991), it was also until recently the 'biggest producer of Gum Arabic in the world' (Food Matters Worldwide, 1991). Sudan was optimistically referred to as an 'awakening giant' by the hype merchants of the 1970's, and its vast plains were seen by development experts as a potential 'bread-basket' - either for Africa or for the Arab World across the Red Sea (O'Brian, 1981, p. 22-26).

In the international wealth scale, measured by gross national product (GNP), Sudan held place 115 at the beginning of the 1990s (UNDP, 1992:128). According to the human development index[2], Sudan has been ranked even lower, at position 145 among 160 countries covered by UNDP (Grawert, 1998:1).

[2] The Human Development Index (HDI) is an index combines average life expectancy at birth, literacy rate and purchasing power parity.

Economic development indicators depict Sudan with the majority of people depending on agriculture, a low degree of industrialisation, a disproportionately large and costly public sector, a high rate of consumer price inflation, and a state budget hit by soaring foreign debt and immense war expenditure (Grawert, 1998:1).

Economic Dilemma

> *"Sudan is one of the poorest countries in the world, with low per capita income (US$280 per year), weak social indicators, and persistent structural distortions and institutional weaknesses in the economy".*
>
> IMF (1999:7)

As indicated by the 1993 census, Sudan is a low-density populated country. Its population was estimated at 28 million people in 1999 of whom some 80 percent are rural (IMF, 1999:7) form a great mosaic of ethnic, tribal, linguistic, religious and cultural affiliations and traditions. However, the economically active population is 32 percent of the total and about 68 percent of them work in agriculture or other related activities (WANA, 1997).

In recent years, growth in urban labour force was much faster than that of the rural labour force. This reflects the observed phenomenon of migration of the economically active population from rural to urban areas in search for work and better living conditions (see Todaro, 1997:119). The concentration of investment in the irrigated and mechanised rainfed schemes in the Central and Eastern States has led to organised movement of about one million seasonal labourers from Western and Southern States during Cotton picking and harvest of Sorghum and Sesame. Poverty and political instability have led to the emigration of a large number of skilled Sudanese over the years, seriously weakening the administrative capacity of the government. By the late 1980s, Sudan had lost nearly 17 percent of its doctors and dentists, 20 percent of its university teachers, 30 percent of its engineers, and 45 percent of its surveyors migrating to Europe and North America between 1985 and 1990[3] (Todaro, 1997:119).

Sudan is currently experiencing the sharpest economic deterioration since the early 1970s as a result of the cumulative impact of a number of internal and external factors. To many economists, the economic problem began when the Nimeri government (1969-1985), against the advice of the World Bank, embarked on an ambitious and expensive programme of development aimed at diversifying and expanding the country's export base (Onimode, 1989).

Over the past two decades, in all but a few years, the country's economic expansion remained well below the population growth rate. The average annual growth of Sudan's real gross domestic product (GDP) was 2.5 percent between 1980 and 1988 (Mattes, 1993:166), and between 1989 and 1992 it varied from –6 to 9.6 percent (Wohlmuth, 1994:204; The World Bank 1992). Grawert, 1998:1, argues this high variation as;

> *agricultural productivity in the 'traditional' and mechanised farming sectors in Sudan depends on the quality of the rainy seasons, and in the irrigated sector it is determined by the uncertain supply and the soaring cost of fuel.*

Indeed, Sudan's real GDP growth averaged about 4.6 percent during the period from 1992/1993 to 1996 (also see Europa, 1998:3167), with agriculture contributing about 1.1 percentage points to average GDP growth (IMF, 1999). However, in its recent economic developments report about Sudan (1999), IMF argues that, since the early 1990s, Sudan's real GDP has grown at an annual average rate of about 5 percent, and the growth has been relatively stable compared to the sharp output swings experienced during the 1980s. Furthermore, in the same report, IMF attributed this stability in part to relatively favorable weather conditions and to the economic liberalisation policies that have sustained growth and fostered greater economic diversification. The report also considers the other notable developments during 1997-98 were the rapid growth of construction activities (triggered in part by the

[3] Although higher figures can be expected now (2000).

construction of the oil pipeline), which contributed an estimated 2 percentage points to the average GDP growth, and the diminishing contribution to GDP growth of trade and other services which barely grew during the period (in part because of the decline of government services).

Meanwhile, the balance of payment deficit has also held back GDP growth; at the beginning of the 1990s, import expenditures were about twice as high as the country's export earnings (HAB, 1995). Sudan is heavily indebted to external creditors with a debt of US$22.4 billion as of end- 1998 (of which US$19.3 billion was in arrears[4]), equivalent to 253 per cent of the GDP and more than 3,655 percent of export of goods and non-factor services (IMF, 1999:7). The high level of arrears and the poor political relations with many creditors and donors have resulted in a near drying up of international aid and credit, further exacerbating the domestic economic difficulties.

Moreover, Sudan as, part of Africa, lags behind many other countries on all other main indicators of socio-economic development. There are large and continuing deficits on both the internal and the external balance; inflation is very high; given the current trends of trade, economic growth is insufficient even to maintain existing standards of living; employment levels are threatened and there is rising unemployment.

Political Dimension

Development and human rights are not separate issues but indivisible aspects of the pursuit of justice, dignity and sustainable livelihoods for all the world's people. Civil and political rights are also essential in people's struggles for change. While civil unrest and armed conflicts eased in some African countries, particularly in Southern Africa, new ones emerged or worsened and in Sudan severely disrupted economic and agricultural activities. In Sudan, politicians and bureaucrats had to be attentive to the parameters which society itself imposed. After coming to power in 1969, the military regime in the Sudan introduced new political and administrative structures which

[4] About US$2.5 billion in obligations to the multilateral creditors is overdue, most of it to the IMF (US$1.6 billion). Arrears to the World Bank (primarily IDA) amounted to US$122 million.

were designed to strengthen the centre and to break the power of the traditional and tribal land-owning elites (Tordoff, 1997:93).

Sudan's political influence in the world is negligible, civil strife and political crisis also affected Sudan. Internally Sudan has been torn apart by the catastrophic civil war which has plagued and been raging the country for over 30 years. The problem posed by (among others) the Southern Sudanese in Sudan, where the problem was solved and the integrity of the state maintained, different means were utilised: by mainly constitutional amendment in the Sudan. The Sudan was one of the very few African states where, following the agreement reached at Addis Ababa in February 1972 between the central government and the Southern Sudan Liberation Movement (SSLM: the recently-formed political arm of the Anya-Nya insurgents), representative assemblies and governments were created at a level intermediate between the centre and the locality (Tordoff, 1997:10). Unfortunately, this agreement failed to bring political stability and economic development to the Southern Region and broke down in 1983, plunging the country again into civil war.

The cost of war is one factor in an increasing spiral of debt facing Sudan and other African countries, costing the Sudanese economy millions of pounds which would be better spent on the welfare of its people and it also resulted in the destruction of the country's natural resources, natural disasters have resulted in over-grazing and the land becomes more barren (Food Matters Worldwide, 1991). In recent years, there has been a major switch from subsistence agriculture to large-scale cash crop schemes. But instead of feeding the people, the farms grow most crops for export. The Cotton and grain sold as animal feed pays for weapons needed to prosecute the war.

Moreover, the current government has not found favour with the west. Because in the eyes of the west, the Sudanese government not only engaged in a cruel civil war and presides with little success over a bankrupt economy, but also violates human rights (Britannica, 1998:318) and perhaps worst of all, the Sudanese government supported Saddam Hussein during the Gulf conflict and engaged in some violently anti-western rhetoric (Food Matters Worldwide, 1991).

What are often lacking are the financial resources and the political commitment to prioritise the rural sector in national development.

Food-Hunger-Poverty Spiral

The Sudan food situation is serious, with indications of declining per capita production and record numbers of malnourished people. Millions of people are at the risk of dying of hunger in Sudan and it now needs millions of tonnes more grain each year than it is producing. In the past food shortages have been bridged, to some extend, by purchases and by food aid, but neither of these options will offer adequate relief in the future (Food Matters Worldwide, 1991).

The current government has made grand claims about self-sufficiency, declaring

> '*we eat what we grow, wear what we manufacture*',

but the reality for most Sudanese people has been food prices soaring way beyond their reach, and dwindling productivity. In the towns, food may be available, but many people are unemployed, and none of who can afford the price increase.

It is often observed that Sudan is prone to drought and famine and that there is little that can be done to prevent either, however, it is poverty not drought that results in famine. During the 1970s, 1980s and 1990s, Sudan experienced severe food shortages and famines and for a country known for its vast agricultural resources, this is both unfortunate and ironic, this is basically because of political reasons (Food Matters Worldwide, 1991).

According to Borlaug (1997), there can be no lasting solution to the food-hunger-poverty problem until a more reasonable balance is struck between food production/distribution and human population growth. The efforts of those on the food-production front are, at best, a holding operation which can permit others on the educational, medical, family planning, and political fronts to launch an effective, sustainable, and humane attack to tame the population monster.

1.3 Agricultural Framework of Sudan

The agricultural sector plays a pivotal role in Sudan's economy, employs 80 percent of the country's labour force and its industry -and those whom it employs- are mostly dependent on its agricultural products (IMF, 1999:9). Agriculture contributes about 42 percent of Sudan's GDP, the largest of all sectors, moreover, the country's exports and foreign cash earnings are over 90 percent agricultural, and in addition it produces over 90 percent of the national food requirements (Europa, 1998: 3167).

In terms of its linkages most of the productive capacity depends heavily on agriculture as a source of raw materials, source of virtually all foreign exchange earnings and as a market for goods and services produced by other sectors and therefore the key determinant of balance of payments developments. The performance of agriculture is also the main determinant of year-to-year changes in poverty levels and the food security of the population. Therefore, productivity and efficiency of the agricultural sector are central to any programme of economic development.

The objectives for agricultural development are:

- Food security.
- Sustainable agricultural development.
- Export enhancement and diversification.
- Efficient resource use.
- Productivity enhancement through technology thrusts, small scale farmer focus and private investment.
- Integrated sectorial development.

Sudan's agriculture consists of crop and livestock sub-sectors. While, the crop sub-sector comprises five sub-sectors: the traditional rainfed, the mechanised rainfed, irrigated (*including the Gezira Scheme*), forest and pasture and Forage Sub-sector, the animal sub-sector consists of livestock, fisheries and wildlife.

Land Resources

From a total land area of 250.4 million ha, 84.0 million ha is cultivable, 24.0 million ha is natural range and pasture and 91.5 million ha is natural forests which produce more than 80 percent of the country's fuel and one of its most important exports: Gum Arabic (WANA, 1997). While cultivable land constitutes 35 percent of the total land area only a maximum of 20 percent of this is cropped in years of good rainfall.

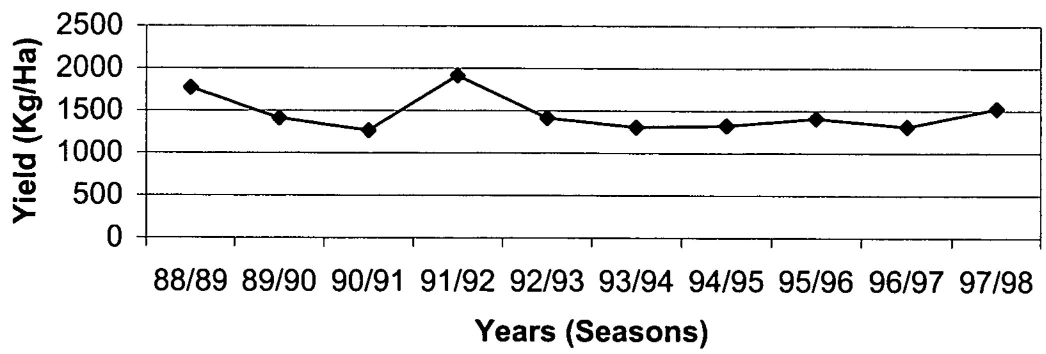
Water Resources

Water in the Sudan is obtained from the Nile system, underground supplies, catchment areas and rainfall. The Sudan has about 64000 Km of the Nile System within its borders. In addition to the Nile system, the Sudan has underground water supply in about 50 percent of its surface area. It is estimated that over 80 percent of the population use underground water for domestic and industrial purposes but only limited amounts of it are utilised for irrigating crops (WANA, 1997).

1.3.1 Gezira Scheme

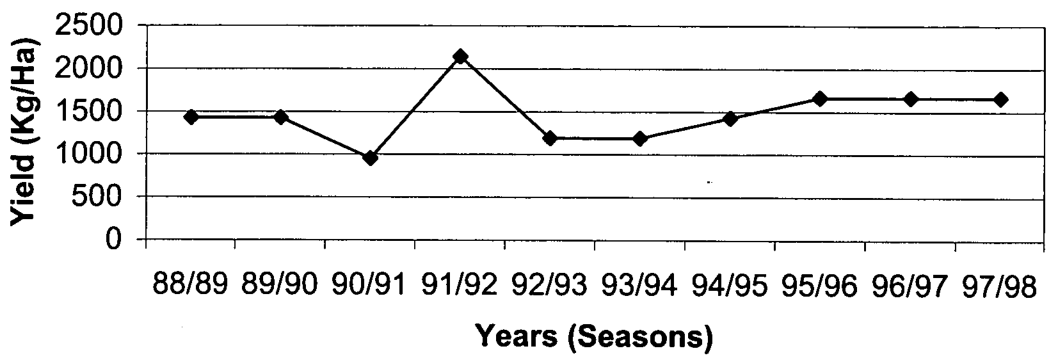
Few agricultural ventures in the developing world, have evoked as much international attention as Sudan's Gezira Scheme. Interest in this 74-year old Scheme (founded in 1925 in an area south of Khartoum), stems not only from its sheer size (over 2 million acres), but also from its embodiment of a variety of important, but controversial tenets of economic and social development (Yousif, 1997). Cotton is the main export crop supplemented with Sorghum, Groundnuts, Wheat, and Rice. For the Gezira Scheme production of Cotton, Wheat, Sorghum, and Groundnuts, see Figures 1.2, 1.3, 1.4 and 1.5 respectively.

Figure 1.2 Cotton Production in the SGB (1988 - 1998)



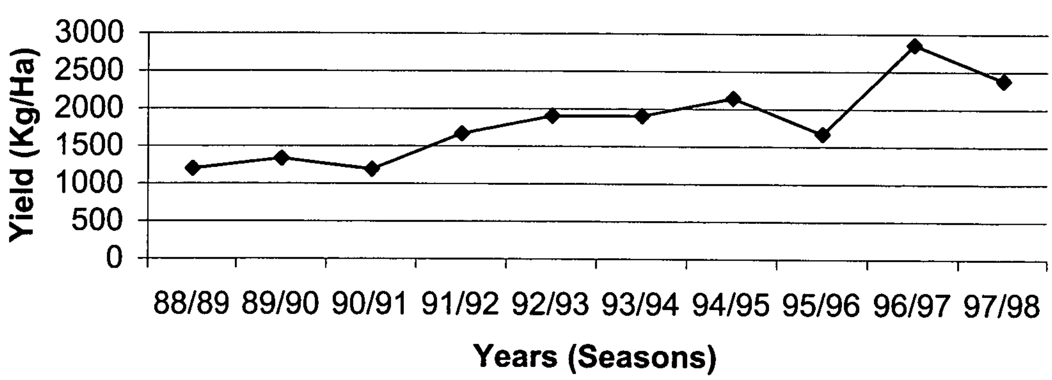
Source: Information Unit, Agricultural Administration – Gezira Scheme (1999)

Figure 1.3 Wheat Production in the SGB (1988 - 1998)



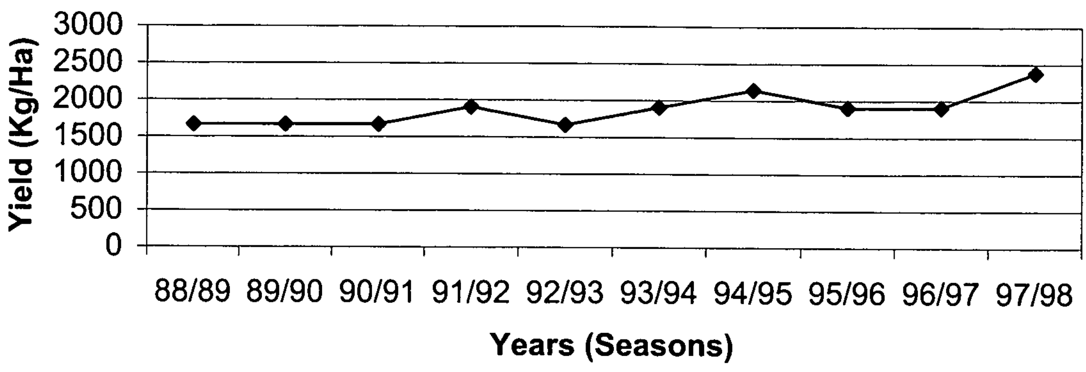
Source: Information Unit, Agricultural Administration – Gezira Scheme (1999)

Figure 1.4 Sorghum Production in the SGB (1988 - 1998)



Source: Information Unit, Agricultural Administration – Gezira Scheme (1999)

Figure 1.5 Groundnuts Production in the SGB (1988 - 1998)



Source: Information Unit, Agricultural Administration – Gezira Scheme (1999)

Cotton exports are handled through the government's Gezira Board (see Gaitskell, 1959). For the Gezira Scheme organisational structures see Appendix-A1, A2, A3 and A4 (Source: Adopted from Yousif, 1997).

Before the Gezira Scheme, it was a common belief among the Sudanese that land is common for all, no private or public property. People in the Sudan at that early time were divided into two groups: the nomadic tribes, who were animal breeders, didn't settle down in one place and they seasonally moved with their animals to wherever there was pasture and water, and the other group was village or town dwellers, who never worried about owning land other than the narrow strip around their homes (Yousif, 1997).

From 1907 to 1910, the Government (Anglo-Egyptian) surveyed all the land in the irrigated area in Gezira and it was then distributed to the tenants on a rental basis. Therefore, the year 1911 was a landmark in the development of the Gezira Scheme (Yousif, 1997) where the Sudan Plantation Syndicate was authorised to begin agricultural operations in the Gezira Scheme. Table 1.1 below shows the traditional production relations among people in the Gezira before 1911.

Table (1.1) Traditional Production Relations in the Gezira Scheme Before 1911	
Production Relations	**Percentage (%) of the Crop Produced**
Land Ownership	10
Sagia* Ownership	10
Animal Ownership	20
Fodder	6.7
Seeds and Agricultural Equipment	13.3
Labour	40

* Sagia is a traditional means of irrigation in Sudan.

Source: Yousif, 1997.

However, one of the main distinctive characteristics of the Gezira Scheme was land acquisition. The land was neither expropriated nor left as it had always been for centuries back. To maintain its status quo would certainly give rise to undesirable social distinctions as some land owners owned large plots of land as compared with minor lots owned by other poorer categories. The decision was to allocate 30 feddans (12,6 Hectare) no matter how much land the farmer previously owned as well as allowing one of the farmer's relatives (nominated by the farmer) to utilise another (12.6 Hectare) of the land. It is to be noted that those allocations had nothing to do with the original ownership of the land for which owners were paid an annual rent. Moreover, this new production relations allowed the SGB administration to evict any tenant who proved to be unable to abide by the set laws and regulations. This agreement was operating until the year 1950 immediately after nationalisation of the Scheme when the tenants were able to enforce an agreement which was then referred to as a joint account or partnership system. The Joint Account System (Partnership) was based on the following terms;

1. Forty percent of the annual net profit for the tenant.

2. Twenty percent for the company which should accordingly be spent on research, social services, pay business profit tax and loan interests.

3. Any surplus in the company's share of profit should be divided between the company and the tenants as a separate fund which later become the reserve fund.

This agreement passed through many phases culminating in the famous formula worked out in the season of 1970/1971 (Table 1.2).

Table (1.2) SGB Production Relations as Percentage of Net Profit (1950-1981)

Production Relations	**Years**						
	50-57	**58-63**	**64-65**	**66-69**	**70-71**	**72-76**	**77-81**
Central Government	40	42	40	36	36	36	36
Local Government	-	2	2	2	2	2	2
Tenants	40	42	44	48	47	47	47
Social Development	-	2	2	2	3	3	3
Administration	20	10	10	10	10	10	10
Reserve Fund	-	2	2	2	2	2	2

Source: PSERU, 1997.

Furthermore, Yousif (1997) argued that the joint account was then subjected to severe criticism by farmers, economists and others on the basis that;

- The joint account did not motivate farmers as they always felt that the benefits of their efforts would be shared by partners who do less work.

- The joint account was applied to the Cotton crop only while Wheat, Sorghum and Ground Nuts were not included and all costs of production of other crops were deducted from Cotton revenues which made tenants concentrate on other crops rather than Cotton.

- Assiduous productive tenants would be bearing a bigger share in the joint account compared with less productive farmers.

- Fluctuations in government revenues meant that the government was unable to prepare a clear specific budget which could meet the technical and administrative costs necessary for development and reconstruction of assets.

The Gezira scheme is seen by some as the first demonstration of Sudan's vast potential as an Arab and World granary (see O'Brian, 1981:22-26). Others see it as a pioneer and successful experiment in the field of direct foreign investment in export oriented production in the Third World. To others it was the earliest proof of the viability of partnership in modern farming. The Gezira scheme, widely known as the Sudan's most successful economic enterprise, is undoubtedly the country's invaluable asset for generations to come. Any Sudanese Government greatly depends on the Gezira scheme for its hard currency return from exports (Yousif, 1997).

Although the Gezira scheme is often cited as the most successful large-scale irrigation project in Africa, large irrigation projects in the Sudan have been plagued by the common problems of lack of participation of farmers in decision making, lack of flexibility in choosing crops, and difficulties in adjusting the size of farms in response to changes in the life cycle of tenant families. For a radical critique of the Gezira scheme, see Barnett (1977, 1979 and 1981).

1.4 Agricultural Research

According to Ageeb[5] (ARC, 1994), agricultural research in the Sudan dates back to the turn of this century. Experimental work started in the Northern Province in 1902 and near Khartoum in 1903 to explore the possibilities of growing Cotton under irrigation. This was followed shortly by similar work at Rumbek and Wau for rain-grown Cotton. The Wellcome Tropical Research Laboratories were established in 1903 with emphasis on medical research, but they also conducted chemical and entomological research related to agriculture. Botanical and agricultural research started in 1904 in Shambat Agricultural Experimental Station.

[5] Professor Osman A. A. Ageeb is the Ex-Director General of ARC - Sudan.

Pilot schemes and experiments by Sudan Plantation Syndicate have shown that Cotton could be grown successfully on a commercial scale in the Gezira area. This prompted the establishment of the Gezira Research Station by the Department of Agriculture in 1918 to serve the development of the large-scale Cotton-growing scheme in the Gezira.

In 1931, the Agricultural Research Service was formed as an independent body, and in 1935 it was absorbed into the Department of Agriculture and Forests. In 1944, a new organisation called the Agricultural Research Division was established under the Chief of the Agricultural Research Division with the intention of relieving the research staff from the purely routine administrative bureaucracy of Agriculture.

Research on animal health started in 1913 while research on animal production was initiated in 1955. After Independence in 1956, agricultural research expanded rapidly to encompass activities in different crops and ecological zones in the country.

To ensure the technical and productive efficiency, flexibility in conducting research programs and training its staff, provision of research equipment and generation of external funds and help, the Agricultural Research Division was awarded its semi-autonomy by the Act of 1967 and became the Agricultural Research Corporation (ARC) which was entrusted with almost all of the applied agricultural research in field crops. In 1977 the Act was amended to cater for the amalgamation of research functions of Food Processing, Forestry, Fisheries and Marine Life and Wildlife as Centres in ARC extending its mandate to cover applied research even though Cotton still received the lion's share.

> *The overall goal for agricultural research in the Sudan is to find ways to increase productivity of specific crop and livestock species, while maintaining soil, water and vegetation as renewable resources.*
>
> (ARC, 1994)

Agricultural research in Sudan is performed by many national institutions, however, the major national agricultural research institutions (NARIs) include the Agricultural Research Corporation (ARC), Animal Resources Research Corporation (ARRC), Environment and Natural Resources Research Institute (ENRRI) as well as the Academic Institutions. NARIs profile is presented in Table 1.3 and for NARIs organisational structures see Appendix-A5, A6, A7, A8, A9, A10 and A11 (Source: Adopted from Ahmed, 1998 and WANA, 1997).

1.4.1 Agricultural Research Corporation (ARC)

The Agricultural Research Corporation is the oldest one in Africa and the major research institution in the Sudan (Yousif, 1997) and in 1991, ARC accounted for nearly half the country's agricultural research capacity in terms of full-time equivalent researchers (ISNAR, 1995:5).

ARC research activities are focused mainly on crops, land and water, forestry, forage and pasture and food processing. Activities in animal production are limited and are being carried out in Western Sudan. ARC has its headquarters at Wad-Medani[6], with 17 regional stations distributed throughout most of the States; one commodity station (Guneid Sugar Station); four national research centres (forestry, food processing, land and water and crop protection), two national laboratories (pesticides-residues and formulation and tissue culture), genetic resource unit and seed production unit.

The research in ARC is co-ordinated by commodity and disciplinary co-ordinators and directors of centres (see Appendix-B1.4). The ARC mission is "to provide attractive and realistic technologies to improve and sustain productivity in agriculture" (ARC, 1994).

It is necessary to establish and maintain linkage between research and relevant bodies to make research efficient and effective through utilisation of the available ARC resources as well as potential internal and external resources and opportunities. Over the years ARC has successfully developed linkage within and outside the Sudan.

Within the country, ad hoc collaborative research activities between ARC and universities are carried out with financing from ARC. Similarly adaptive research is

[6] Wad-Medani is the second big town in Sudan after the capital Khartoum.

carried out jointly with externally funded development projects, public corporations, commercial companies and non-governmental organisations working on human relief and rehabilitation programs.

Technology transfer is carried out in collaboration with extension services, production corporations, private companies, development projects or individual farmers and tenants. Moreover, joint task forces are formed by ministerial decrees to identify production constraints and attempt to solve them at field level. Each task force comprises representatives from ARC, extension, universities, production corporations and tenants. ARC also produces extension leaflets and audio-visual programs as well as providing technical services to various governmental and non-governmental institutions. These services take the form of consultancy studies, joint meetings and task forces. ARC staff assist universities in teaching and supervision of students and developing curricula. It also trains agricultural extensionists and other staff and tenants.

Outside the country, ARC has a wide network of linkages with many bilateral and multilateral development agencies and other national, regional and international research organisations. ARC receives technical assistance from various regional and international organisations, e.g., ICARDA, ICRISAT, CYMMYT and INTSORMIL[7] in the form of joint research activities, training, research inputs (*e.g. germplasm*) and technical backstopping.

In recent years ARC has been a participant member in inter-country regional research networks, e.g., Nile Valley Regional Program (Sudan, Egypt and Ethiopia), Sorghum and Millet and Oilseed Crops Development Projects (Sudan, Egypt, Yemen and Somalia) and East Africa Sorghum/Millet Project (Sudan, Kenya, Uganda, Tanzania and Burundi). During the last 25 years ARC has generated a wealth of improved technologies including cultivars, methods, knowledge and advice. See Appendix-B1.7.

[7] CIMMYT is the Centro International de Mejoramiento de Maiz y Trigo, ICARDA is the International Centre for Agricultural Research in Dry Areas, ICRISAT is the International Crops Research Institute for the Semiarid Tropics, and INTSORMIL is the International Sorghum and Millet Research Programme.

1.4.2 Animal Resources Research Corporation (ARRC)

Research on animal health started in 1913. Animal production research was initiated in 1955 following the establishment of the Animal Production Research Administration (APRA). Prior to 1996 research on animal resources was mainly the responsibility of two Directorates of the Secretariat for Animal Resources: APRA and Central Veterinary Research Administration (CVRA). In addition the ARC was in charge of research in Fisheries and Wildlife. ARRC is a semi-autonomous organisation with a Board of Directors and a Director General directly responsible to the Minister of Animal Resources. ARRC is composed of seven research centres i.e. Fisheries, Wildlife, Animal Production, Animal Health, Camel, Vaccine Production and Radioisotope. The APRA has five departments namely, Animal Breeding, Animal Nutrition, Meat Production and Technology, Dairy Production and Poultry Production. Each department has well-specified objectives and research priorities.

1.4.3 Environment and Natural Resources Research Institute (ENRRI)

ENRRI is one of the ten research institutes of the National Centre for Research (NCR). The institute is entrusted with applied, adaptive and on-farm research in integrated pest management, biological nitrogen fixation, animal production, apiculture and remote sensing. Major research thrusts are crop improvement, pest management, animal health, soil and water, animal husbandry and environmental concerns. Commodity priorities include cereals, grain legumes, forage crops, vegetables, industrial crops, and poultry.

1.4.4 Academic Institutions (Universities)

Higher education institutions are semi-autonomous and each created by an Act. They are affiliated to the Ministry of Higher Education and Scientific Research (MHESR) and their mandates are mainly for teaching and research. The principal function is teaching undergraduate and graduate students, in addition to some basic, applied and adaptive research and community services. However, within the universities sector, there are six faculties focusing on agriculture. Moreover, during the last eight years 11 Agricultural, Veterinary and Animal Production faculties were established in the various states but to a great extent they are under staffed and are not yet engaged in agricultural research. For the academic institutions research see Appendix-B2.

1.5 Agricultural Extension

According to Yousif, (1997), agricultural extension in Sudan was considered as the main factor in creating means of communication between the field inspectors and the farmers as well as one of the effective means of transferring scientific advice to the farmers to be adopted in their agricultural operations.

Before the late 1980s, technology transfer activities were limited mainly to the provision of supplies and services through the top-down "inspectorate" system of the Agricultural Production Corporations in the irrigated areas (World Bank, 1985). And although a network of Regional Agricultural Centres with specific responsibility for technology development was established under the Agricultural Research Corporation in the 1960s, linkages between research and extension remain inadequate (Schwartz, 1992).

The Agricultural Research Extension and Training Project (ARETP), started in 1986, intends to establish a professional extension system for the irrigated sector based on the Training and Visit extension model (T&V model). Although costs have been a serious constraint, pilot extension activities have been started successfully at Rahad and New Halfa, and have been expanded to the Gezira/Managil Scheme. T&V-based extension systems introduced in two pilot projects in rainfed areas include: the Southern Kordofan Agricultural Development Project (effective February 1989) and the Southern Kassala Agricultural Project (effective July 1989). Critical problems are: clarifying the goals of extension activities, identifying relevant technologies and developing appropriate training programs for extension staff. A following-up Agricultural Technology and Training Project (AGTECHP) was established to assist agricultural research and extension services in irrigated and rainfed areas in the context of a reinforced national organisation responsible for all publicly financed agricultural research. This project has also involved the agricultural universities in training and extension education (see Ahmed, 1999b)

The establishment of the agricultural extension services in Sudan was connected with the need to develop agricultural activities and to fulfil the farmers' needs for improving their living conditions. It was also a logical endeavour to transfer the new information to help the farmers embark on growing different crops. Within the Gezira area, three main extension institutions are; Extension Services, State Ministry of Agriculture and Animal Wealth, ARC/FAO Extension Project (IPM) and the Extension Services, Gezira Scheme.

1.5.1 Extension Services – Ministry of Agriculture (MOA)

The extension department of MOA, Central State is staffed with 40 male and 32 female extensionists; all of them are BSc degree holders, located in eleven remote extension centres (Dabrowski, 1997:56). Each centre usually has an extension unit with one or two offices, a meeting room, accommodation for the extension agent, a main store (50-105m^2) for fertilisers and a small store (19-24m^2) for seeds and agrochemicals. There is a plan to transform these centres to IPM centres for Farmers Field Schools (FFSs) and Rural Women Schools (RWSs). In addition to these stations, there are four stations of integrated services for vegetables and fruit farmers. The extension department closely co-operates with the Plant Protection and Horticulture Departments in its field activities. According to Ahmed[8], this department is the first governmental institution in the Sudan to initiate the establishment of FFSs as a model of extension activities.

1.5.2 Extension Services - ARC/FAO (IPM) Project

FAO started implementation of the extension participatory approach in the 1970s and showed that the most effective means for achieving farmers' objectives are small demonstration and informal groups, co-operatives, organisations and Farmer Field Schools (FFSs) (Dabrowski, 1997). FAO believes that this approach will be an essential part of any strategy to meet new challenges (FAO, 1988; Schulten, 1989; FAO, 1990 a, b). However, before FAO had introduced the concept of IPM and the

[8] Saud Mohammed Saad Ahmed is the Director of Extension Administration, MOA, Gezira State, Wad Medani.

extension participatory approach in Sudan, extension activities were characterised by the following;

- poor technology transfer as field inspectors' time was over stretched by the administrative activities.

- extension approach used to be very formal, highly traditional and did not implement any participatory approach.

- poor linkages between extension services and research institutions.

- poor training for both extensionists and farmers.

- poor education backup for farmers for the implementation of the technical advice.

The IPM project entitled "development and application of IPM in cotton and rotational food crops" was initiated in Sudan in 1979 and Sudan has been the first country in Africa to adopt this system (ARC, 1997). The project underwent four phases with a total cost of ($7,287,679) sponsored by the Netherlands government and in phase IV (93/94) the project introduced the FFSs system to promote the implementation of IPM (ARC, 1997). Moreover, the idea of FFSs is now adopted and declared as the sole extension approach in the Gezira state and in the Gezira and Rahad schemes.

However, despite the benefits of IPM project to farmers, some problems have been mentioned by extensionists included;

- resources shortages negatively impacted the FFSs and RWSs.

- shortages of transportation, fuel and spare parts.

- funding problem.

- low prices and marketing problems.

- lack of extension supporting materials and demos.

- poor extension staff training.

- farmers' instability and absence from the school as result of the interference between the school activities and the other field activities (*land preparation, irrigation, harvesting, ...etc.*).

- IPM staff concentrates more on the blocks located near the scheme HQ in Barakat.

1.5.3 Extension Services - Gezira Scheme

According to Sid Ahmed[9], extension services in the Gezira Scheme started in the 1969/1970 season in five blocks in the centre group to improve performance and increase productivity and since several approaches have been used. The aims were:

1. Exploiting and utilising all the potentialities available for the benefits of the individuals and society.

2. Advising and enlightening the farmers to become more experienced and highly skilful.

3. Educating the farmers and their families to know about the national problems besetting their society such as illiteracy, rural development and co-operative understanding.

4. Playing a role in organising extension campaigns to urge the farmers to respect and abide by the regulations and orders issued by the management, particularly in the area of agriculture.

[9] Mohamed Sid Ahmed is the Director Extension Department and FFSs Area Co-ordinator, Gezira Scheme.

However, the new re-organisation of the agricultural extension (since 93/94) aims at generalising the above through an integrated system which includes the following:

1. Establishing an agricultural extension unit at the level of each geographical group.

2. Appointing an expert extensionist to be responsible for planning and executing the extension programmes in the group according to the duties stated. It was thought better to start in a small area to guarantee good performance.

3. Appointing an agricultural extension assistant for each group to help the senior staff in expanding and propagating new ideas.

And for an effective transfer of new technologies and advice, the agricultural extension officer is provided with the following:

1. A car for the mobile cinema.

2. Tape recorders, projectors and other media equipment.

3. The Information Unit provides the officer with pamphlets, books and other stationary according to the seasonal nature of the work.

The duties of the agricultural extension officer are:

1. Propagating new agricultural concepts among the farmers, through workshops, meetings, lectures, symposia and other printed materials.

2. Organising visits and trips to research centres.

3. Supervising experiments and demonstration plots for effective field application.

4. Establishing new clubs for rural TV watchers.

5. Training the local leaders (members of the councils of productions)

6. Propagating co-operative knowledge among the farmers.

7. The co-operation with other organisations and corporations working in the rural development programmes to find suitable solutions to emerging obstacles.

8. Submitting rising problems and complaints to the concerned authorities to find acceptable solutions.

9. Initiating co-operation within the section to elucidate the problems that impede both the planning and work procedures.

10. Following up the extension work through reports and questionnaires to evaluate progress.

The extension department is currently (1999) staffed with 13 extensionists; all of them are BSc degree holders and some educated to MSc level, all are located in Barakat HQ and they work in co-ordination with the 250 field inspectors. However, the relationship between extension officer and field administration is supposed to be built upon objectivity and good understanding. But the weak base of co-operation between the field inspector and the extension officer has led to serious overlapping and conflict.

According to the new scheme policy, a monthly extension program including field days will be designed by the extension department and then circulated to the blocks' managers[10] or deputy managers in their monthly co-ordination meeting held in Barakat. And as FFSs activities had become a part of the extension programme in the Gezira Scheme since 1994/1995 season, in this monthly meeting each block activities for the previous month with regard to the FFSs will be reviewed accordingly. The

[10] The Gezira scheme is divided into eighteen administrative blocks.

actual extension activities are therefore not performed by the extensionists but performed by field inspectors spread over the whole scheme.

1.6 Structure of the Thesis

This thesis has been organised into eight Chapters.

Chapter 1: includes background to the study and a brief profile of Sudan.

Chapter 2: includes the review of the literature on the technology transfer and the productivity gap determinants. This Chapter also includes the variables selected for investigation.

Chapter 3: deals the research methods used in the study.

Chapter 4: examines the technology development and research linkages.

Chapter 5: discusses the farmers and the adoption of technology.

Chapter 6: examines the extension services and the transfer of technology.

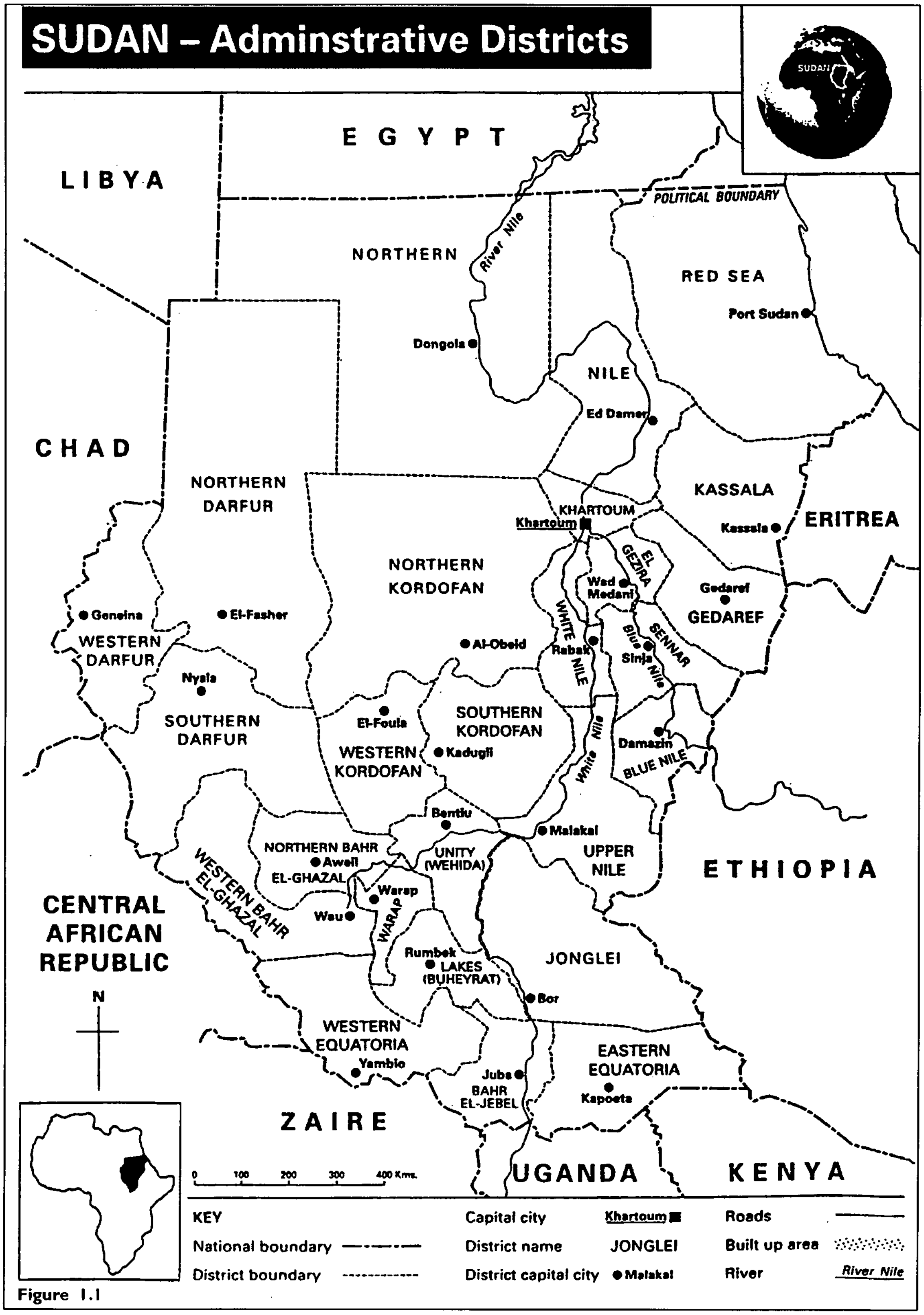
Chapter 7: identifies the determinants of the productivity gap in Sudan.

Chapter 8: summarises the findings and conclusions.

1.7 Summary

This Chapter described the importance of this study in relation to the technology transfer and productivity gap in Sudan. A brief overview on Sudan was outlined in order to give a clear understanding of the study area. A structure of the thesis is also given. The following Chapter establishes the research in the context of a literature review and to specify the set of variables which were used.

Figure 1.1 Map of Sudan



Source: Map by courtesy of Minority Rights International, London

Table 1.3 Summary Profile of National Agricultural Research Institutions – (1997)

Name	ARC	ENRRI	ARRC	FASUG	AFANRUG	FVSUoK
Year Established	1967	1992	1995	1978	1978	1938
Status	Public Institute	Public Institute	Public Institute	Public Institute	Public Institute	Public Institute
Affiliation	Minist. Agric. & Forests	NCR of MHESR	Min. of Anim. Wealth	MHESR	MHESR	MHESR
Autonomy	Semi-autonomous	Depart. Within NCR	Semi-autonomous	Semi-autonomous	Faculty within Univ.	Semi-autonomous
Governance	Board of Directors	Research Council	Board of Directors	University Council	University Council	University Directors
Mission	Research 70% Teaching and Training 10% Extension 15% Consultancy 5%	Research 60% Teaching and Training 20% Extension 5% Consultancy 10% Community Services 5%	Research 65% Teaching and Training 15% Extension 10% Consultancy 5% Community Services 5%	Teaching and Training 70% Research 10% Extension 10% Consultancy 5% Community Services 5%	Teaching and Training 80% Research 10% Extension 4% Consultancy 3% Community Services 3%	Teaching and Training 75% Research 20% Community Services 5%
Mandate	Crop Land and Water Forestry Food Science	Crop, Livestock, Land and Water, Fisheries, Pollution and Environmental Studies	Crop Fisheries Wildlife	Crop, Livestock, Land and Water, Extension, Agric. Economics, Forestry	Crop Land and Water	Livestock
Client	Farmers Agricultural Corp. & Co.	Farmers Public	Animal Owners Private Sector			
Internal	Universities Other National Research Institutions	Universities Other National Research Institutions	Faculty of Vet. Sci. Faculty of Animal Production			
External	ICRISAT,UNDP, IFAD, ICARDA,CIMMYT,FAO	ICIPE, IGADD, UNDP	ACSAD, FAO, AOAD			

Source: Ahmed, 1998 and WANA, 1997.

CHAPTER TWO

Literature Review

CHAPTER –2-

LITERATURE REVIEW

2.1 Introduction

> *"The production of knowledge about African development still remains to a substantial degree in the hands of expatriates"*
>
> (Eicher and Baker, 1982:24)

The literature underpinning research into technology transfer and productivity gap in Sudan is examined in this Chapter. The main focus will be on:

(i) the general theory of technology transfer,

(ii) empirical studies of technology transfer and productivity gap, and

(iii) variables used for technology transfer and productivity gap analysis in this study.

The Chapter will close with a review of the variables considered to be significantly important for study in this thesis.

Prior to the 1960s, little attention was focused on the importance of indigenous agricultural research in developing countries (Norton and Alwang, 1993:281). It was thought that possibilities of transferring technologies from developed countries were substantial and that, therefore, extension programs were needed to assist in this transfer. The relative lack of success with direct transfer of technologies to the developing countries led to the realisation that improved developing-country research capacity was essential. Moreover, the transfer of research results involves costs of information and screening or testing and most of these transfer costs increase with the physical size and environmental diversity of the country.

Norton and Alwang, 1993, argue that it may be more cost-effective for larger countries to conduct their own research than for smaller countries. Meanwhile, the "green revolution" (1960s) provided a stimulus to rural development through the transfer of agricultural technology from the industrialised countries which played a pivotal role in anti-poverty programmes.

The introduction of new techniques into the rural sector however, is different compared to urban communities[1] as traditional methods are deep rooted in the rural communities and form an integral part of the culture which binds the community together. Radical technological change affecting important aspects of the traditional lifestyle is capable of producing deep-seated attitudinal and economic changes that can fundamentally affect the structure and cohesiveness of the community (Powelsen, 1977). Therefore, in order for individuals and families in these communities to cope with such a change, they would need to develop new aspirations and new sets of relationships. In addition to that, Pomfret (1997) lists several reasons why technical change does not occur within traditional agriculture including; much of modern "agricultural technology" is designed for large-scale farming inappropriate to most Least Developing Countries (LDC) settings, low education levels, inadequate motivation on the part of farmers, and a host of other barriers to the adoption of new techniques which are specific to the physical and institutional context (see also Ahmed, 1998).

Moreover, agricultural technology has been introduced in a number of ways. In some cases a deliberate transfer of technology has come about through specific programmes as part of a national development plan. Sometimes the transfer has been imposed from above; at other times it has arisen as a result of encouragement by government but without imposition. Examples abound of technology which has been introduced in communities as a result of community pressure itself. By a common recognition of the ability to improve standards of living such action has been generated by farmers themselves (Campbell, 1990).

[1] Urban communities, in general, appear to be easily adaptable to technology changes because they experience regular exposure to modern technology in the day-to-day environment. Thus adjustment to new techniques can be more readily accepted and lifestyles can alter relatively easily to accommodate new priorities and changes to the environment. Changes in work techniques also may be absorbed without personal or family problems except in the short term.

2.2 Agricultural Productivity

"The man who farms as his forefathers did cannot produce much food no matter how rich the land or how hard he works".

(Schultz, 1964: 3)

Although, the literature on economic development during the 1950s offered little clue as to how higher agricultural productivity could be achieved, Norton and Alwang, 1993:263, argue that productivity increases can be generated through agricultural research which imply a shifting upward of agricultural production functions.

From Fig. 2.1, if a more responsive seed variety is made available through research, output produced per kilo of fertiliser (input) may increase.

Figure 2.1. The effect of research on input productivity.

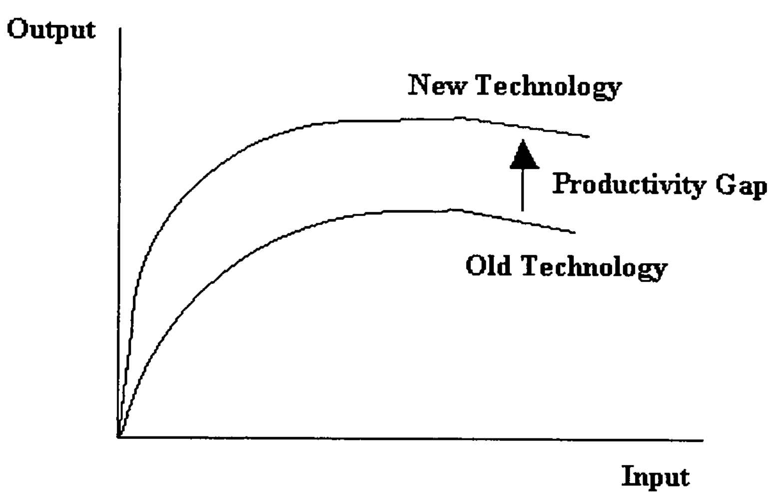
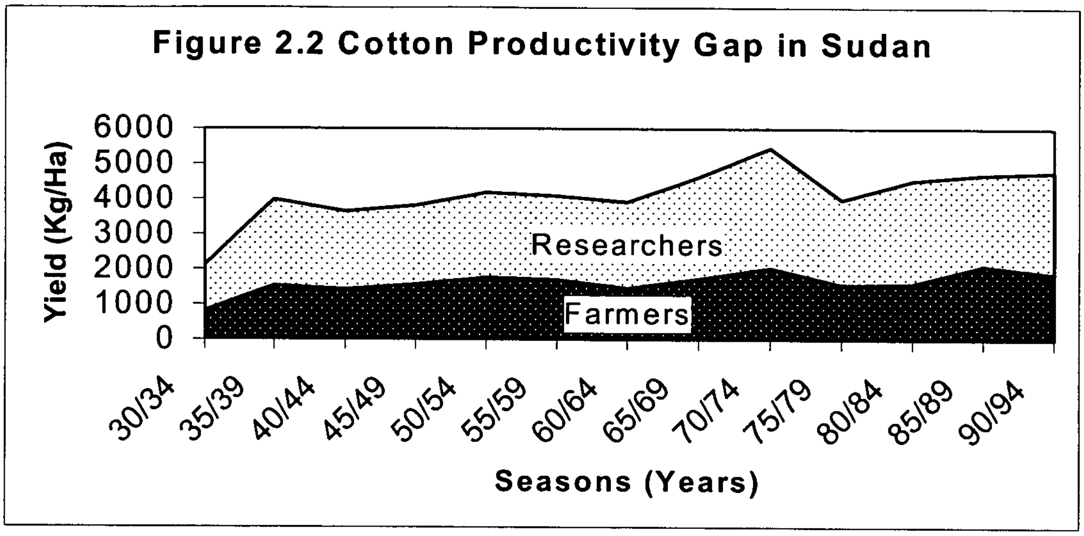


Figure 2.2 below illustrates the productivity gap in the production of Cotton in Sudan between researchers and farmers.



Source: Elsiddig, 1997.

However, the measurement of total productivity gain due to research requires netting out the cost of any additional inputs employed with the improved technologies. The resulting total net cost reduction per unit of output produced can then be used to summarise the total productivity effect. This total productivity effect is illustrated in Figure 2.3.

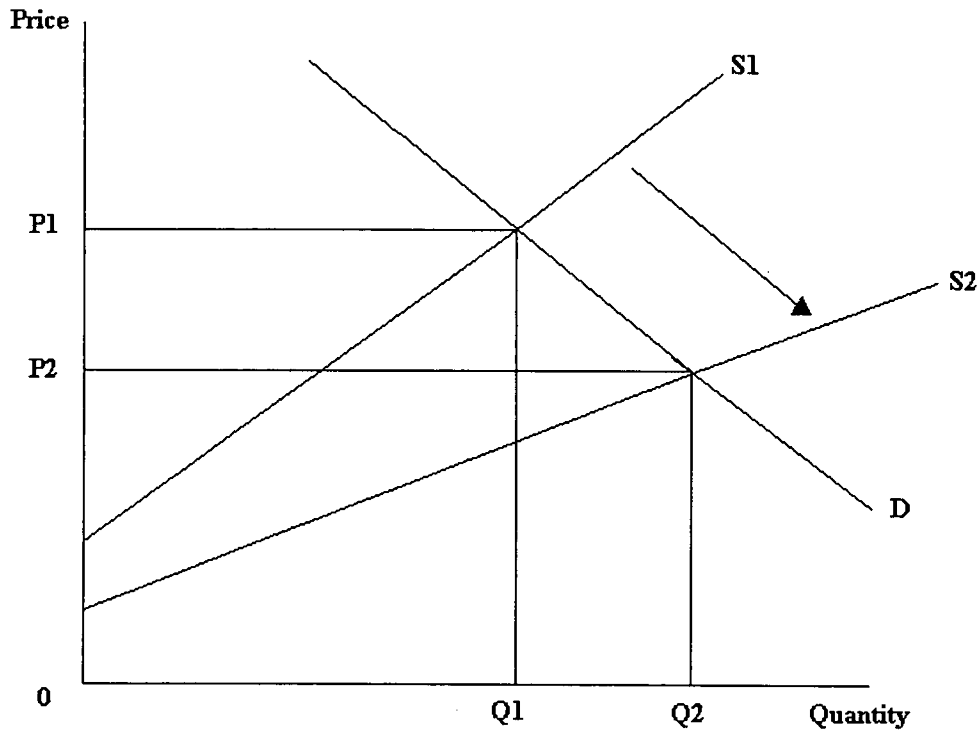
Agricultural research reduces the cost per unit of output, thereby causing the supply curve to shift down to the right (Norton and Alwang, 1993:265). New or improved technology shifts the original supply curve (S1) downward to (S2) because the supply curve is a marginal cost curve and the new technology has reduced the cost of production. The new lower cost of production per unit of output means that more output is produced at a lower price.

Many studies have been conducted to estimate the economic returns to society from public research investments aimed at achieving these productivity increases. Internal rates of return[2] (IRR) is a widely used criterion for determining the value of a project or investment (Gittinger, 1982: 329-342). Most studies have found very high annual

[2] The IRR is the discount rate that makes the net present worth of a project's stream of benefits minus its stream of costs equal to zero. It represents the maximum interest that could be paid for the resources if the investment is to recover costs and still break even. The higher the IRR relative to the interest rate on borrowed money, the more favourable is the investment (Gittinger, 1982: 329-342).

rates of return to agricultural research, often in the 20 to 60 percent range (Norton and Alwang, 1993:264).

Figure 2.3. The effect of research on supply.



The issue of whether improved agricultural technologies benefit large farms more than small farms has been the subject of substantial debate. Evidence illustrated by Scobie, (1979) suggests that "farm size" has not been a major impediment to adoption of new technologies, the major focus of developing country agricultural research. And as tenant farmers represent an important producer group in many countries, it is therefore, difficult to generalise about the effects of research on the "incomes" of tenants versus landlords.

However, the biggest single long-range effect upon agricultural production has been the widespread transfer from subsistence to cash crops whereby the peasant farmer may develop not only products required for sustaining life but those that can be sold for profit to national and overseas markets (see Ahmed, 1998). The change has been one from a subsistence orientation to an economic development orientation.

Norton and Pardey (1993) argue that contractual arrangements influence the distribution of research benefits, and the arrangements may change as well as a result of new technologies. Often, increases in "land" productivity are bid into land rents, and land owners are able to capture these rents by changing tenancy agreements (land ownership implications on the technology adoption will be discussed in more details in Chapter 3 question no. 3.3.1). Furthermore, new technologies allow the same output to be produced with fewer "resources", thus freeing up those resources to be used elsewhere in the economy. The dual-economy model illustrated the potential for "labour" released from agriculture to become a fundamental source of industrial growth (Norton and Alwang, 1993:270).

However, the rise in agricultural output over the past two decades has confounded the predictions of wide-spread famine which were common in the 1950s and 1960s. If agricultural technologies can be improved, additional resources mobilised, and appropriate policies adopted in industrial and developing countries, then faster agricultural growth will be achieved. Economic development, particularly of the poorer countries, will speed up and poverty will be reduced.

2.3 Theoretical Background

The economic impact of technology transfer in African agriculture has been the objective of a number of studies (see Ahmed, 1998 and 1999c). According to Bryant (1982), the social implications of transfer have not been examined to the same degree and to date there is no study that is both comparative in nature and of sufficient depth to be capable of providing empirical evidence of the extent and direction of social change occasioned by the introduction of a new and radical technology.

Meanwhile, rural development has been an issue of academic discussion since the mid-1970s, when the shortcomings of the green revolution were seen and the basic-needs strategy was set up as an internationally recognised priority. Furthermore, the process of agricultural growth has remained outside the concern of most development economists (Hayami and Ruttan, 1985:41).

Many theories have been suggested to explain how the basic sources of "growth" (labour, natural resources, capital, increase in scale or specialisation, improved efficiency, and technological progress) can be stimulated and combined to generate broad-based agricultural growth (Norton and Alwang, 1993:170). Hayami and Ruttan, have characterised previous agricultural development theories into six basic approaches:

(1) resource exploitation.
(2) resource conservation.
(3) location.
(4) Diffusion.
(5) high-payoff input.
(6) induced innovation.

Resource Exploitation and Conservation Theories

These theories argue that one means of generating agricultural production is to expand the use of "land" and "labour". The development of agriculture in North America, South America, Australia, and other areas of the world during colonisation was based on using new lands (Norton and Alwang, 1993:170). Furthermore, they have also explained some cases where indigenous labour was also exploited and the opening up of forests and jungles by local populations in parts of Africa, Latin America, and Asia provide additional examples of expanded resources use. However, expansion of unutilised land resources provides few opportunities for substantial growth in developing countries today where in many areas additional land does exist, and disease, insect, and soil problems prevent its use in agriculture (Norton and Alwang, 1993:171). Most growth in per capita agricultural output however, will have to come from more intensive use of existing resources. Hayami and Ruttan, (1985:52), estimate that agricultural development based on similar types of "conservation" has been responsible for sustaining growth rates in agricultural production in the range of 1 percent per year in many countries, including developing countries, for long periods of time.

Location Theory

It has long been recognised that the pattern and intensity of agricultural production vary in relation to the proximity of urban-industrial centres and to the quantity and quality of transportation systems (Norton and Alwang, 1993:172). The optimal intensity of farm enterprises in relation to urban areas was first studied by Heinrick Von Thunen (1783-1850) (see Dickinson, 1969 and Grigg, 1982). Schultz (1953) used a model of "location" to explain why agriculture in some areas grew more rapidly than in other areas (see Chapter 3 question 3.3.1 for more details on the effects of farm location on farmers' productivity). Closeness to cities and transport matters because of differences in transportation and marketing costs, in the effects on labour and capital market, in the ease of obtaining new and more productive inputs, and in the ease of information flows. However, one implication of this location theory of agricultural development is that countries should encourage decentralised industrial development, particularly in the middle and late stages of development (Norton and Alwang, 1993:172). Strong linkages between agriculture and markets for inputs and outputs can help stimulate the local economy. Therefore, the location theory of agricultural development stresses only the importance of the market linkages.

Diffusion Theory

In relation to the location theory, the "diffusion" theory, stresses the importance of linkages among farmers themselves (see Chapter 3 question 3.3.1). The basic idea is that transfer of existing technologies and economic knowledge from the more progressive to the lagging farmers could increase productivity (Norton and Alwang, 1993:172). This idea has provided part of the rationale for agricultural extension systems, particularly in farm management.

Moreover, innovation was thought to be the best single indicator of the multi-faceted dimension called modernisation, the individual-level equivalent of development (Rogers, 1976a). Therefore, research on the new technologies was justified because it was assumed that technology was the prime mover in development.

One of the main contributions of diffusion studies has been the evidence provided on the relationship between extension services and patterns of adoption of new technology (Eicher and Baker, 1982:156).

> *"diffusion studies have provided valuable information on the influence of institutions, particularly extension services, on the adoption of innovations and farmers assessment of new technology".*
>
> (Eicher and Baker, 1982:158)

Diffusion theory has been in some cases criticised for leading to unrealistic expectations of the size of potential productivity gains under the existing level of technology (see also Norton and Alwang, 1993) and that it has also led to attempts to directly transfer knowledge and technologies from more-developed to less-developed countries. Roling (1970), argued that variables such as age, education of the farmers, and the ratio of extension workers to farmers were unable to explain the behaviour of non-innovators. Rogers (1976b) surveyed 1,800 diffusion studies in developing countries and concluded that the studies were too narrowly conceived, they ignored important structural barriers to change, and they did not study non-innovators. More success however, has been achieved with transferring knowledge than with transferring technologies and adoption of transferred technologies has been limited except where efforts have been made to adapt the technologies to the new setting.

High-Payoff Inputs Theory

A major theoretical development came with T. W. Schultz's book "*Transforming Traditional Agriculture*", (1964) which challenged the caricature of LDC agriculture as well as many of the structuralist assumptions implicit in the suggested solutions. For Schultz, the critical factor in raising productivity is "technical change" and the role of the Government is to promote technical change (see Chapter 3 question 3.3.4). Schultz's policy prescription was for government to invest in agricultural research stations and in the provision of agricultural extension services (the effects of the implementation system on the adoption of technology and productivity gap is discussed in question 3.3.4 in the next Chapter).

Rural education could also help the spread of new techniques and their better implementation. However, based on the fact that farmers in traditional agriculture are rational and efficient given their current resources and technologies, a new approach articulated by Schultz (1964) emerged in recent years that builds on the conservation, location, and diffusion approaches. In addition to these approaches, the new approach adds the important dimension that the process of agricultural development can be accelerated through provision of new and improved inputs and technologies (particularly improved seeds, fertilisers, pesticides, and irrigation systems). What farmers need are new high-payoff inputs and technologies to increase their productivity. Hayami and Ruttan, 1985, have labelled Schultz's approach the "high-payoff input" model. Schultz's approach however, is neo-classical[3] in its emphasis on technical change as the prime source of growth, couched within the price mechanism. That is, it was an attempt to integrate microeconomic theory as it had developed since the 1870s into development economics as it had evolved since the 1940s.

However, the unambiguous message from this approach is that free markets provide the best incentive to speed technological advance. This goes beyond the static argument that market prices encourage "appropriate" techniques (Ahmed, 1993 and 2000).

Furthermore, Norton and Alwang, 1993:173, argue that, the high-payoff input theory has been widely accepted because of the success achieved by modern wheat, corn, and rice varieties beginning in the 1950s and 1960s. These varieties are highly responsive to fertilisers, pesticides, and water management and have resulted in substantial growth in agricultural output in many developing countries. Hayami and Ruttan, 1985, argue that the high-payoff input theory is incomplete because it fails to incorporate the mechanism that induces these new inputs and technologies to be produced in a country. The theory also fails to explain how "economic conditions" stimulate the development of public agricultural research institutions and educational systems. It does not attempt to identify the process by which farmers organise collectively to develop public "infrastructure" such as irrigation and drainage systems

[3] The central features of the neo-classical theory are its assumptions concerning sustainability (in production and demand) and the maximising behaviour of individual economic agents.

(Hayami and Ruttan, 1985:62). Therefore, to address these issues, Hayami and Ruttan proposed the induced innovation theory.

Theory of Induced Innovation

The theory of induced innovation was developed originally by John R. Hicks (1932) and during the 1960s, Hayami and Ruttan were the first to apply the theory to agricultural development (Norton and Alwang, 1993:173). Their underlying assumption is that technological and institutional changes are vital to agricultural development. The induced innovation theory helps explain the mechanism by which a society chooses an optimal path to technical and institutional change in agriculture. The theory argues that technical change in agriculture represents a response to changes in resource endowments and to growth in product demand and that changes in institutions[4] are induced by changes in relative resource endowments and by technical change (see Chapter 3 question 3.3.2).

Technical change in agriculture can follow different paths. Technologies can be developed that facilitate the substitution of relatively abundant and low cost factors of production for relatively scarce and high cost factors. Norton and Alwang, 1993:174, argue that a rise in the price of one factor relative to others will induce technical change that reduces the use of that factor relative to others.

The theory of induced institutional change addressed many questions with regard to the "origin" of the new technologies, how farmers acquire them as well as whether these developed technologies are "suitable" for all farmers or for some of them (the discussion on technology and advice appropriateness and relevance to farmers' needs will be discussed in question 3.3.2 in the next Chapter). Hayami and Ruttan, 1985, argue that public research scientists and administrators are guided by price signals and by pressures from farmers. The more highly decentralised the research system, the more effectively these pressures work. Therefore, the development of the research systems themselves can be the result of farmers who are responding to market forces.

[4] Hayami and Ruttan (1993:94) define institutions as "the rules of society or of an organisation that facilitate co-ordination among people by helping them form expectations which can reasonably hold in dealing with others. They reflect the conventions that have evolved in different societies regarding the behaviour of individuals and groups relative to their own behaviour and the behaviour of others".

The theory of induced institutional innovation recognises that institutions can become obsolete and in need of adjustment over time and that new technologies and changes in relative resource endowments or price changes provide incentives for a society to demand new institutional arrangements (Norton and Alwang, 1993:177).

2.4 Models of Agricultural Development

The assumptions of the neo-classical economic models were considered to be irrelevant to Africa and the resulting policy prescriptions were not taken seriously (Eicher and Baker, 1982:35). In retrospect, the neo-classical economists argued that the major shortcoming of Western development models was their excessive macro orientation and the inability of these models to provide a convincing specification of the agricultural sector[5]. According to Eicher, most models ignored structural problems as they focused on the supply side and ignored the structure of demand and its relationship to income distribution and employment.

However, while the land-surplus model has rightly been rejected as too global, valuable theoretical frameworks have been proposed for migration (Todaro, 1969), rural small-scale industry (Liedholm and Chuta, 1976), and consumption (King and Byerlee, 1978). Byerlee and Eicher (1974) proposed a multi-sector rural economy model to examine the linkages between rural and urban firms, both large- and small-scale, and small- and large-scale agricultural producers. It is notable that the authors were proposing these models to serve as a framework for conducting empirical research rather than for devising policy recommendations (Eicher and Baker, 1982:35). This reflects the fact that a consensus had emerged among Western development economists by the early 1970s that because of the failure of Western development models to deal with the key problems of employment, equity, and food supply, it was necessary to go back to the basics, building an understanding of development in African rural economies based on meticulous microeconomic research.

[5] The agricultural sector employs 50 to 95 percent of the total labour force in African economies.

During the late 1960s and early 1970s, several scholars developed models based on African resource endowments and institutions in an attempt to address the weakness of imported development models. For example, Hayman and Ruttan (1971) noted that there was a need to step up micro research in the 1970s in order to provide the data necessary for a convincing specification of the agricultural sector. This has left Western economists open to the challenge from radical scholars that their micro studies are a historical, overstress technical and infrastructural constraints, and give too little attention to the influence of the world economy. However, for a critique of "conventional development research" and the role of Western social scientists in Africa, see Amin et al. (1978).

2.5 Technology Development

> *"Agricultural knowledge systems still hold the answer for whatever Africa can do in hoping for its own green revolution ... increasing the pace of evolution is needed, with better understanding of current practices and better use of existing systems"*

says the Director General of the International Institute of Tropical Agriculture (IITA, 1994)[6].

Every country in sub-Saharan Africa (SSA) has a national research program which conducts a wide range of agricultural research. And while substantial increases in yields of export crops have been achieved on experiment stations and on farm, there are few areas in Africa where there are proven food crop packages ready for farm-level adoption (Eicher and Baker, 1982). Moreover, agricultural researchers in SSA have focused on helping farmers through; research on improved varieties and agronomic practices, including spacing, timing of planting, weeding, and the application of fertilisers, herbicides, and pesticides and research on mechanical technology, including hand tools, animal traction, and tractor mechanisation. For the history of agricultural research in SSA see Appendix-C1 and C2.

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[6] Quoted from an interview with the IITA Director General by Food Action Media Service, IITA, Ibadan, Nigeria, February, 1994.

Most agricultural research has been carried out on experiment stations and has focused on increasing yields, yield stability, and insect and disease resistance. Research on animal traction, tractor mechanisation, and selective mechanisation of particular tasks has been dominated by two groups of researchers over the past 25 years: engineers and economists. The engineers have concentrated on how mechanisation influences variables such as yields, acreage, timeliness, and cropping intensity (see Kline, Green, 1969; Giles, 1975). Economists have focused on the financial and economic profitability of alternative types of mechanisation and more recently on the employment and income distribution consequences of mechanisation (also see Gemmill and Eicher, 1973; Binswanger, 1978).

However, since the mid-1970s, there has been growing interest in irrigation and in farming systems research to complement commodity research programs. And although research on plant breeding, agronomic practices, and mechanisation has been extensive, African agriculture is less mechanised and has been less affected by new technologies than other areas of the world (see Eicher & Baker, 1982).

2.5.1 Small-Farmers Focus

Several researchers (Belshaw and Hall, 1972; Palmer-Jones, 1977; Collinson, 1981; and Eicher and baker, 1982) argue that much of the micro-economic information collected in the sixties and seventies was of limited relevance to small farmers in Africa for the following reasons:

1. Most studies failed to address the information needs of small farmers in the context of their goals and management strategies (see question 3.3.3 in the next Chapter).

2. There was a large gap between the values, interests, and education of researchers and extension agents on the one hand, and small farmers on the others (for details see the research questions in Chapter 3).

3. Many researchers studied only one or at most a few enterprises.

4. Most studies failed to take into account the impact of social and political institutions on household decision making (see question 3.3.3 in the next Chapter).

5. Research findings rarely were disseminated in a form usable by farmers.

In light of these difficulties, numerous researchers recommended that more research should be pursued within a cropping and farming systems framework (CGIAR, 1978; Norman, 1980; Gilbert, Norman, and Winch, 1980; Byerlee, Collinson, 1980; Collinson, 1981, 1982; and Eicher and Baker, 1982).

Therefore, the primary goal of agricultural research is to design research programs which are holistic, interdisciplinary, and cost-effective in generating technology which is appropriate to the production and consumption goals of rural households in specific microenvironments (see question 3.3.2 in the next Chapter). However, the problem of identifying groups of farms which are sufficiently homogeneous to serve as recommendation domains continues to be one of the main challenges facing farming systems research (FSR) (Eicher and Baker, 1982:159). The extent to which small farmers are homogenous and can therefore be treated as a group has been long debated (e.g., Hill, 1968; Collinson, 1972; Heyer, 1981). Another major problem is the issue of sufficient conditions for aggregation (e.g., Odero-Ogwel and Clayton, 1973). For discussion of these issues in the context of FSR, see Crawford (1982) and Byerlee, Collinson (1980).

All farmers -small, medium, and large- respond to economic incentives, but the focus on farmers calls for special attention to the small farmer. Far from being tradition-bound peasants, farmers have shown that they share a rationality that far outweighs differences. Even in centrally planned economies such as in China and Hungary, farmers have responded to economic incentives (World Bank, 1982). In some instances, their response exceeded the expectations of policy-makers. Farmers in the irrigated areas of South Asia responded dramatically to the new incentives of the Green Revolution. Small farmers can be highly productive. Typically, they produce more from each acre than large farmers despite the often considerable disadvantages of their limited access to services, markets, and production inputs such as fertiliser

(World Bank, 1982). Programs and policies dealing with these problems thus offer substantial economic benefits, as well as increase employment and income among the poor.

Eicher and Baker, 1982:113, have argued the fact that; there has been a long history of research recommendations being rejected by farmers and endless debates about the need to reorganise national research systems. However, there are many reasons for the lack of progress in generating food crop technology which is relevant to small farms;

First

There is a gap between resource endowments of experiment stations and small farms (for the direct and indirect implications of resources differences between farmers and researchers, see questions 3.3.1 and 3.3.2 in Chapter 3). For example, soils on research stations often have a history of better management, including previous applications of fertilisers and dry season conservation practices. Experiment station plots are usually ploughed and seeded at optimal times, weeding often exceeds levels practised by small farmers, and complementary inputs such as insecticides and fertilisers which are routinely used on experiment stations are often not available to farmers in village markets. As a result, many of the technical recommendations presented to farmers have proven to be overly optimistic.

Second

Many of the technical packages which increase yields and yield stability call for practices which are not consistent with the goals of farmers or their "prevailing wisdom" about optimal cultivation practices under environmental uncertainty. For example, researchers frequently have recommended early planting of cash crops in rows even though most farmers have traditionally intercropped and planted food crops before cash crops, believing that these practices increase the probability that household food requirements can be met even in low rainfall years. As a result, farmers have selectively adopted some of the components of technical packages such as an improved variety, applying small amount of fertiliser, or changing planting dates rather than adopting the entire package. Even where entire packages have been adopted, farmers generally have done so sequentially over a period of several years. Thus, there is a continuing need to take into account the goals, resource endowments, and constraints faced by farmers in designing on-station research. Finally, there is a need to increase on-farm research of promising technology.

2.5.2 Farmer First

The purpose of farmer "participation" in agricultural research is to involve small farmers as "active decision-makers" in the development and transfer of new technology (see questions 3.3.1, 3.3.3 and 3.3.4 in Chapter 3). The result is they get the technology they "want" and "can" adopt. Bureaucratic public sector agricultural research systems consistently fail to serve the majority of small farmers effectively-especially in developing countries. This is partly because small farmers lack the formal channels to communicate their needs and ideas to technology designers in these research systems on a regular basis. Research systems also lack institutionalised procedures for responding to the priorities of many diverse farm communities.

The resultant gulf between public agency priorities and small farmers' needs is reflected by the many technical recommendations which are never adopted by farmers. At the same time, farmers on their own continue to invest and adapt locally appropriate farming practices, without the integral support of modern science.

Eicher (1989:24-25) argues that;

> "*the resource-transfer model of foreign assistance must be replaced by a human- capability/institution-building model of development, producing sustainable institutions for sustainable agriculture*".

Ashby (1995) also argues that; one reason why new technology is not adopted is because small farm systems (particularly those in tropical agriculture) are so highly diverse and that public sector institutions cannot afford accurately to adapt new technologies to each local set of circumstances. Instead, they rely on blanket recommendations. This causes farmers to lose confidence in public agricultural research services. As a result, farmers feel all the more need to test and adapt recommendations themselves (see questions 3.3.1 and 3.3.2 in the next Chapter). Farmers who experiment with new ways of farming are an important resource helping rural communities to solve their farming problems. Yet these experimenting farmers are generally unrecognised, unsupported, and disconnected from the often substantial investment in formal agricultural research.

Experimenting farmers are a neglected resource because conventional approaches to agricultural technology generation are top-down. Technology is designed by scientists who make decisions about what to recommend to farmers without giving farmers any direct say in this process. The conventional approach is like a doctor-patient relationship. The researcher and extensionist (like the doctor) are supposed to formulate a prescription to cure the farmer-patient's ills. When the doctor or scientist cannot diagnose problems correctly nor formulate appropriate prescriptions because farmers' needs are many and diverse, this approach breaks down (see questions 3.3.1 and 3.3.2 in Chapter 3).

Developing technology which is suited to the particular location, specific needs and problems of the 1.5 billion people who depend on complex, diverse, risk-prone agriculture requires a different approach (Ashby, 1995).

Participatory methodologies, which aim to institutionalise a role for farmers, usually start out with a menu of technological alternatives. Instead of being taught blanket recommendations, farmers take part in selecting promising items from this menu and are involved in experimenting with them (see question 3.3.1 in Chapter 3). They participate in evaluating the results of their experiments and in formulating recommendations. If a technology cannot be locally adapted, this information is systematically fed back to researchers (see question 3.3.2 in the next Chapter). Experience with this approach shows that new technology selected with farmer participation methods is better adapted to local conditions than that recommended by researchers working on their own (Ashby, 1995).

2.6 Technology Transfer

While technology transfer typically "*refers to the development of a technology in one setting which is then transferred for use in another setting*" (Markert, 1993, p. 231), diffusion is used to describe the "*spreading*" or use of a technology within a society, organisation, or group of individuals (Rogers, 1995).

Technology transfer tends to focus on the producer of the technology while much of the focus of diffusion relates to the end user of the technology. Viewed from the holistic perspective of technology development and utilisation, these two areas are closely interrelated and must be considered together. Therefore, in this research, the term technology transfer will be defined broadly to include both the movement of technology from the research institution (*site of origin*) to the farmer (*site of use*) and issues concerning the ultimate acceptance and use of the technology by the farmers (*end user*).

Adopting this broad definition of technology transfer implies that a technology has not been successfully transferred until it has been accepted and used by the farmers. In its most basic form, the technology transfer triangle includes the transfer item itself, the developer of the technology (*researchers*), various channels to accomplish the transfer (*extension services*), and the technology recipient (*farmers*).

2.6.1 Information to Farmers

Information is an essential production factor in agriculture. Farmers need information to improve or adapt their farming. Farmers need extension only to the extent that it can provide them with relevant and timely information (for the role of extension services in the transfer of technology see question 3.3.3 in the next Chapter). However, agricultural information services in Ministries of Agriculture present a common scenario: an operating premise that an approved body of knowledge and practices has to be disseminated and that farmers are willing recipients rather than independent seekers of information. Modernisation of backward agriculture gives priority to highly skilled manpower for research stations, while less skilled people become extensionists. To meet national needs, such as earning foreign exchange, farmers are encouraged to grow cash crops as well as subsistence crops, with production for export. Hence the need to disseminate becomes a need to be selective in dissemination, to steer farmers in a particular direction (see question 3.3.3 in Chapter 3).

In his overview of the problems of extension services in developing countries, Stavis (1979) argued that extension agents in developing countries frequently are only a marginal source of information for farmers, that extension services are directed by political priorities, and that by themselves they cannot do much to help the small farmers (also see Benor and Harrison, 1977). De Wilde (1967), E. Hopkins (1974), Chambers (1974), De Vries (1976, 1978), and Leonard (1977) review extension services in Africa.

Meanwhile, an agricultural information service also has internal pressures and tensions in defining its audience and its needs: top echelons may favour commercial farmers to maximise production, extension workers may identify with small holders (their own background), and external aid-related forces may promote the poorest of the poor.

2.6.2 Critical Role of Agricultural Extension

"Agricultural extension" as A. H. Maunder defined it in the Food and Agriculture Organisation reference manual is;

> "*a service or system which assists farm people, through educational procedures, in improving farming methods and technique, increasing production efficiency and income, bettering their levels of living, and lifting the social and educational standards of rural life*".
>
> (FAO, 1988:2)

The function of agricultural extension is to enhance learning among those who till the soil and tend the livestock of the world - learning of those things they need to know in order to feed themselves and others (FAO, 1988). Sometimes it functions to bring farm people into contact with sources of practical and useful information through organised group action. Large numbers of these agricultural extension workers are organised into an agricultural extension system which provides them with a constant supply of useful extension messages, technical and administrative supervision, and logistical support. However, each agricultural extension organisation is a reflection of a particular purpose in its own setting.

There are many different types of agricultural extension systems. However, compared to Asia and Latin America, extension in Africa has often failed to reach resource-poor farmers and current extension strategies do not adequately meet the needs of this group. To make a greater impact on this group, extension must be placed in the context of an overall rural development strategy (Schwartz, 1992).

The contributions of agricultural extension are found throughout the world, and are many and varied. The best known, perhaps, has been increased production of food and fibre in many parts of Asia and Latin America, and in some African locations. When the international and national agricultural research systems introduced the new high-yield varieties (HYV), agricultural extension often provided the interface which made them known to farmers (see questions 3.3.1 and 3.3.3 in Chapter 3). Some called it "The Green Revolution" (Campbell, 1990). And while much of the recognition for the achievement in productivity has been credited to the agricultural research institutions, in every country where there has been a significant gain, agricultural extension performed its vital function.

Extension personnel facilitated the communication of messages, not only about the new improved seeds, but also about fertilisers and water requirements, and other cultural practices so necessary. Agricultural extension has contributed in both directions. It has facilitated and expedited the flow of useful technical information from sources (providers) to users (clients); and it has facilitated and expedited the flow of information about technical problems from farm people to research and development organisations (see Ahmed, 1998). In such situations, if there were not already existing agricultural extension activities, the research organisations would have had to invent them and propagate them.

Early agricultural research farms in Germany and in Scotland had a problem with farmers who came to the gate seeking suggestions about varieties or pest control, and early agricultural chemists doing soil testing had a constant problem with farmers seeking individual services (see FAO, 1988). For the history of Agricultural Extension see Appendix-C3.

More recently, the international agricultural research centres have had to face the same problem. If any organisation conducts agricultural research without a direct interface with farmers, it has several problems. There is difficulty in making its findings relevant to and useful for real farmers. When agricultural scientists make their own research agenda without guidance from practical farmers, they learn many useful things, but farmers may later find that those new technologies simply do not fit their own "farming systems", and therefore they do not adopt them. For this reason, most of the international agricultural research centres have had to become involved in "farming systems research and extension", and some have built networks of relationships with national agricultural research organisations which had their own interface with extension (see Ahmed, 1998, 1999a and 2000).

In their International Directory of National Extension Systems, Swanson and Rassi (1981) provided descriptive data on the Agricultural Extension Systems of 104 different countries. The different agricultural extension approaches have also been described and compared in recent studies by Roling (1982), Pickering (1987), Axinn (1987), and FAO, 1988).

However, an "approach" to extension is the essence of an agricultural extension system. Each system has an organisational structure; leadership; resources of personnel, equipment, and facilities; programme with goals and objectives as well as methods and techniques for implementation; and it also has linkages with other organisations and various public as well as its particular clientele (see question 3.3.3 in the next Chapter).

The approach is the style of action within a system that embodies the philosophy of the system. It is not merely one of the components of the system, but more like a doctrine for the system, which informs, stimulates, and guides such aspects of the system as its structure, its leadership, its programme, its resources, and its linkages. But whether these systems are centralised or decentralised, whether their strategy is technology transfer or enhancement of rural life, there are several approaches which have been used. Over the years, practice has demonstrated that certain approaches are more effective than others under particular circumstances.

However, according to FAO (1988), each approach can be characterised by the following seven dimensions:

1. The dominant identified problem to which the approach is to be applied as a strategic solution, referred to here as the basic assumption made by those who establish it.

2. The purposes it is designed to achieve.

3. The way in which the control of programme planning is carried on, and the relation of those who control programme planning; to those who are the main target audience for the programme.

4. The nature of the field personnel including such aspects as their density in relation to clientele (ratio of field staff to clientele), levels of training, reward system, origin, gender, and transfers.

5. The resources required, and various cost factors.

6. The typical implementation techniques used.

7. How it measures its success.

Each approach is demonstrated through the ways in which an extension system uses these methods, the types of objectives or targets it sets, and the means by which it seeks to implement larger national strategies. It can also be seen in the ways in which it selects, trains, and rewards the staff, the number of staff required, and the types of relationships between the staff and the farm people. And since all are merely different approaches to the same agricultural extension phenomenon, there are commonalties among all. For example they all:

- employ non-formal education procedures.

- have content related to agriculture.

- seek to improve the standard of living of rural people.

Meanwhile, efforts have been made by FAO (1988), to identify ten major extension approaches for the benefit of agricultural development decision makers. Some of these have limited practical utility, while others are being adopted in several countries. These systems include;

1. The general agricultural extension approach
2. The commodity specialised approach
3. The training and visit approach
4. The project approach
5. The farming systems development approach
6. The cost sharing approach
7. The educational institution approach
8. The agricultural extension participatory approach
9. Farmer first' approach: scientist-farmer reversal
10. A participatory-oriented approach: strategic extension campaign

For full details of the different extension approaches see Appendix-D.

2.6.3 Gaps between Research and Extension Missions

Most countries have units of agricultural research and agricultural extension in their Ministries of Agriculture. Most countries have a functional gap between the two also, despite the inappropriate knowledge of technology for rural development. SSA started independence with a profound extension bias (21,200 extension agents and 1,329 researchers) and this bias was intensified by hiring an additional 36,000 extension agents over the next 20 years (Judd, 1987:11-13).

One-way paradigms of extension have been thoroughly criticised in recent years. A major weakness is the inadequate linkage between research and extension. Research and extension actually operate in many countries, both developed and developing, with more independence than complementarity.

According to McDermott[7], the problem is that research (left) and extension (right) too often work toward the poles of this continuum, with a great gap in between. Without on-farm trials, research stops after "Technology Development" or sometimes slightly into "Technology Testing". Without appropriate extension specialists and on-farm trials, extension starts with "Diffusion" thus leaving neglected the important in-between, linking areas of technological testing, adaptation, and integration. Extension units may think of diffusion only--the peddling of handed-down technology on the assumption that farmer-ready technology exists "somewhere". It often does not exist because that readying process falls in the no-man's land between self-contained research and self-contained extension.

Completing the cycle of the technology innovation process, without such breaks, is the objective of Farming Systems Research/Extension, the latest of many historical efforts to preserve and smooth out the continuum. The "/Extension" part of this systematic approach offers challenges, too. Often there is no co-operation with researchers to adopt technology and integrate it into packages because subject- matter specialists are not available, as so often in Africa and Asia. There is no reaching-back mechanism for effective linkage with research or for gaining the confidence of the researchers. And as stated above, there is often the erroneous assumption that extension is only the diffusion of technology, simplistically ignoring the human agents, the institutional structures, and the resource components. Extension, then, needs to be defined in each country so that it completes the continuum and interlocks with research.

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2.7 Adoption of Technology

Interest in why technologies were or were not being adopted stimulated social science research on the diffusion of innovations beginning in the 1960s (see Ahmed, 1999b & c and Ahmed and Adams, 2000). The adoption of innovations in agriculture has been studied intensively since Griliches (1957) pioneering work on adoption of hybrid corn in the USA. The majority of the previous adoption research has been concerned with answering the questions:

(a) *what determines whether a particular producer adopts or rejects an innovation*, and (b) *what determines the pattern of diffusion of the innovation through the population of potential adopters* (Lindner, 1982; Feder, 1985; Lindner, 1987; Tsur, 1990; Leathers and Smale, 1992; Feder and Umali, 1993; Saha, 1994; Marsh, 1995; Rogers, 1995).

Overall, despite numerous studies, the results of research in this field have been disappointing (Abadi Ghadim and Pannell, 1999) and most of the statistical models developed have low levels of explanatory power, despite long lists of explanatory variables (Lindner, 1987). Furthermore, the results from different studies are often contradictory regarding the importance and influence of any given variable (Abadi Ghadim and Pannell, 1999).

Risk has often been considered as a major factor reducing the rate of adoption of an innovation (Lindner, 1982; Lindner, 1987; Tsur, 1990; Leathers and Smale, 1992; Feder and Umali, 1993). However the issue of risk in adoption has rarely been addressed adequately. The missing link is usually the dynamic nature of adoption decisions involving changes in farmers' perceptions and attitudes as information is progressively collected.

In developing a conceptual framework of adoption, Lindner, 1987, reached some important conclusions and highlighted the inconsistencies in the results obtained from most of the empirical studies on adoption of agricultural innovations and identified some reasons for the shortcomings observed in many of those studies. These included;

- biases from omitted variables.

- poor model specification.

- failure to account for the importance of the dynamic learning process in adoption.

- failure to relate hypotheses to a sound conceptual framework.

He argued that weaknesses such as these were the prime cause of findings in some studies that farmers behave against their own best-interest in adoption decisions. Lindner concluded that,

> "*As long as the findings of methodologically flawed studies are ignored, there is compelling empirical support for this emerging consensus that the final decision to adopt or reject is consistent with the producer's self-interest*".
>
> (p. 148)

> "*The finding that the rate of adoption as well as ultimate adoption level are determined primarily by the actual benefits of adoption to the potential adopters is by far and away the most important result to be culled from the empirical literature on adoption and diffusion*".
>
> (p. 150)

In addition, farmers' decisions to adopt a new agricultural technology in preference to other (old) technologies depend on complex factors. In their analysis of farmers' adoption decisions in Ethiopia, Negatu and Parikh (1999) identified different factors. One of these factors is farmers' perception of the characteristics of the new technology vis-à-vis that of the existing (old) technology.

This perception however may be with respect to the straw quality, grain yield and/or marketability of the new variety. These measures are ordinal and as a result the perception variable is treated as an ordered probit. Negatu and Parikh's (1999) study of a sample of Ethiopian farmers suggested that farmers' perceptions of the modern variety have a highly significant effect on adoption. Their most robust result was the role of perception in influencing adoption; farmers' perceptions about grain yield and marketability of the product were found to be the two most important ingredients affecting the adoption decision.

Other factors which influence farmers' adoption decision are the conventional (traditional) ones: resource endowments; socio-economic status; demographic characteristics; and access to institutional services (extension, input supply, markets, etc.) (see question 3.3.1 in the next Chapter). Studies on the effect of these conventional factors on adoption are extensive and numerous (Feder,1985; Feder and Umali, 1993, and Negatu and Parikh, 1999).

The role of farmers' perception in adoption decisions is, however, scarcely studied (Adesina and Baidu-Forson, 1995). Recently, Adesina and Baidu-Forson (1995) and Adesina and Zinnah, 1993, have demonstrated the impact that farmers' perceptions of the characteristics of different varieties (food quality, yield, tillering capacity, etc) have on the adoption of modern sorghum and rice varieties. This is a useful dimension to look for ways of facilitating farmers' gains in perception of the real characteristics of new technologies, and to identify factors that make differences in perception formation among farmers (see question 3.3.1 in the next Chapter). Awareness of the factors that influence perceptions would also facilitate the enhancement of the development and transfer of appropriate technologies.

Negatu and Parikh (1999) argue that Adesina and Zinnah's (1993) model for the farmers' technology adoption decisions was based on Rahm and Huffman (1984) which assumed that utility maximisation remains unobserved and the decision whether to grow a modern variety in relation to a traditional variety is based on a comparison of marginal net benefits of one against the other.

Meanwhile, the paradigms or conceptual models employed to explain the decision of small farmers to adopt new technology can be categorised into three groups:

(i) the innovation-diffusion model.

(ii) the economic constraints model.

(iii) the technology characteristics-user's context model.

The Innovation-Diffusion Model

This model also called transfer-of-technology (TOT), follows from the initial work of Rogers (1962). According to this model, a technology is transferred from its "source" (research institutions) to final "users" through "agent-medium" (extension services) and its "diffusion" in potential user-communities depends mainly on the "personal characteristics" of the potential individual user (see question 3.3.1 in the next Chapter). What is assumed by this model is that the technology is "appropriate" for use unless hindered by the lack of effective "communication".

The Economic Constraints Model

The central assumption of this model, also known as the factor endowment model, is that the distribution of resource endowments among the potential users in a country/region determines the pattern of "adoption" of a technological innovation (see question 3.3.1 in Chapter 3). The model assumes that market prices (or surrogate prices induced by policy and institutional interventions) reflect the relative scarcity of the factors, implying the existence of (or need for) well-performing markets and the importance of price policies (Hayami and Ruttan, 1971 and 1985).

Adesina and Zinnah (1993) distinguish these two types of paradigms (models) and though both assume that the technologies' characteristics determine their adoption and diffusion (see question 3.3.2 in the next Chapter), these are included only in few empirical models (Fliegel and Kivlin, 1966; Byerlee and de Polanco, 1982; Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995). Most empirical studies concentrate on the effects of farmers' characteristics on adoption decisions. They compare farmers who have adopted or rejected a certain technology at a point in time, but say little about the influence of technology characteristics on adoption and diffusion of different technologies.

However, this knowledge would improve planning for research and development considerably. Knowing the characteristics which have determined the adoption and diffusion in the past would indicate which characteristics new technologies should possess to become quickly and widely adopted in the future which is the information prior to be known for planning purposes (Anthony and Anderson, 1991; Alston, 1995).

The Technology Characteristics-User's' Context Model

This model integrates approaches which assume that characteristics of a technology under-lying users' "agro-ecological", "socio-economic" and "institutional contexts" play the central role in the adoption decision and diffusion process (Biggs, 1990; Scoones and Thomson, 1994).

This model can also consider the "perceptions" of potential adopters regarding the characteristics of a technology as a component affecting adoption decisions and hence the diffusion of the technology (Gould, 1989). The model implies the importance of the "involvement" of farmers in the technology development process with the aim of generating technologies with "appropriate" and "acceptable" characteristics (for farmers' involvement in technology development, see questions 3.3.1 and 3.3.2 in Chapter 3). The model also implies the importance of institutionalisation of research policies and strategies that facilitate the participation of farmers and other relevant stakeholders in the technology development process.

2.8 Regressions and Modelling Strategies

The first application of linear programming to African agriculture was Clayton's (1961) study of the effect of resource constraints on the profitability of typical farms in Kenya (Eicher and Baker, 1982:90). Despite methodological problems, Clayton made a valuable contribution in identifying family labour rather than land as the major constraint on increasing farm output. Furthermore, in 1963 Clayton used parametric programming to indicate the effect of differing resource endowments on farm profitability and to derive a normative supply curve. Heyer's (1966) programming analysis of Kenyan agriculture represented a major improvement over Clayton's work and was further refined in 1971.

According to Eicher and Baker (1982:91), linear programming models emerged during the 1970s as one of the most important tools used by researchers studying smallholder farming and attempts to use programming models to evaluate new technologies appear to be one of the most promising applications of individual farm models. See Vail (1973) and Ogunfowora and Norman (1974).

However it must be noted that models used to date have varied greatly in their sophistication and care must be used in interpreting policy recommendations (Eicher and Baker, 1982:93). Therefore, the increasing dissatisfaction with the policy prescription obtained from models has stimulated several researchers to develop models which more nearly reflect decision-processes of small farmers. See Low (1974 and 1978), Heyer (1972), Farrington (1976), Palmer-Jones (1977 and 1979) and Niang (1980). Also see Hardaker (1979) for further discussion of alternative analytical techniques used in farm management research in developing countries.

In a study by (Batz, Peters and Janssen 1999) carried out in Kenya to analyse the impact of technology characteristics on the rate and speed of adoption, technology characteristics were measured by applying a scoring approach which involves assessments made by extension workers working in the study area. The use of the scoring approach was necessary because quantitative assessment of the profitability and risk characteristics for each technology would have involved considerable costs for data collection and farm-modelling. However, although this approach is less costly it does result in the loss of information due to the use of scores instead of a continuous measure. Batz, Peters and Janssen (1999) analysed the influence of technology characteristics on the adoption parameters by using linear regression analysis. The regression models used combinations of relative complexity, relative risk and relative investment as explanatory variables for the adoption parameters. The basic models are presented below;

$$\boldsymbol{AR_{(94)}} = \beta_0 + \beta_1\textbf{time} + \beta_2\textbf{Relative complexity} + \beta_3\textbf{Relative Risk} + \beta_3\textbf{Relative Investment} + e \quad (1)$$

$$\textbf{Speed/Speed}_{(94)} = \beta_0 + \beta_1\textbf{Relative complexity} + \beta_2\textbf{Relative Risk} + \beta_3\textbf{Relative Investment} + e \quad (2)$$

Where $AR_{(94)}$ is the rate of adoption in 1994[8], **time** is the number of years passed by from start of diffusion until 1994 and e the random disturbance term.

However, in another study Abadi Ghadim and Pannell (1999) presented a framework that conceptualises adoption as a multi-stage decision process involving information acquisition and learning-by-doing by chick pea growers who vary in their risk preferences and their perceptions of riskiness of an innovation. The results of their study show that information from trialing and innovation has two aspects: skill improvements, and better decision making. A wide range of socio-demographic attributes have also been found to be related to adoption. Abadi Ghadim and Pannell's basic model is presented below;

$$I_D = \mathrm{NPV}^n_{t=2}\,[(G^*_{ct} - G_A)\,\Delta_{At}]$$

Where I_D is the value of information from trialing for decision making, $\mathrm{NPV}^n_{t=2}$ is the net present value of the profits from year 2 to year n, G^*_{ct} is the gross margin of the innovation if the farmer uses A^*_{ct} as a planting rule[9], G_A is the mean gross margin of the alternative enterprise over the area planted and Δ_{At} is the change in the allocation of resources to the innovation in year t as result of a trial in year *one*.

[8] The rate of adoption (AR) up to the year when the study was carried out (1994) was calculated to describe the history of adoption.
[9] A^*_{ct} is the optimal allocation of resources to the innovation in season t if the farmer trials the innovation in the first year.

From this model the value of information from trialing in the model is the gain in profit on the area converted from the alternative enterprise to chick peas in future years as a result of the trial.

Binary dependent variable models have been used to evaluate factors affecting the decision to adopt improved technologies. Falusi (1974/75), for example, used a multivariate probit model to analyse factors affecting the decision to use fertilisers in Nigeria. Aklilu (1980) used a logit model in his study of fertiliser adoption in Ethiopia.

In the present study the process of technology development, transfer and adoption are linked. An attempt is made to model the adoption of technology by farmers, the transfer of technology from researchers to farmers by extension services and the productivity gap between researchers and farmers. The latter two are amenable to standard linear modelling however the adoption decision requires a different approach. The two studies cited above (Falusi and Aklilu) used probit and logit models respectively for the adoption decision. The nature of the data for the present study lends itself very well to the logit approach. This is because the problem is a straight forward binary choice problem (as opposed to a multinomial choice set). This effectively means that, given a binomial choice set, the error distribution function behaves as standard normal. In a multinomial context the error distribution is Weibull. This means the logistic regression coefficients can be smoothly transferred to the probability function where;

$$\mathbf{P_A} = \frac{\mathbf{1}}{\mathbf{1 + exp\ (-bz)}}$$

where P_A is the probability of adoption, b is a vector of coefficients and $\mathbf{z}$ is a vector of the included variables.

It should be noted however that the calculation of P_A is only valid where the coefficients within the vector b are robust and statistically significant. These theoretical and modelling considerations are fundamental to the key research questions which will be identified in the next Chapter. However, the adoption, transfer and productivity gap models are presented in Chapters 5, 6 and 7 respectively.

2.9 Variables Selected For Investigation

From the above discussion of the technology transfer literature, a number of important variables emerged which should be included for investigation. Technology transfer models will be developed using this information in order to fulfil the specific objectives of this study. The variables considered for this investigation are described in this section. The full questionnaires of this survey can be found in appendix-E.

The variables selected for the research and academic institutions surveys analysis are as follow:

Respondent's age:

Age of respondent at the time of interview, recorded in years.

Respondent's education:

Respondent's education is recorded in the survey as higher degree(s) obtained.

Respondent's speciality:

Respondent's speciality is recorded as the main area of research/teaching specialisation.

Respondent's work allocation:

Specifically in the survey, the question "*How many (days/month) do you spend on?*" was asked to include any type of work the respondent does in a daily or monthly basis. In addition to this question, the academic staff were asked the question *"Do you do any field work?"* and respondents ticked either yes or no. However, if they ticked no they have to explain why they do not carry any field work.

Researcher/academic staff linkage:

Researcher/academic staff linkage defined as whether or not the researcher have linkage with the academic staff and vice versa and if yes how this linkage operates.

Respondent/extensionist linkage:

Respondent's linkage with extensionists defined as whether or not the respondent have linkage with the extension services and if yes how this linkage operates.

Respondent/farmer on farm visit:

Respondents were asked whether or not they have visited the farmers in their farms and if yes how regular these visits are.

Respondent/farmer off farm meeting places:

Respondents were asked whether or not they have met the farmers elsewhere outside their farms and if yes where these meetings have taken place.

Facilities provided to the farmer:

In order of importance, respondents were asked to prioritise from one to seven the facilities they provided during their visits to the farmer.

Research findings transferred to the farmers:

In the survey respondents were asked the question "*Have all your research/experiment/study findings transferred to the farmers?*" and respondents ticked either yes, no or do not know. However, if they ticked no they have to specify why by ticking in order of important the reasons listed.

Research findings implemented by the farmers:

In the survey respondents were asked the question "*Have the farmers implemented all your research findings that transferred to them?*" and respondent ticked either yes, no or do not know. However, if they ticked no they have to specify why by ticking in order of important the reasons listed.

Productivity increase:

In the survey respondents were asked the question "*To what extent did your recommended research findings resulted in productivity increase and/or quality improvement to farmers' products?*" and respondents have to specify why if there is no productivity increase as a result of their research findings.

Respondent/farmer productivity difference:

In the survey respondents were asked the question "*What is the difference between the level of productivity increase and/or quality improvement you achieved by your research and that achieved by farmers?*" and respondents have to specify why if there is no productivity difference as a result of their research findings.

Respondents opinion about the productivity gap:

Respondents were asked to tick as many as they think apply from the list of reasons given with regard to the productivity gap. They also asked about how this gap can be closed in the future.

The productivity gap and the research strategy:

In the survey respondents were asked the question *"Have you changed you research strategy as a result of this productivity gap?"* and respondents ticked either yes or no. However, if they ticked yes they have to explain how they changed their research strategy.

Research priorities:

In order of importance, respondents were asked to rank from one to five the most important issues upon which they prioritise and choose their research objectives.

Research findings included and used in universities manuals:

In the survey researchers were asked the question *"Have any of your research/experiment/study findings included in universities' curricular teaching/demonstration manuals?"* and respondent ticked either yes, no or do not know. However, if they ticked no they have to specify why by ticking in order of importance the reasons listed. Academic staff were asked the question *"Do you use your research findings in your teaching/demonstration manuals?"* and respondent ticked either yes or no. However, if they ticked no they have to specify why they are not using such findings in their teaching manuals.

However, the variables selected for farmers survey analysis are as follow:

Respondent's age:

Age of respondent at the time of interview, recorded in years.

Respondent's education:

Respondent's education is recorded in the survey as years of schooling.

Farming activities:

Respondents were asked whether or not farming is the only job they do and if not what else they do. Respondents were also asked about the different agricultural operations they perform in each month of the year.

Farm ownership

Respondents were asked whether or not they own their farms and if not to whom they belong.

Farm location

Respondents' farms location is categorised into three locations as near, moderate and far away relative to the main irrigation canal.

Production data:

Respondents were asked about the different crops they grow, yield per unit area and price per unit output. During the survey local area and yield measurements were converted into standard international measurements. Respondents were also asked to identify the different production cost of the different production operations they perform.

Labour input:

Respondent were asked about the number of labour (family members and/or paid workers) they use on each month of the year as well as the wages of each paid workers.

Finance:

Respondents were asked to tick as many as they think apply from the list given with regard to the different sources of finance available to them. They were then specifically asked the question *"Do you have any problem with finance?"* and respondents ticked either yes or no. However, if they ticked yes they have to explain the difficulties they have in financing the different farming activities.

Sources of information:

Specifically in the survey, the question "*From where do you receive information and advice about farming practices?*" was asked to include all sources of information available to farmers in order of importance.

Respondent/extensionists on farm visit:

Respondents were asked whether or not they have been visited by an extensionists in their farms and if yes how regular these visits are.

Facilities provided by extensionists:

In order of importance, respondents were asked to rank from one to seven the facilities they received from the extensionists during their visits to the farms.

Respondent/extensionists off farm meeting places:

Respondents were asked whether or not they have met the extensionists elsewhere outside their farms and if yes where these meetings have taken place.

Implementation of the research findings:

In the survey respondents were asked the question *"Have you implemented all the advice he/she delivered to you?"* and respondents ticked either yes or no. However, if they ticked no they have to specify why by ticking as many as they think apply form the reasons' list provided.

Productivity increase:

In the survey respondents were asked the question "*To what extent did the advice he/she delivered to you resulted in productivity increase?*" and respondents have to specify why if there is productivity decrease as a result of the implementation of the research findings.

Farmers union:

In the survey respondents were asked the question *"Are you member of the Farmers Union?"* and respondents ticked either yes or no. However, if they ticked yes they have to record in order of importance from one to six the facilities provided by the farmers union.

Loss of produce:

In the survey respondents were asked the question *"Have you ever lost your produce?"* and respondents ticked either yes or no. However, if they ticked yes they have to record from the list provided in order of importance the three most important reasons which they think were behind the loss of their produce.

Marketing of produce:

Respondents were asked about how they market their produce.

2.10 Summary

A review of the agricultural research findings in this Chapter clearly shows that agricultural development today requires a research system with internal and external linkages that bring in appropriate technologies; screen, adapt, and produce new technologies and institutions; and perform both on-station and on-farm testing. Several theories and models of agricultural development have been proposed over time. However, technical and institutional changes are key components of an operational agricultural development strategy.

It has been observed that some findings are common in Sub-Sahara Africa, however others are not. Therefore, it is difficult to build a general technology transfer model due to the diverse socio-economic and cultural contexts of African countries. Nevertheless, for any particular country it is worth attempting to build a country-specific technology transfer model, but it may be possible to apply such a model to other African countries.

Building on the literature and the conceptual view of technology transfer illustrated in this Chapter, the transfer of any new advice or technology from NARIs to farmers impacted by several factors include; models of transfer, NARIs linkage policies, principal consideration of farmers in the design of technologies, appropriateness of technology, barriers that impede the transfer, communication, funding, and the timing of the transfer. These "key factors" are the basis for the research questions and the survey design which will be well explained in the next Chapter which will establish the research aim and give a brief discussion of research approach, methods and materials for the study.

Moreover, it also apparent from the literature that a number of important variables need to be investigated in order to understand the determinants of technology transfer. Therefore, this study will attempt to carry out such analysis by considering all these key variables. This will be covered in Chapters 4, 5, 6 and 7 in which a descriptive summary of how the variables mentioned above affect the efficient and effective technology transfer is presented.

CHAPTER THREE

Research Method

CHAPTER –3

RESEARCH METHOD

3.1 Background

There is much evidence from the literature in Chapter Two, that a productivity gap exists between research demonstration farms and real farms in Sudan. Crop productivity is extremely low and does not exceed thirty percent of the level attained in research or demonstration farms (ISNAR, 1994).

However, as clearly stated in Chapter One, the aim of this study is to critically evaluate the implementation capacity constraints which exist in formal agricultural research and the impact this has on the development of the agricultural sector of the Sudanese economy. Therefore, this Chapter will review and justify the approach used to conduct this research.

3.2 Methodological Issues in Rural Surveys

Since most small farmers are illiterate and do not keep farm account books[1], three methods have been used to generate information (Spencer, 1972):

(1) case studies.

(2) infrequent surveys.

(3) cost route or multiple visit surveys.

[1] There have been occasional attempts to use literate children to keep rudimentary records (MacArthur, 1968) but this approach has largely been abandoned in Africa.

Case Study

The case study or model farm approach provides descriptive information on a single farm or a number of farms purposively selected to be representative or to reflect the practice of progressive farmers.

Infrequent Survey

There are numerous terms such as reconnaissance, exploratory, informal, and farm business surveys[2] for what are essentially infrequent visit type of surveys. Infrequent visit surveys entail visiting a farm once or a few times to collect a range of stock (inventory) data and information about current practices.

Cost Route (Multiple Visit) Survey

The cost route derives its name from the repeated nature of the survey over the course of a year in order to derive data to compute costs and returns of production. In the cost route (or multiple visit) approach, farmers are visited regularly by an enumerator over an entire cropping season or full year, generally one to three times weekly and from 50 to 150 times a year. The rationale for using the cost route approach is that it is an effective way to capture flow (input/output) data on the magnitude and variability of labour-the most important input on small farms.

During the 1960s, researchers in East Africa used all these approaches to collect farm-level information (Hall, 1970). Examples include, Clayton, 1963; MacArthur, 1968; Heyer, 1966; Collinson, 1962-64; and Pudsey, 1967.

However, during the late 1960s and early 1970s, the case study approach was largely abandoned by agricultural economists in English-speaking countries and researchers shifted to surveys and random sampling to ensure that input/output data reflected typical farm-level conditions (Eicher and Baker, 1982:73).

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[2] The farm business survey terminology is a western concept which was used in some African countries in the 1960s but the term was subsequently dropped (Eicher and Baker, 1982:72).

Eicher and Baker, 1982:73, argued that the cost route or multiple visit surveys have provided the most reliable data on input flows, particularly labour inputs, but this type of survey is substantially more costly per farm interview than one-shot surveys. As a result, there is a trade-off between sample size and visiting frequency.

However, starting in the late seventies, there was a discernible shift from cost route to infrequent visit surveys. Meanwhile, in presenting results, researchers generally have devoted little space to justifying the approaches they followed in collecting and analysing survey data (Eicher and Baker, 1982:76). But the choice of data collection and analysis procedures may importantly influence survey results. For example, the decision to use open-ended questionnaires as opposed to structured instruments can exert a major influence on the results obtained. However, additional survey design issues which may influence survey results include:

1. Selection of the sampling frame.

2. Procedures used for gaining knowledge of local farming practice in order to design questionnaires.

3. Approaches for securing support and co-operation of interviewees.

4. Choice of direct measurement techniques-primarily for field size, yields, and intensity of labour use-to supplement recall information.

5. Alternative methods for gathering information about sensitive issues such as the size of land holdings or livestock, buildings, and credit.

6. Methods for making field data checks to reduce inconsistency and to verify recorded responses.

3.2.1 Data Processing

Processing of survey data has posed a major problem for researchers throughout Africa (Eicher and Baker, 1982:77).

There has been a tendency to collect a wide range of data, paying little attention to how the data is to be analysed until after data collection is finished (Abalu, 1980). Therefore, several major decisions have to be made at or before the beginning of data cleaning and validation. Often, little attention is given to the following two critical issues:

(1) how to stratify sample households into appropriate groups for subsequent analysis, and

(2) how to convert labour into a homogenous unit in order to make labour record more manageable (Norman, 1972).

Several approaches have been used for stratification.

3.2.2 Adoption and Diffusion Studies

In most diffusion studies, however, farmers are interviewed in one-shot interviews in order to trace the acceptance of a particular innovation (Eicher and Baker, 1982:156). Correlation analysis is usually used to assess the correlation between attributes of individuals such as age and education and the spread of the innovations. Research on the correlation between extension and diffusion of technology was also carried out because it was thought that information on the pattern of diffusion could be of direct help to extension workers in speeding up the adoption of new technology (Eicher and Baker, 1982:156). Researchers have included a wide range of independent variables in adoption and diffusion studies. Gerhart's (1975) study of maize diffusion in Kenya took into account such factors as population density, proximity to a research station, average annual rainfall, education, knowledge and credit, number of extension visits, and farm size and found that agroclimatic zone was the most important variable in explaining adoption.

3.3 Research Questions

Given the nature of the problems discussed in Chapter Two a number of research questions can be immediately identified:

3.3.1 *Is farmers' absorption capacity for technology and agricultural practice changes adequate? Therefore, the research must;*

- Assess the farmers' absorption capacity for technology and agricultural practice changes.

- Identify extension and research strategies associated with the transfer and adoption of the technology.

- Examine the linkage(s) between farmers, NARIs and extension services.

3.3.2 *Is there a divergence between NARIs' goals and orientation? To examine this, there is a need to;*

- Assess NARIs and universities efficiency and effectiveness for technology development.

- Evaluate the role of NARIs and universities in the transfer of technology and linkage(s) with farmers and extension services.

- Examine the linkage(s) between NARIs and universities.

3.3.3 *Does the implementation system fail to recognise the fundamental economic constraints facing traditional farming systems? This requires;*

- Review and analysis of the current role of extension services in transferring technologies from NARIs and universities to farmers.

- Assessing the extension services potentials and limitations.

- Evaluating the extension services linkages with farmers, NARIs and universities.

3.3.4 *Are the above key determinants of the productivity gap? A diagnostic procedure is needed to;*

- Examine the productivity gap between research farms and farmers.

- Examine the relative effects of the implementation system on the adoption of technology and productivity gap.

- Examine the extension services' role in the productivity gap.

These research questions are operationalised into a (*larger*) number of testable hypotheses derived from current theoretical knowledge in this field and the analysis conducted in Chapter Two.

3.4 Questionnaires Design

A series of detailed (*interview-based*) surveys were implemented in order to generate the data required to measure the economic and technical variables associated with the development, transfer and implementation of agricultural technology within the Gezira scheme.

The qualitative data from the different focus group interviews conducted during 1996[3] were used extensively in the design of these surveys. These surveys focused on the technology developers; researchers of ARC and the Gezira University, technology users; different categories of Sudanese farmers from the Gezira scheme as well as the technology transfer agencies and extension services in the Gezira State.

[3] These focused groups organised during the researcher's MSc Dissertation (96-97) entitled: The Impact of In-Country Research Upon Agricultural and Related Economic Development in the Third World - Sudan Case Study.

Farmers

Multiple choice and scale type questions were used in order to identify and assess farmer's experiences, skills, attitudes, and knowledge of the technology. Most of the questions in the survey were in relation to the traditional farming practices and participants in the four blocks[4] were either adopters or non-adopters of the technology provided by the ARC and delivered by the SGB extension services. The whole questionnaire text was translated into Arabic language and was examined for content and face validity by SGB staff.

Researchers

Multiple choice and scale type questions were used in order to identify and assess researchers' experiences, roles, attitudes, and approaches for the development and transfer of the technology. Most of the questions in the survey were in relation to the research efficiency and effectiveness in the development and transfer of technology as well as the linkages with farmers, extension services and universities. However, all participants in the survey were either research scientists or assistant research scientists. The whole questionnaire was examined for content and face validity by ARC senior staff mainly Dafaalla[5] and Ageeb[6].

Academic Staff

Multiple choice and scale type questions were used in order to identify and assess academic staff's experiences, roles, attitudes, and approaches for the development and transfer of the technology as well as their linkages with other participants of the technology transfer process.

Most of the questions in the survey were in relation to the university efficiency and effectiveness in the development and transfer of technology as well as the linkages with farmers, extension services and other research institutions. All participants in the

[4] A block is an administrative region designed by SGB for management purposes.
[5] Professor Babo Dafaalla is the ARC Director for Training and Publishing.
[6] Professor Osman Ageeb is the ARC Ex- Director General and Ex- National Co-ordinator for Wheat Research.

survey were either teaching or teaching assistants staff. The whole questionnaire was examined for content and face validity by Habeeb[7], Abdul Aziz[8] and Mahran[9].

Extension Services

The contents of these interviews were structured in order to identify and assess extensionists' experiences, roles, attitudes, and approaches for the transfer of the technology. Most of the questions were in relation to the extension efficiency and effectiveness in the transfer of technology as well as the linkages with farmers, NARIs and universities'. All participants in the survey were either extensionists or blocks' manager or deputy managers.

3.5 Sampling Structure

Farmers

For the purpose of the study, the Gezira scheme is divided into three geographic groups, south, north and centre. See Figure 3.1 for the Gezira Scheme Map. In this stage the centre group was selected to represent the scheme as a whole and this is attributed to the fact that it has the same average yield (1498 Kilogram/Hectare) as the whole scheme for cotton[10]. See Figure 3.2 for the detailed Map of the Centre Group. The centre group is accessible by roads and has varied socio-economic characteristics and resource endowments. **(1st sampling unit).**

Since the distance of households from a town or from the main roads connecting villages within the blocks or a neighbouring village is considered to be a possible important factor influencing farmers' access to information, inputs and markets (see Chapter 2), it was used as a stratifying criterion to select the different administrative regions (blocks) within the centre region. Thus four blocks were chosen from the centre group, Barakat, Hamad Elnile, Abdel Hakam & Elkomor. **(2nd sampling unit).**

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[7] Professor Habeeb Allah is the Dean, Faculty of Agricultural Sciences, University of Gezira.
[8] Dr. Haj Hamad Abdul Aziz is the Head of Agricultural Economics Section, Faculty of Agricultural Sciences, Gezira University.
[9] Dr. Hatim Mahran is the Dean, Faculty of Economics and Rural Development, Gezira University.
[10] Cotton is the main crop grown in the Gezira Scheme.

Thirty (30) tenants were drawn from each selected block at random. These selected tenants within each block were categorised into three strata, high-, medium- and low. This stratification was based on cotton yield variability from the last season, where those who achieved more than (2043 Kg/Ha) were considered high, (1498–2043 Kg/Ha) were considered medium and less than (1498 Kg/Ha) were considered low. Therefore, the total sampling units is (120) tenants chosen from 4 blocks. **(3rd sampling unit).**

Researchers

The ARC was selected to represent the NARIs as a whole since it is the major research institution in the Sudan responsible for almost all of the agricultural research in the country. **(1st sampling unit).**

The GRS was chosen for the study because its mandate is to initiate, develop and execute research programs in the Gezira environment and to carry out on-farm research on different crops in different locations to verify research findings under farmers conditions. Moreover, according to the new crop oriented research approach adopted by ARC, eight of the (15) research program co-ordinators, more than 40 percent of the total ARC researchers as well as most of the senior scientists, are all based at this station. The Land and Water Research Centre and Crop Protection Research Centre are also based at the Gezira Research Station. **(2nd sampling unit).**

The sampling for GRS included all the research staff (research scientists and assistant research scientists) as per the complete staff list, (123) research staff with different specialisation including research professors, associate professors, research scientists and assistant research scientists. However, out of the total research staff, (13) were on study courses, (1) on thick leave, (3) on leave without pay and (2) seconded to other organisations. **(3rd sampling unit).**

Academic Staff

The Gezira University was selected to represent the academic institutions as a whole and this is mainly attributed to the fact that Gezira University is one of the leading universities in Sudan. Its mandates are mainly for teaching and research.

The principal function is teaching undergraduate and graduate students, in addition to some basic, applied and adaptive research and community services. Its very much oriented towards agricultural and rural developments in the Central State with most concentration on the Gezira area. **(1st sampling unit).**

Within Gezira University, the Faculty of Agricultural Sciences was chosen for the survey as it initiates, develops and executes some research programs on crop production in the Gezira environment and it also carries out on-farm research on different crops in different locations to verify research findings under farmers conditions in collaboration with the Gezira Scheme. The Plant Production and Plant Protection Research Centres, National Institute for Promotion of Horticultural Exports as well as the National Institute for Aromatic and Medicinal Plants Research are also based at the GU. **(2nd sampling unit).**

The sampling unit for Faculty of Agricultural Sciences included all the academic staff (*teaching and teaching assistants*) as per the complete list provided by Habeeb. The list included (56) academic staff with different specialisations; professors, associate professors, lecturers and teaching assistants. However, out of the total academic staff, (11) were on study courses and (2) on maternity leave. **(3rd sampling unit).**

Extension Services

Within the Gezira area, the sampling unit included all the three major extension institutions; ARC/FAO Extension Project (IPM), Extension Services, State Ministry of Agriculture and Animal Wealth and the Extension Services department, Gezira Scheme. Five FFSs were selected from the different groups as well as the four already selected farmers' blocks.

3.6 Data Collection

3.6.1 Secondary Data Collection

Building on research previously undertaken (Ahmed, 1998), a comprehensive review of the literature in Chapter Two focused on the derivation of appropriate testable hypotheses linked to the research questions above.

A number of key databases were used to extract published and comparative data focused on agricultural productivity, agricultural research and extension services.

3.6.2 Primary Data Collection

This is based on field work undertaken in Sudan over a period of two months consisting of participant observation, interviews with farmers, staff in the agricultural research institutions and the academic institutions, visits to the Gezira scheme and other agricultural projects' sites and administration offices and meetings with officials and relevant focus groups. Selected participants from each survey were interviewed for pre-testing of the questionnaire.

During the study, time was allocated from each survey day for checking and clarifying the completed questionnaires, correcting any information or descriptions while they were fresh in the memory as well as gathering all relevant literature. After incorporating corrections, the final version of the questionnaires were produced and data was then gathered from the selected participants as designed. See Appendix-E for the full set of these four questionnaires. See Appendix-G for a selected pictures taken during the Field Survey in Sudan 1999.

Farmers

The Agricultural Extension Section of the Faculty of Agricultural Sciences, University of Gezira was chosen as a meeting point where meetings and discussion sessions were conducted with the six enumerators[11] on the aim and content of the survey questionnaire. Twelve farmers, three from each block were interviewed for pre-testing of the questionnaire where each enumerator interviewed two farmers. However, the final version of the questionnaire was produced in English and then translated into Arabic language and data was then gathered from the selected 120 farmers as designed.

Researchers

Six researchers from different sections were interviewed for pre-testing of the questionnaire. During the survey, all relevant literature form the ARC library and programs leaders was gathered. As designed, (84) questionnaires were successfully completed and successful interviews were conducted with (6) of the eight programmes leaders as well as the heads of units and centres based at the GRS.

Questionnaires were successfully performed with (29) of the staff, (11) were on study courses and (2) on maternity leave. I am expecting (possibly) to receive all or some of the remaining valid questionnaires next month.

Academic Staff

Three academic staff from different sections were interviewed for pre-testing of the questionnaire. During the survey, all relevant literature was gathered from the university library, heads of sections and directors of research centres and institutes. Thirty three questionnaires were successfully completed and successful interviews were conducted with (3) Heads of Sections, the Director of Plant Production Research Centre as well as the Director of the National Institute for Promotion of Horticultural Exports.

[11] Six final year students from the faculties of Economics and Rural Development and Agricultural Sciences were used as enumerators to collect the data from the selected blocks. These enumerators were chosen from the selected blocks so as to give full assurance to the farmers regarding the confidentiality of the information given.

Extension Services

In this particular survey, a participatory approach method was used i.e. instead of filling the questionnaires with field inspectors (*extensionists*), full participation in the actual extension process as well as in selected FFSs was undertaken. Six successful interviews were conducted with the extension manager and/or their field inspectors for each selected group. During the survey, the researcher participated in two FFSs as well as two extension campaigns from their initial start point at Barakat (HQ) to the farmers' fields and finishing at the Gezira Local TV[12].

3.7 Limitations of the Research Method

The sampling unit of the farmers' survey (120) farmers compared with the total number of farmers in the whole Gezira Scheme (114000) would be considered relatively small. In addition to that the data gathered are only for one year, thus making it difficult to generalise the conclusions of the study to Sudan as a whole. As discussed earlier the sheer size of the Gezira Scheme with different agro-climatic zones, time and resources limitations as well as the sensitivity of the data gathered under the current administration security procedures are all behind this small sampling unit. In connection with these difficulties the data regarding labour inputs and costs of production were not possible to acquire. Another limitation of the study is that sampling is based on Cotton yield only while it would be a more representative sample if based on all (or more than one) crops since the farmers' perception of technology might be different. The data gathering period is also considered another limitation as a longer period with the farmers and building trust with them would enable better and more reliable data collection. Furthermore, selecting areas of different distances from information sources would also improve the quality of the data and make it more representative than the study data which is collected from areas which are generally considered nearer to the information and finance sources. For more details of the limits of validity of the research method please see Chapter Eight (8.5 Areas for Further Research).

[12] For a clear presentation of the extension campaign, different documentary picture where taken, a two-hour video film was recorded as well as lots of leaflets and booklets.

3.8 Data Analysis

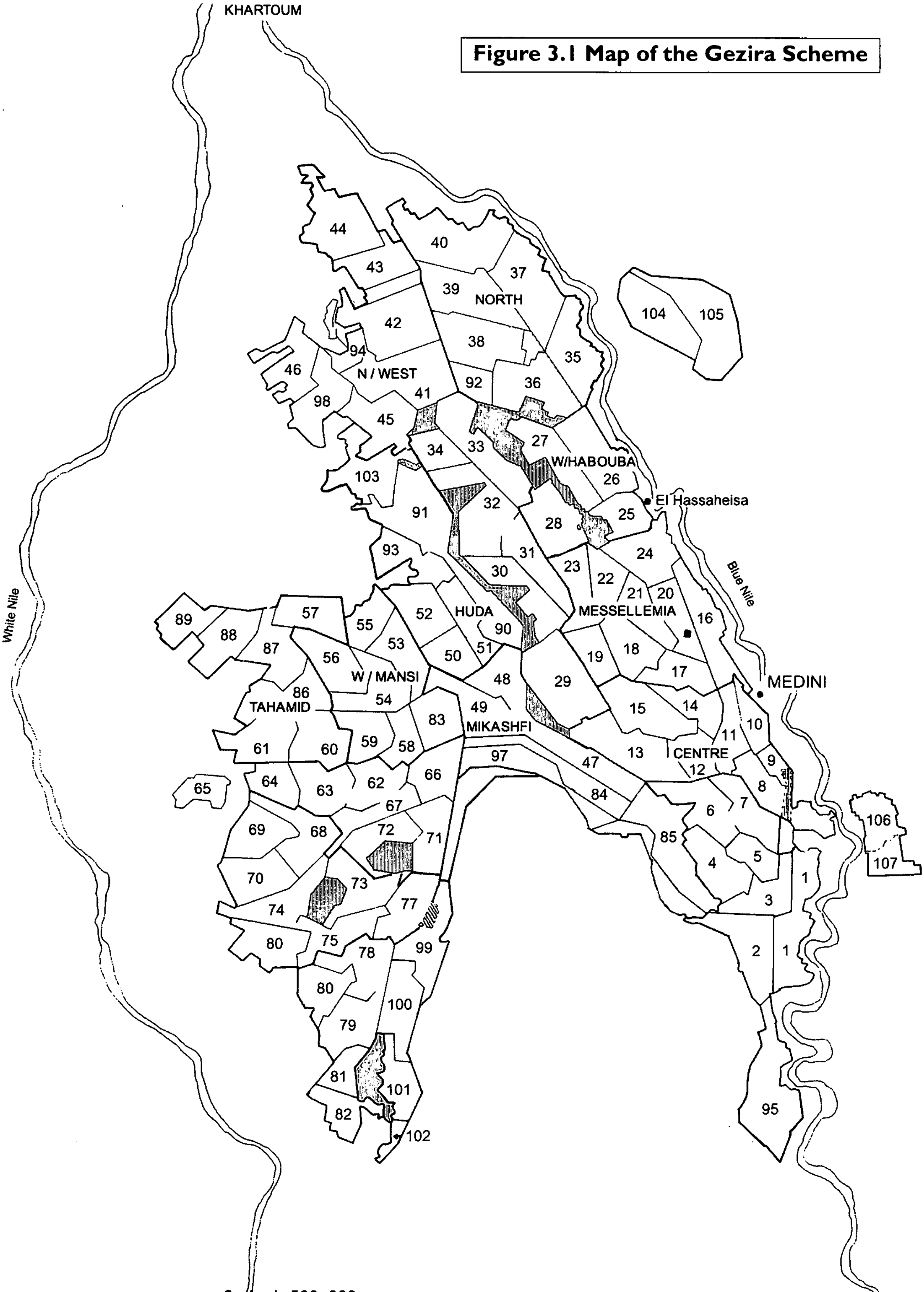
Results of the surveys were transcribed and analysed using the Statistical Package for the Social Sciences (SPSS) (see Appendix-F for the full data sets).

This computer software provided data analysis by utilising an approach similar to factor analysis for organising, and identifying qualitative data by frequencies, means, variables, cross-tabulations, commonality, and other modelling considerations (Bryman, 1997).

3.9 Summary

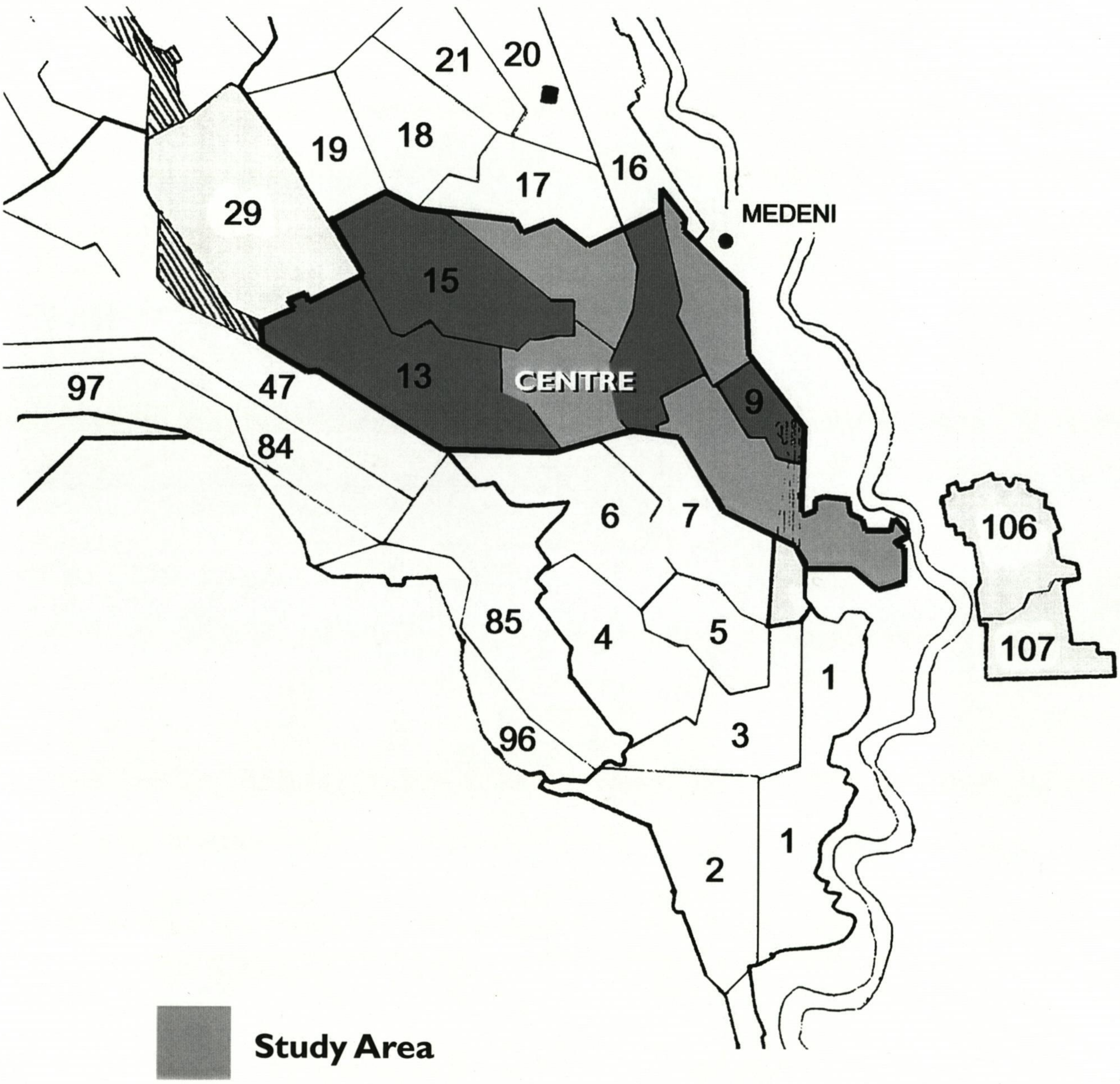
In this chapter the nature of the research method and the specific research questions to be investigated have been outlined. The details of the descriptive statistics are discussed in the next three Chapters (Four, Five and Six).

Figure 3.1 Map of the Gezira Scheme



Scale: 1: 500: 000
Source: Maps and Surveying Unit, ARC, Wad-Medani, 2000.

Figure 3.2 Map of the Gezira Scheme Centre Group



Scale: 1: 500: 000
Source: Maps and Surveying Unit, ARC, Wad-Medani, 2000.

CHAPTER FOUR

Technology Development

CHAPTER–4
THE DEVELOPMENT OF TECHNOLOGY

4.1 Introduction

It can be concluded from the literature that technologies and advice generated by researchers are associated with different factors including the nature of the technology and/or the advice itself as well as the transfer linkages upon which the timely and proper adoption will take place. The literature review also outlined different examples of technologies and/or advice that either did not suit the needs of farmers or that were not available to farmers. The aim of this Chapter is to focus on key aspects concerning the development of appropriate and relevant technologies and advice in Sudan by research and academic institutions as well as the role of these institutions in the proper and timely transfer of these technologies and advice to farmers for their ultimate adoption.

4.2 Efficient and Effective Technology Development

4.2.1 Human Capital

Table 4.1 reveals the ARC and GU staff age structure. Forty percent of ARC researchers are aged between (35-50) years old and (74%) of them are male and (45%) of GU staff are aged between (40-50) years old and (88%) of them are male. Virtually all of the ARC researchers (62)[1] and the GU staff (31)[2] have completed PhD and MSc degrees, (44%) PhD and (56%) MSc for ARC researchers and (52%) PhD and (48%) MSc for the GU staff (Table 4.2).

[1] The remaining (22) are assistant research scientists (ARS).
[2] The remaining (2) are teaching assistants (TA).

Table (4.1) ARC and GU Staff Age Groups and Gender						
	ARC (n=84)			GU (n=33)		
Age Groups	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
(25 – 29)	8	7	**15 18%**	0	1	**1 3%**
(30 – 34)	7	8	**15 18%**	2	1	**3 9%**
(35 – 39)	15	5	**20 24%**	6	0	**6 18%**
(40 – 50)	19	2	**21 25%**	13	2	**15 45%**
Over 50	13	0	**13 15%**	8	0	**8 25%**
Total	**62 74%**	**22 26%**	**84 100%**	**29 88%**	**4 12%**	**33 100%**

Source: Field Survey Data, Appendix-F2 & F3.

However, according to the national research and higher education training strategies all the MSc degrees should be undertaken within Sudan to give young researchers and academic staff deeper insight into the Sudanese traditional farming systems and hence only (26%) of the ARC researchers and (20%) of the GU staff MSc degrees were undertaken abroad. However, the situation for the PhD degree is more complicated as funding for such a degree is not available and national universities are not yet capable of such training, therefore international sponsorships by many international research and academic training institutions mainly in the UK, USA and Germany are the backbone for ARC and GU[3] to get their staff trained to such a level although a few ARC researchers and GU staff are currently undertaking their PhD training within the Sudan[4].

Moreover, some of those who were sent abroad from both ARC and GU have not returned and there is skewed distribution of ARC scientists and GU staff between specialities (see Table 4.2). There is also skewed distribution of ARC researchers between the different research stations as more than (40%) of the total ARC researchers now (1999) work in the GRS as well as most of the senior staff.

[3] During the last two years (1997-1999) GU succeed to secure different training arrangements with the French government.
[4] Five academic staff from GU are currently (1999) completing their PhD training within the Sudan.

Table (4.2) ARC and GU Staff Specialties, Qualifications and Country of Study									
ARC (n=84)									
	Qualifications within Sudan					Qualifications Abroad			
Specialty	**BSc**	**Diploma**	**MSc**	**PhD**	**S/Total**	**MSc**	**PhD**	**S/Total**	**Total (%)**
Soil	0	0	7	3	**10**	2	4	**6**	**19**
Breeding	4	0	3	0	**7**	3	4	**7**	**17**
Entomology	5	1	3	1	**10**	1	3	**4**	**17**
Agronomy	1	0	2	0	**3**	0	5	**5**	**10**
Pathology	3	0	2	0	**5**	0	2	**2**	**8**
Engineering	3	0	0	0	**3**	0	1	**1**	**5**
Weeds	1	0	2	0	**3**	0	0	**0**	**4**
Forestry	0	0	3	0	**3**	0	0	**0**	**4**
Economics	0	0	0	0	**0**	1	1	**2**	**2**
Horticulture	1	0	1	0	**2**	0	0	**0**	**2**
Textile	0	0	1	0	**1**	1	0	**1**	**2**
Technology	1	0	0	0	**1**	0	0	**0**	**1**
Protection	1	0	0	0	**1**	0	0	**0**	**1**
Pesticide	0	0	1	0	**1**	0	0	**0**	**1**
Chemistry	0	1	0	0	**1**	0	0	**0**	**1**
Cotton QC	0	0	1	0	**1**	0	0	**0**	**1**
Tissue	0	0	0	0	**0**	0	1	**1**	**1**
Botany	0	0	0	0	**0**	0	1	**1**	**1**
Genetics	0	0	0	0	**0**	1	0	**1**	**1**
Biochemistry	0	0	0	0	**0**	0	1	**1**	**1**
Total	**20**	**2**	**26**	**4**	**52**	**9**	**23**	**32**	**100**

GU (n=33)								
	Qualifications within Sudan				Qualifications Abroad			
Specialty	**BSc**	**MSc**	**PhD**	**S/Total**	**MSc**	**PhD**	**S/Total**	**Total (%)**
Soil	0	0	0	**0**	1	3	**4**	**12**
Breeding	0	1	0	**1**	0	2	**2**	**9**
Entomology	0	1	0	**1**	0	3	**3**	**12**
Agronomy	0	0	0	**0**	0	2	**2**	**6**
Pathology	0	1	0	**1**	0	0	**0**	**3**
Engineering	0	1	0	**1**	1	0	**1**	**6**
Weeds	0	0	1	**1**	0	0	**0**	**3**
Forestry	0	1	0	**1**	0	0	**0**	**3**
Economics	0	1	0	**1**	0	1	**1**	**6**
Horticulture	0	0	0	**0**	0	1	**1**	**3**
Extension	1	1	0	**2**	0	0	**0**	**6**
Environment	1	0	1	**2**	0	0	**0**	**6**
Animal	0	5	0	**5**	1	1	**2**	**21**
Biometrics	0	0	0	**0**	0	1	**1**	**3**
Total	**2**	**12**	**2**	**16**	**3**	**14**	**17**	**100**

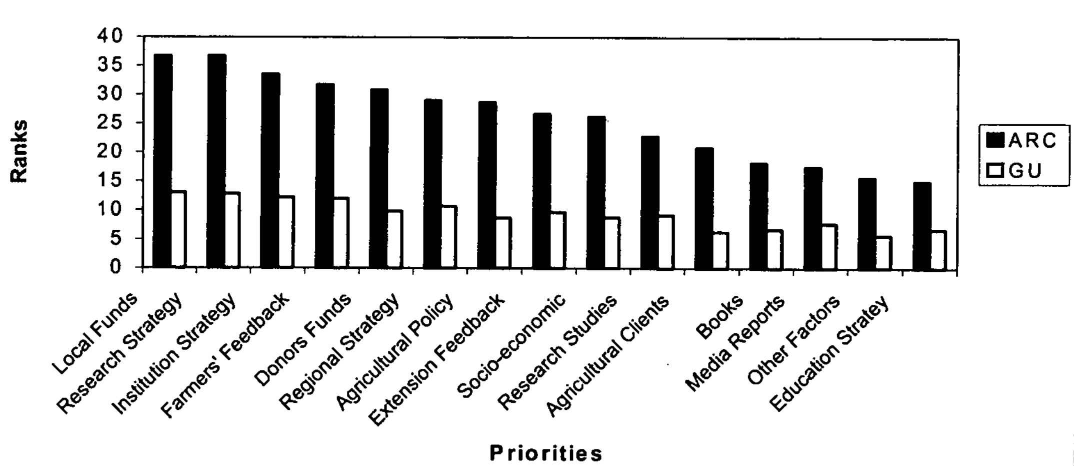
Source: Field Survey Data, Appendix-F2 & F3.

Furthermore, the survey (Table 4.2) also reveals that only two of the (22) ARC assistant research scientists (ARS) have been trained to higher diploma level, the rest have completed their BSc degrees within Sudan and currently most of them are undertaking postgraduate studies, mainly MSc, as part of their research training to become research scientists. However, there are only two teaching assistants at the GU educated to BSc level.

4.2.2 Research Priorities

The research agenda for ARC is, to a large extent, sustainability-oriented and emphasises resource conservation, diversification and socio-economic research. Technologies developed and transferred are assumed to be technically feasible, economically viable, socially acceptable and environmentally favourable (WANA, 1997). In ARC priorities for commodities, agro-ecological zones and research areas are clear. They are ranked and established based on national objectives using sound diagnostic methods of problem identification and assessment. According to its mandate, ARC research plans have clear objectives and target groups, resource needs and performance indicators are defined with full participation of management, researchers and extension workers. However, despite such a mandate the survey (Figure 4.1 and Table 4.3) reveals that farmers' feedback and involvement in research strategies is not a top priority as researchers and academic staff ranked this number four as a priority in setting research targets.

Figure 4.1 ARC/GU Research Priorities



Source: Field Survey Data, Appendix-F2 & F3.

Table (4.3) Ranking[5] Average of ARC and GU Research Priorities		
Research Priorities	**ARC (n=62)**	**GU (n=33)**
Availability of Local Funds	36.7	13
National Research Strategy	36.7	12.8
ARC/GU Research Strategy	33.5	12.2
Farmers' Feedback	31.7	12
Availability of Donors Funds	30.8	9.8
Agricultural Policy Directions	29	8.7
Regional Research Strategy	28.7	10.7
Extensionists' Feedback	26.7	9.7
Socio-economic factors	26.2	8.8
Research Studies Report(s)	22.8	9.2
Other Agricultural Clients	20.8	6.3
Books	18.2	6.7
Media Report(s)	17.5	7.7
Other Factors	15.7	5.7
Higher Education Strategy	15	6.7

Source: Field Survey Data, Appendix-F2 & F3.

[5] Rank scores are generated for all the multi-response questions representing variables selected for investigations. Rank scores are produced by multiplying each response range by its frequency of occurrence. In all the rank score Figures each variable mean is represented by the bold line and its value is indicated on the Y – axis.

This supports the criticism made by Chambers (1993 and 1997) where he strongly argued that researchers need to put farmers first in their research priorities and objectives.

From Figure 4.1 and Table 4.3 above, ARC researchers reported the availability of local funds as the most significant priority in setting research targets. This is closely followed by the national research strategy as well as ARC research strategy. The financial resources for ARC come from four main sources (ARC, 1998);

- Government contribution through the annual budget[6] into Chapter 1 and Chapter 2.

- Loans and donations from bilateral and multilateral donors. For example the ARC received in 1994 a generous support from the Netherlands Government to Wheat and cool season food legumes and (IPM) research, a loan from the World Bank to improve the research and technology transfer in the irrigated sector, and a loan from IFAD to improve the research in the Northern State to contribute to agricultural development.

- Annual contribution from Gezira, Rahad and New Halfa Schemes and annual contribution from Sugar companies to Sugar Cane research.

- Income generating activities and sales of products.

Table (4.4) below shows the actual fiscal budget of ARC and Table (4.5) gives details of how this budget is allocated as a percentage of total expenditure.

[6] Chapter 1 of the ARC budget consists of ARC staff salaries and allowances and Chapter 2 consists of the operations and development budget assist in developing improved technologies for specific development projects.

Table (4.4) Actual Fiscal Budget (LS Million*) of ARC	
Fiscal Year	**Budget**
1997	3370
1996	2090
1994	660
1992	120
1987	20

* 1997 Exchange Rate to £ was 2247 and currently (1999) is 3844.

Source: WANA, 1997.

Table (4.5) ARC Budgetary Allocation as Percentage of Total Expenditure -1997	
Expenditure	**Budget Allocation (%)**
Salaries and Wages	37
Operational Cost	49
Training Cost	4
Capital Investment	0
Maintenance	10

Source: WANA, 1997.

From Table 4.5 above, most of the ARC budget is allocated to operation costs and staff salaries with small percentage allocated for maintenance which has become a serious problem in ARC affecting laboratories, buildings, cars, machinery, equipment, ..etc. Also budget allocated for training is not at all adequate for development targets with no budget allocated for investment.

Furthermore, the survey (Figure 4.1 and Table 4.3) reveals that the availability of donors funds came fifth in the researchers' priority ranking. This is followed by agricultural policy directions and regional research strategy. The survey also reveals that extension services feedback is not considered as an important priority for researchers where almost (60) researchers have reported no priority is given to extension services' feedback which could also be attributed to the fact that (47) of the researchers have reported (*in another question*) having no linkage whatsoever with the extension services. See Figure 4.2 below.

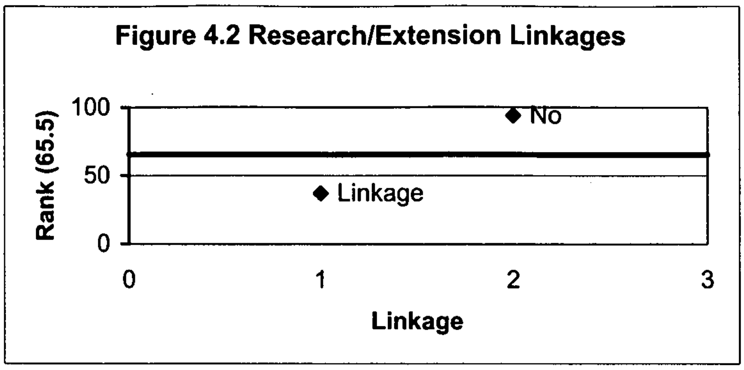


Figure 4.2 Research/Extension Linkages

Source: Field Survey Data, Appendix-F2.

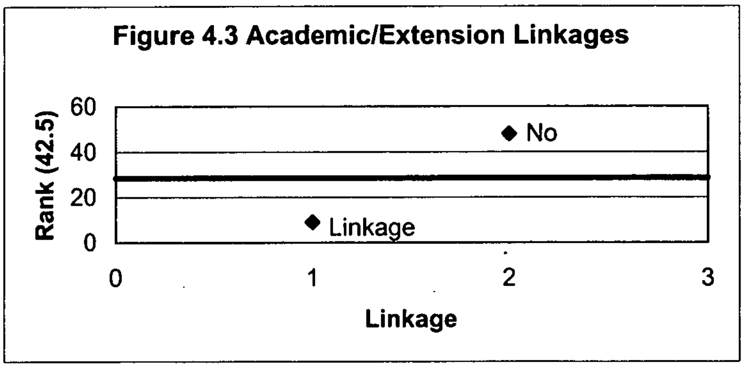
However, other priorities mentioned by a few researchers include; consumer feedback (*horticultural crops researchers*), local, regional and world market demand as well as quality control problems (*ground nuts researchers*); book(s), report(s) on research studies, media report(s), other agricultural clients, socio-economic factors and the national higher education strategy.

The GU staff are largely occupied by teaching (*almost all their time*) and their research and extension services are generally very limited. The research structure of the university is very weak or lacking and accordingly management is weak. This is attributed to unavailability of funds for research and the rapid increase in the number of students[7] entering the university every year.

However, similar to ARC, the survey (Figure 4.1 and Table 4.3) reveals that farmers' feedback and involvement in universities research strategies is not the top priority. The top priority for GU staff is the availability of local funds. Research funds for universities come from the Government, except for very few limited grants that are not sustainable. Lately, research funds have seriously declined to a level that restricted research activities. Research funds for postgraduate studies are insufficient whether they come from the government institutions supporting the students or from the private students who pay their own tuition fees.

This is closely followed by the national research strategy as well as GU research strategy. Within the GU libraries are reasonably updated but there is no documentation centre for agricultural research which could serve as a communication centre to take full advantage of data banks and information. The Gezira University also lack good computer facilities, inadequate laboratory equipment and poor maintenance, insufficient farm machinery and vehicles, lengthy administrative procedures hampering timely availability of supplies and materials, irregular electricity and water supply ...etc. and lack of supplies and other research inputs.

Furthermore, the survey (Figure 4.1 and Table 4.3) reveals that the regional research strategy came fifth in the academic staff research priorities followed by availability of donors funds and extension services' feedback. Again this result could also be attributed to the fact that (73%) of the academic staff have reported (Figure 4.3) having no linkage whatsoever with the extension services.



Source: Field Survey Data, Appendix-F3.

However, other priorities mentioned by the academic staff include; socio-economic factors, book(s), report(s) on research studies, media report(s), other agricultural clients, the national higher education strategy and two academic staff have mentioned the lack of information on specific subject areas as a priority for their research.

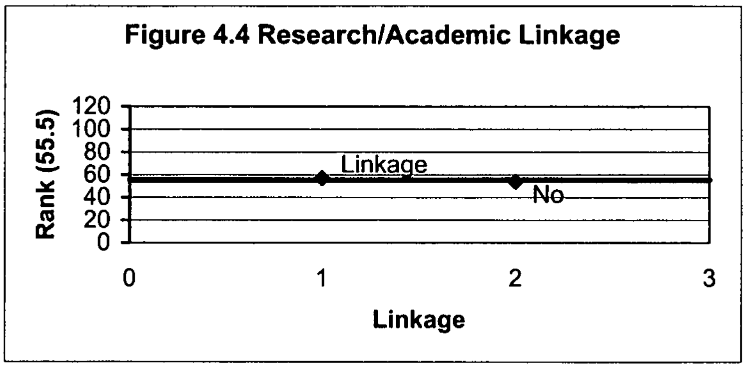
4.3 Research/Academic Institutions Linkages

The policies which guide collaboration between agricultural research and higher education are lacking (WANA, 1997). Despite this, the survey reveals that informal linkages do exist between ARC and nearby universities, mainly Gezira University.

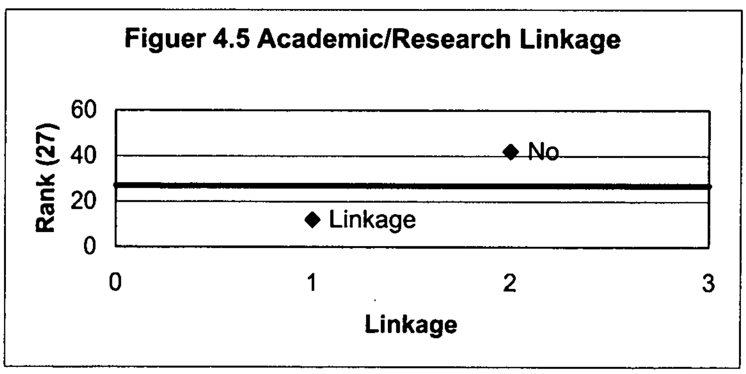
[7] According to Dr. Mahran (Dean Faculty of Economics & Rural Development), the number of undergraduate students at his faculty have increased from (300) in early nineties to (3000) students last year using the same limited facilities and severe staff shortage.

Formal joint research programs and scientific activities, co-operation to avoid duplication in the basic research preceding the applied research, contractual research, networking and sharing of information are generally limited in magnitude or lacking. Most of the universities have seconded and absorbed scientists from ARC, but no reciprocal arrangements for exchange are effected. Facilities and/or equipment of the research institutions are to a large extent used by post-graduate students where the research is jointly supervised.

The survey (Figure 4.4 and Figure 4.5) reveals that (68%) of the ARC researchers have good but informal linkages with universities and that (36%) of GU staff have similar informal good linkages with ARC.



Source: Field Survey Data, Appendix-F2.



Source: Field Survey Data, Appendix-F3.

And although almost all the academic staff (96%) are using their research findings in their teaching and/or demonstration manuals, almost half of the ARC researchers (51%) reported that some or all of their research findings are included in universities curricular teaching/demonstration manuals, (24%) did not know whether their research findings are included or not and the remaining (25%) reported that none of their findings were included in any university's curricular teaching/demonstration manuals.

Table 4.6 reveals the reasons stated by ARC researchers (15) with regard to why their research findings are not being endorsed by the universities.

Table (4.6) Reasons for ARC Findings not Included in Teaching Manuals

Reasons (n=15)	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**
Out of date teaching manuals	3	1	0	1	0	0
Ineffective linkage with universities	2	1	1	1	0	0
Other reasons	3	0	0	0	0	0
Theoretically oriented universities	1	3	0	0	0	0
Universities don't believe on them	1	0	0	0	0	1
Inappropriate for teaching purposes	0	0	2	0	0	0
Rejected by universities	0	0	0	0	1	0

Source: Field Survey Data, Appendix-F2.

Again the lack of effective linkages between research institutions and universities is one of the reasons mentioned by researchers as (13%) ranked this 1st and (6%) ranked it 2nd, 3rd and 4th, few researchers (6%) said that universities did not consider the research institutions' findings and depended mainly on their own research findings and that universities tended to concentrate on other countries' research work rather than that being carried out in the Sudan, however, (20%) criticised universities as being inefficient in updating their curricular teaching manuals (ranked 1st) and (6%) ranked 2nd and 4th.

Universities are also criticised by some researchers as being only theoretically oriented towards rural development where (20%) ranked this 2nd and (6%) ranked 1st.

4.4 Research Strategy

However, despite the productivity difference 71% of the ARC researchers and 70% of GU staff have not changed their research strategy to close the gap (Table 4.7) as they reported that most of the reasons behind this gap are far beyond their control.

Table (4.7) Research Strategy Changes as a Result of the Productivity Gap

Strategy Changes	**ARC (n=56)**	**GU (n=33)**
No	71%	70%
Yes	29%	30%

Source: Field Survey Data, Appendix-F2 & F3.

Some ARC researchers argued that the research strategies are based on a specified mandate and are not set by researchers and they are institutional and that the productivity gap existed even before setting the strategy. Accessibility to some areas, especially in the Southern part of Sudan (*forestry research*) is not possible due to the war and this therefore hinders data collection from these areas.

However, the remaining (29%) of ARC researchers and (30%) of GU staff have either changed their research strategy or are undergoing change. Different examples were given by ARC researchers and GU staff with regard to how they have changed their research strategies;

- some researchers said that their experiments are currently mostly towards improvement of the farmers produce and usually on-farms trials.

- more on-farm research and demonstration plots are being carried out.

- more emphasis on socio-economic studies and more research is geared towards policy analysis as well as work on the adoption rates and impact analysis.

- improving the physical properties of the soils in order to improve the water-soil relation.

- using PTD to determine farmers problems and how to solve them.

- modifying research objectives to suit and fit with the prevailing conditions.

- transfer of technologies to farmers has become one of the most important activities of the researchers and is done through on-farm research (adaptive research and demonstration plots) and farmers field schools.

- conducting more applied research in which all the factors hindering farmers from the adoption of these findings can be considered.

- improved linkage with farmers.

- re-evaluating the recommended agronomic practices that might lead to better pest control and economical value using the IPM participatory approach, higher productivity through decreasing the cost of production by decreasing the number of pesticide applications per season so as to conserve natural enemies and also more emphasis on clean produce, thus, studies in economic threshold levels of insects are being promoted.

- improving storage facilities to bridge the productivity gap resulting from climatic variability.

- giving priority to research work in improving traditional techniques for increasing productivity/ unit land.

- concentrating on developing genetic material for low input environments and the adoption of organic practices to utilise organic fertilisers.

The survey also reveals that extension services feedback and reports are not included in ARC and GU research strategy as some ARC researchers and GU staff admit the very poor linkages between extension services and ARC and GU although there is participation in seminars, workshops and meetings. These poor linkages result in extensionists not being much involved in ARC and GU research strategies. In addition to that ARC and GU follow their own research strategy and sometimes reject the extensionists feedback for unexplainable reasons.

4.5 Problems and Constraints

There are serious problems in technology development, assessment and transfer system that impinge on the dissemination and adoption of technologies in Sudan. All research linkages are very poor and all research facilities are moderate, but heavily utilised. Inadequate national funding to operate the public agricultural research and academic institutions is a critical constraint. In Figure 4.6, Ageeb (1999) outlines the different steps of the on-farm trials and in Figure 4.7 illustrates the agricultural research systems and linkages.

Efficiency and effectiveness have suffered as a result, and institutional sustainability has become doubtful. Moreover, the influence of the government on technology transfer is evident in this research. The government is interested solely in increasing the production of exportable cash crops, mainly cotton and hence the political agenda largely ignores the needs of the small-scale farmers. To make best use of available resources, program design must give primary consideration to the needs of research users.

In addition to the funding problem, research (particularly universities) is also hampered by poor libraries (*some are reasonable*), absence of a documentation centre, poor computer facilities, inadequate laboratory equipment and very poor maintenance, insufficient farm machinery and vehicles, poor maintenance of research facilities, lengthy administrative procedures hampering the timely availability of supplies and materials, irregular electricity and water supply and the lack of supplies and other research inputs.

Figure 4.6 On Farm Trials

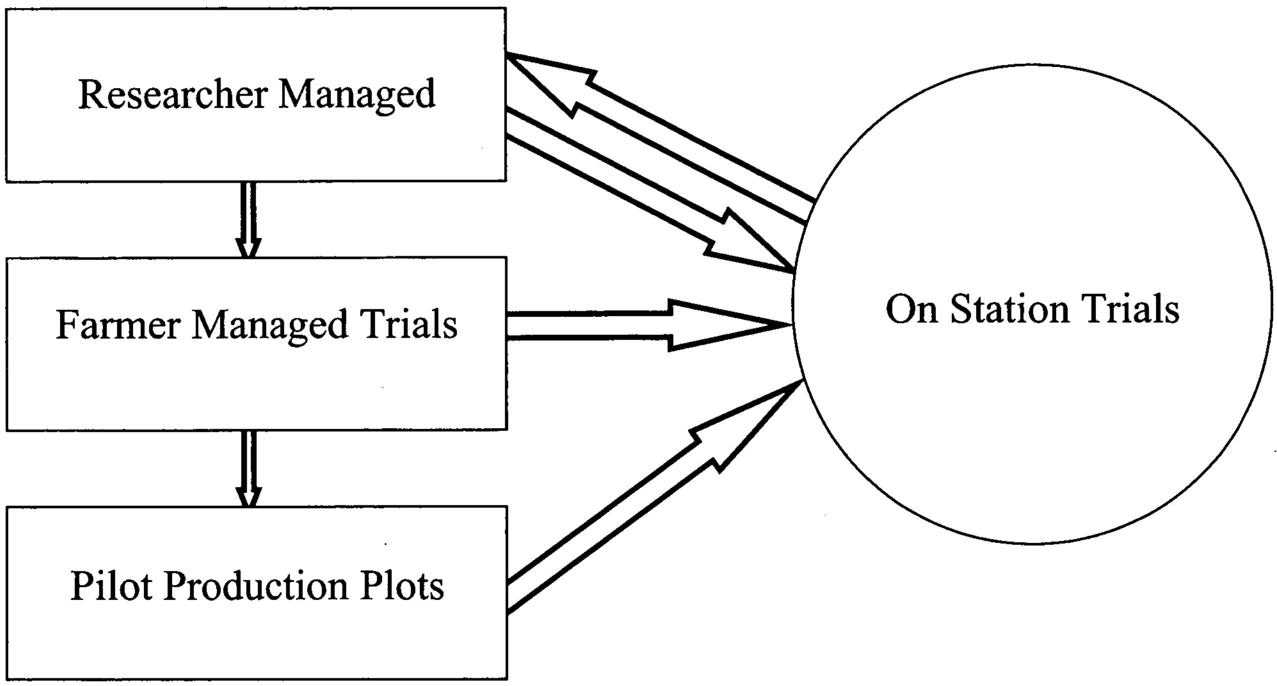
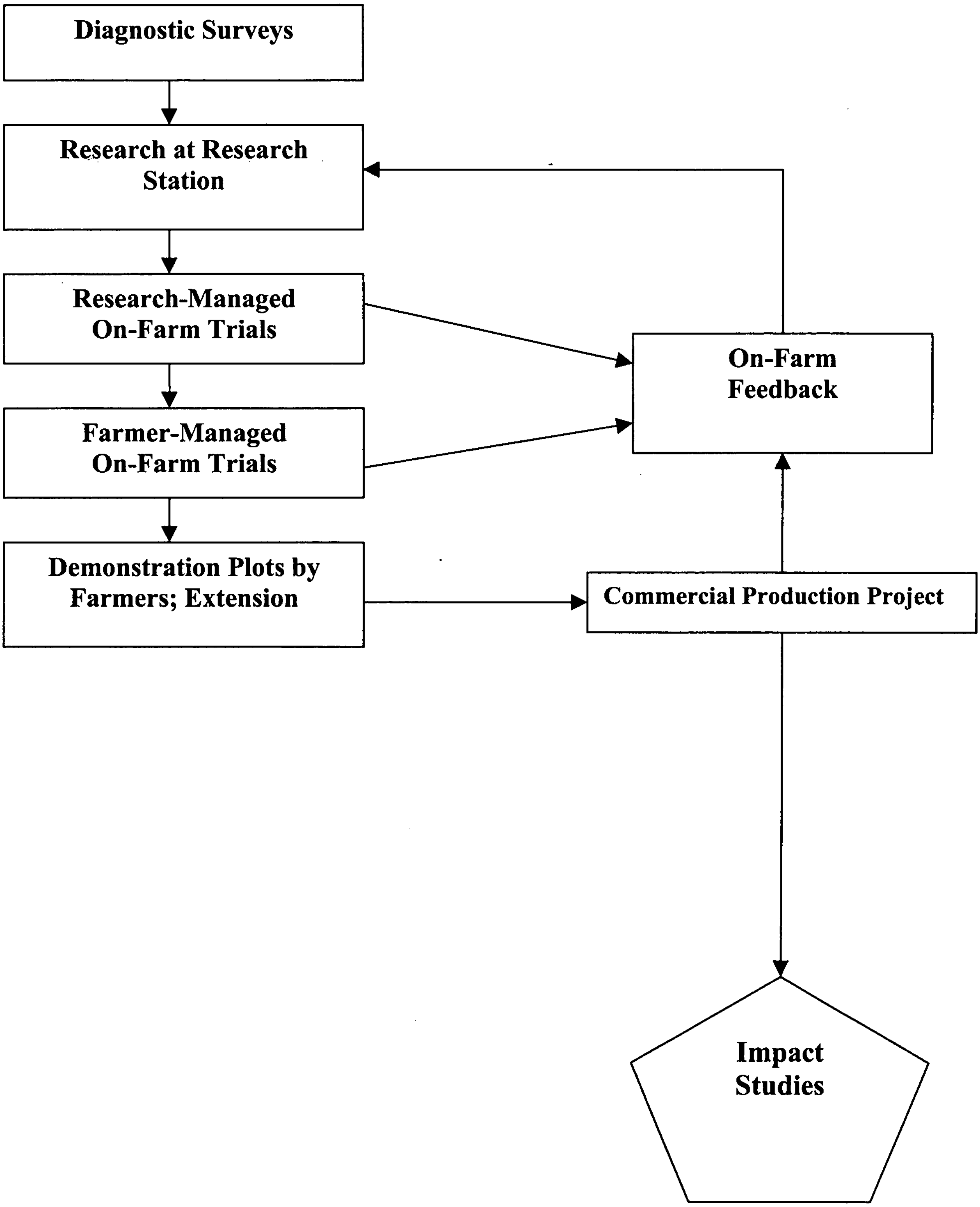


Figure 4.7 Agricultural Research Systems and Linkages



National universities in general, including GU, are not considered as integral elements of NARIs. And although GU represents one of the largest concentrations of highly trained scientists capable of conducting research on topics of national importance, they are under-utilised for agricultural research and they are largely occupied by teaching (*almost 90% of their time*).

However, research policies in the university are generally incoherent and research objectives and projects are largely derived and chosen on a personal interest basis and rarely reflect the priority needs of agricultural sector objectives and national development and society goals. Generally, the research structure of the university is very weak. The bulk of research conducted so far by the university has been linked to the graduate studies programs in partial fulfilment of the MSc and Ph.D. degrees.

4.6 Summary

This Chapter outlines different issues associated with the productivity gap with regard to the nature of the technologies and advice developed by research and academic institutions in Sudan. It also illustrates the weak linkages between these institutions and farmers and extension services as one of the critical factors that have hindered the effectiveness of agricultural research in Sudan. However the process of technology transfer will not be considered successful unless these technologies reach the final user (*farmer*), are accepted and adopted. The factors influencing the farmers' adoption decision of any new technology and/or advice are explored in the next Chapter.

CHAPTER FIVE

Technology Adoption

CHAPTER-5

THE ADOPTION OF TECHNOLOGY

5.1 Introduction

In Chapter 4, a number of factors impacted on the development of appropriate and relevant technologies and advice by NARIs researchers as well as the proper research linkages were identified. The aim of this Chapter is to focus on all the different factors which influence the farmers' adoption of any new technology and/or advice that properly and timely reached the farmers.

5.2 Farmers' Absorption Capacity for Technology and Advice

The survey reveals that farmers' ages range from (25-62) years with (35%) aged above (50) years old. Most of the farmers are male (95%) and almost (35%) have completed high school[1], (30%) have completed primary school, (7%) have some post secondary education including university level while the remainder have never been to school and cannot read or write.

Moreover, the survey also reveals that achieving any level of education particularly higher levels within the farmers' community has encouraged them to leave farming to find another job in the nearby town or city.

Thirty four percent of the farmers are performing other jobs in addition to farming to earn extra income. Additional jobs include: local village traders or businesses, local school teachers, employee, working in the nearest big towns as well as doing some casual jobs in their villages[2].

[1] In the past high school in Sudan refereed to intermediate and secondary school while today there are only secondary schools and their graduates can read and write perfectly.

[2] For most farmers farming is just a tradition they inherited and they cannot think of themselves doing anything else.

Almost (85%) of the farmers surveyed tenanted their farms and for the rest (15%) the farms either belong to other family member or a close relative and there is only one partnership arrangement[3] where the farm does not belong to the farmer interviewed. Furthermore, (41%) of the farms are located near the irrigation canal, (35%) moderately located and (23%) located far away from the canal. Nearest farms are most likely to be visited by extensionists, researchers and other officials as well as receiving enough irrigation water and according to SGB regulations nearest farms should be cultivated with vegetables[4] which farmers prefer for their quick and direct return.

The survey also reveals that finance is the major constraint facing farming in Sudan where the majority of the farmers (88%) have serious problem(s) with finance[5] and for the remaining (12%), for whom finance is not a problem, they either have their own businesses (trade) or receive substantial support from other family member(s) or relative(s) working abroad (mainly in the Middle East).

As mentioned in Chapter 1, the farmers' accounts system in the Gezira Scheme started as a joint accounts system which was then abolished and replaced by the individual account system in June 1980. The individual account is aimed at motivating tenants to increase crop production where they would be responsible for all costs as well as pay certain land and water charges to the government. Different components were included in these charges including irrigation costs, administration costs, depreciation and interest on capital. The charges were made according to the number of irrigation intakes for each crop in the agricultural rotation. Moreover, the land and water charges as well as Cotton and Wheat prices were fixed by a technical committee set up by the Minister of Agriculture and the Ministry of Finance, SGB, Rahad Scheme and ARC are all represented in this committee.

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[3] Partnership arrangement is a common subletting contract (mostly verbal) takes place between the farm owner and a third party where the third party will cultivate the land and pay all the farming costs and then pay the owner an agreed share from the produce or simply agree on certain rent to be paid at the harvesting period.

[4] As vegetables need adequate irrigation water at regular intervals, therefore, they should be grown in the farms near to the main irrigation canals to avoid any water shortages. Farmers normally prefer vegetables over other crops (like Cotton) as they are allowed to sell them directly in the market and under their full control unlike the case of Cotton where the government collects the crop immediately after harvesting and sells through certain official channels.

[5] According to most of the farmers surveyed, the financial problems are mostly created by the SGB.

The net profit would thus go to the tenant after the deduction of all individual costs and accountability would be in accordance with the purchasing system proclaimed by the State. Table 5.1 below shows all costs of production for a typical tenant farmer in the Gezira Scheme.

(Table 5.1) A Typical Farmer's Production Cost (Ls/Fed*) in the SGB 1995/1996

Components	**Cotton**	**Wheat**	**Sorghum**	**Groundnuts**
Land Preparation	8.590	7.528	4.300	4.200
Cultural Operations	20.610	6.555	10.510	13.100
Harvesting	21.477	12.914	10.785	21.463
Material Inputs	112.088	56.437	14.860	17.070
Services	1.150	-	-	-
Land and Water Charges	11.900	-	-	-
Transport	7.924	2.468	-	3.135
Other Expenses	-	650	-	-
Total Cost	183.739	86.552	40.455	58.968

* Current (1999) Exchange Rate to £ is 3844.

Source: PSERU, 1997.

The most evident disadvantage of this system is that the farmer would bear any risk that might inflict his/her crops due to reasons beyond human control, such as unfavourable weather conditions. However despite this the advantages of the individual account are;

- Tenants' rights are secured and preserved.
- Tenants are well acquainted that high yields would dependent on their individual efforts.
- Tenants can evaluate which crops are more profitable than others.
- Farmers have become land owners instead of government labourers which encouraged more production.

- To reduce crop deterioration.

- To subsidise Government revenues from water and land charges.

Moreover, the survey reveals the following problems in relation to finance include;

- SGB delays previous payments which results in deficit in the next season and usually these payments are not made at the time needed.

- Low profitability of the different crops grown. For the farmer's net returns from the different crops produced see Table 5.2 and Table 5.3.

- High taxes.

- Water charges.

- SGB normally provides fertilisers with prices above the market prices or does not provide fertilisers and in this case farmers have to pay the black market price.

- Hybrid seeds are very expensive and not included in the credit package provided by SGB.

- Low productivity in the previous season(s).

- Banks and village traders refuse to provide farmers with loans[6] which result in financial difficulties for farmers.

[6] Due to the very difficult economic situation of the country and the very high inflation rate, businesses including Banks have become very sensitive to the daily speculations about prices change and uncertainty particularly farm products. Furthermore, Banks are no longer confident of farmers returns as the government pays farmers only after a long period of time.

(Table 5.2) Net Returns to Farmers (Ls/Fed*) in the SGB 1984-1996				
Season	**Cotton**	**Wheat**	**Groundnuts**	**Sorghum**
1984/85	258.10	-	137.89	358.35
1985/86	0.01	30.13	414.80	101.02
1986/87	375.70	133.93	330.11	5.37
1987/88	334.28	201.26	289.98	254.64
1988/89	1.299.58	790.09	131.45	152.80
1989/90	746.91	903.08	1.278.99	737.36
1990/91	285.58	861.67	5.642.36	4.081.48
1991/92	3147.18	3.164.00	7.895.29	2.330.00
1992/93	1.105.80	1.872.00	4.688.60	941.00
1993/94	16.478.94	5.580	16.983.00	11.844.00
1994/95	57.033	10.433	42.335	16.839
1995/96	162.315	82.628	34.997	38.595

* Current (1999) Exchange Rate to £ is 3844.

Source: PSERU, 1997.

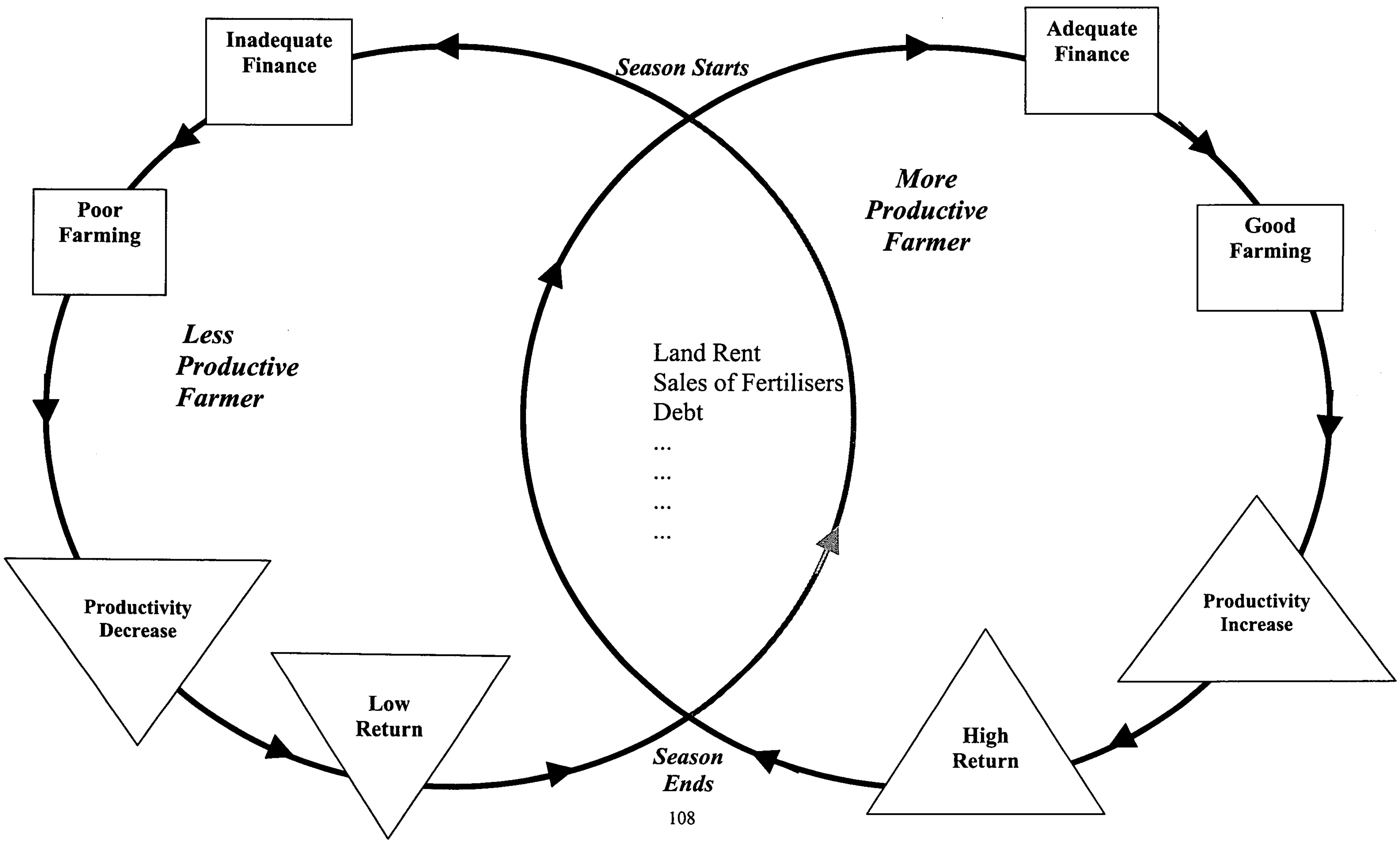
(Table 5.3) Overall Farmer Crops Returns (Ls*/12,6 Ha) in the SGB 1995-1996		
Crops	**Production Cost**	**Net Returns**
Cotton	1.837.739	1.623.150
Wheat	865.520	826.280
Sorghum	404.550	349.970
Groundnuts	589.680	385.950

* Current (1999) Exchange Rate to £ is 3844.

Source: Adopted from Yousif, 1997.

The impact of finance and funding availability on farmers' productivity is clearly illustrated in Figure 5.1 (Adopted from El Siddig, 1997), where farmers with inadequate funding enforced to either rent part of their land or sell part of their fertilisers to other farmers who can afford the cost of farming obtained from other sources.

Figure 5.1 The Impact of Finance and Funding Availability on Farmers' Productivity



From Table 5.4, the majority of the farmers surveyed (76%) depend mainly on their own personal financing since they receive no support from SGB for their Sorghum, Groundnuts, Vegetables and other crops. According to most of the farmers interviewed, very little financial support is provided by SGB for the Cotton and Wheat crops.

(Table 5.4) Finance Sources Available to Farmers	
Source of Finance	**Percentage (%)**
Personal financing	76
Bank loan	27
Other loan	21
Other source	30

Source: Field Survey Data, Appendix-F1.

Therefore, farmers have to find other sources of finance; (30%) are either in partnership arrangements for their Groundnuts and Sorghum, or sell some household items, animals and even sell part of their fertilisers supplied by SGB to finance important timely operations such as cultivation of Cotton. Moreover, (27%) of the farmers receive Bank loans as a source of finance and (21%) receive loan(s) from merchants, friends or relatives.

5.3 Linkages with the Research Institutions

The survey (Table 5.5) reveals that (23%) of the researchers never visit any farmer's field although some have argued this is due to working all day in their laboratory and the nature of their work does not require them to visit the farmers. However, the frequency of the visits in question varied from every week (13%) particularly during the rainy season (*according to a few researchers*), every month (13%), every three months (7%), every six months (7%) to every year (16%). Some researchers (21%) agreed that their visits to the farmers' fields are always associated with either an official tour, before any major cultural operation, when an unexpected disease appeared in any crop(s), the application of fertilisers or during the harvesting period.

(Table 5.5) Researchers/Farmers On-Farm Visits	
Time	**Percentage (%)**
Never	23
Other	21
Every year	16
Every week	13
Every month	13
Every 3 months	7
Every 6 months	7

Source: Field Survey Data, Appendix-F2.

A few ARS stated that they visited the farmers just to collect their MSc research data which depended largely on the presence of farmers on their fields. Some researchers, mainly soil scientists, reported visiting farmers just for sampling purposes for their soil survey field work, others to collect germplasms, one researcher said that he only visited the farmers when he needed to clarify some technical issues and some researchers said they only visited the farmers' fields when they are requested to do so by farmers.

According to a number of research scientists, in the mid eighties until 1996 researchers used to visit farmers' fields every week and there were some programs in which transfer of technology was a major component but they all terminated due to the lack of finance.

During these visits (Table 5.6), technical advice is considered the most important facility provided by researchers however no significant advice is delivered to the farmers with regard to the purchasing of input materials. Other facilities provided by researchers during their visits include; showing farmers how important the genetic diversity of their traditional cultivars is as well as inviting them to the experimental research fields.

(Table 5.6) Facilities Provided by Researchers at On-Farm Visits							
Type of Facilities	**First (%)**	**Second (%)**	**Third (%)**	**Fourth (%)**	**Fifth (%)**	**Sixth (%)**	**Seventh (%)**
Technical advice	61	9	7	9	0	1	1
Listening	16	44	20	3	0	1	0
Demonstration	10	12	13	21	4	3	0
Feedback	6	16	33	18	6	1	0
Inputs materials	1	1	1	4	15	7	1
Credit	0	6	1	1	7	16	3
Other facilities	1	1	0	0	3	1	9

Source: Field Survey Data, Appendix-F2.

The survey also reveals that the majority of the researchers (85%) have met the farmers away from their fields (Table 5.7).

(Table 5.7) Off-Farm Researchers/Farmers Meeting Places	
Meeting Places	**Percentage (%)**
Researchers offices	60
Researchers demonstration farms	45
Education sessions	38
Farmers union hall	15
Other place	15

Source: Field Survey Data, Appendix-F2.

Sixty percent of the researchers used to meet the farmers in their offices and some farmers did come to researchers' offices seeking help. This is followed by meetings on the research demonstration farm where (45%) mentioned bringing farmers to their demonstration farms.

However, education sessions organised by the extension services or others are also reported by (38%) of the researchers as a place for meeting farmers as well as the farmers union hall where (15%) mentioned this. Other meeting places include; meeting farmers' leaders during cotton cultivars committees, in the ARC conference hall during training programs organised by ARC, farmers field schools, SGB tours and meetings and sometimes in the market.

Table 5.8 reveals that not all farmers to whom technologies and advice are transferred have adopted them.

(Table 5.8) Research Findings Adopted by Farmers	
Adoption	**Percentage (%)**
Yes	45
No	35
Don't know	20

Source: Field Survey Data, Appendix-F1.

However, according to researchers (Table 5.8) farmers have rejected these technologies and advice for different reasons include;

- Many farmers found these technologies expensive to adopt and they have no source of funds to adopt them even if they are not expensive in the first place.

- Others found them of no significant returns compared to their traditional practices.

- Problems with irrigation water make it impossible for farmers to adhere to the recommended packages.

- Priorities are always given to Cotton rather than other crops.

- Farmers' personal social beliefs.

- Lack of effective linkage between research institutions and extension services.

- Lack of frequent meetings between researchers and farmers.

- Farmers poor farming experience.

(Table 5.9) Reasons for Research Findings not Adopted by Farmers

Reasons	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**
Farmers rejected the advice for other reasons	5	2	0	0	0	0
Ineffective linkage between researchers and farmers	2	1	1	0	1	0
Extension services make alterations on the advice provided by the research	0	1	0	1	0	0
Extension services transferred only the advice which they think more relevant and appropriate to farmers	0	0	1	0	0	0
Advice is too scientific for farmers to absorb	0	0	0	0	0	1

Source: Field Survey Data, Appendix-F1.

Moreover, according to nine researchers (Table 5.10) where their findings are adopted by farmers, (4) farmers have achieved a productivity increase[7] of more than 50 percent, (3) and (1) achieved a productivity increase of more than 30 percent and 20 percent respectively and the remaining farmer achieved no increase[8].

(Table 5.10) Productivity Increase Achieved by Farmers	
Productivity Increase	**Number**
Increase of more than 50%	4
Increase of more than 30%	3
Increase of more than 20%	1
No increase	1

Source: Field Survey Data, Appendix-F1.

5.4 Linkages with the Academic Institutions

The survey (Table 5.11) reveals that (33%) of the academic staff never visit any farmer's field although most of them have explained this by being fully involved in teaching.

(Table 5.11) Academic Staff/Farmers On-Farm Visits	
Time	**Percentage (%)**
Never	33
Other	18
Weekly	15
Every month	12
Every 3 months	12
Every year	6
Every 6 months	3

Source: Field Survey Data, Appendix-F3.

[7] Productivity increases measured in terms of output per farm, for example, kg/ha, ton/ha, ..etc or quality improvement as is the case for some research programs (e.g. pathological research).
[8] No clear explanation is given by researchers for such a result.

However, the frequency of the visits in question varied from every week (15%), every month (12%), every three months (12%), every six months (3%) to every year (6%). Some staff (18%) stated that their visits to the farmers' fields are not on a regular basis and only happen during field trips and students tours, during university field days (*every six months*) or when asked by farmers (*e.g. poultry producers may want to know how to solve a certain problem*).

And as in the case of the researchers, during these visits to farmers, technical advice is considered the most important facility provided by academic staff (Table 5.12).

(Table 5.12) Facilities Provided by Academic Staff

Type of Facilities	First (%)	Second (%)	Third (%)	Fourth (%)	Fifth (%)	Sixth (%)	Seventh (%)
Technical advice	45	4	18	4	0	0	0
Listening	27	36	9	4	0	4	0
Feedback	13	18	4	18	0	4	0
Demonstration	9	18	27	0	0	0	0
Input materials	0	0	0	4	13	0	4
Credit facilities	0	0	0	4	4	4	0
Other facilities	4	0	9	0	0	0	0

Source: Field Survey Data, Appendix-F3.

There is no significant advice delivered to the farmers with regard to the purchasing of input materials where (13%) rank this 5th and only (4%) have ranked credit/ financial facilities 4th, 5th and 6th. Other facilities provided by staff during their visits include; enabling students to ask and to get all information they need from farmers, detecting population level of pests under study as well as to collect pests and the collection of some questionnaires.

The survey reveals that the majority of the academic staff (88%) have met the farmers away from their fields (Table 5.13).

(Table 5.13) Academic Staff/Farmers Off-Farm Meeting Places	
Meeting Places	**Percentage (%)**
Academic staff demonstration farms	59
Education sessions	59
Academic staff offices	34
Other place	24
Farmers Union hall	17

Source: Field Survey Data, Appendix-F3.

This is also the case for researchers. Fifty nine percent of the academic staff used to meet the farmers in their demonstration farms as well as within the different educational sessions. This is followed by meeting the farmers in their offices (34%), (24%) in other places; the market, villages and farmers residential areas, the Ministry of Agriculture meeting hall as well as the farmers union hall.

Furthermore, the survey (Table 5.14) reveals that only two academic staff (6%) have reported the adoption of their technologies and advice by farmers.

(Table 5.14) Research Findings Adopted by Farmers	
Adoption	**Percentage (%)**
Don't know	52
No	42
Yes	6

Source: Field Survey Data, Appendix-F3.

5.5 Effects of the Implementation System on Technology Adoption

The survey (Table 5.15) reveals that more than (91%) of the farmers have lost their produce during the last period for a variety of reasons.

(Table 5.15) Loss of Produce

Reasons	First (%)	Second (%)	Third (%)	Fourth (%)
Diseases	24.5	16.4	7.3	0
Bad management	27.3	7.3	7.3	0
Theft	0	0.9	0	0
Inputs shortage	0.9	0.9	1.8	0
Performance	5.5	11.8	4.5	0.9
Inferior seeds	6.4	4.5	3.6	0
Other reasons	36.4	21.8	6.4	0

Source: Field Survey Data, Appendix-F1.

Disease is one of the most important factors where the farmers ranked this 1st (24%), 2nd (16%) and 3rd (7%). Different causes are mentioned;

- Inefficient pesticide delivered by SGB for different crops.
- Bad pesticide recommended for cotton[9].
- Weeds (e.g. Adar, Puda, ..etc.) destroyed the Wheat and Sorghum.
- Unavailability of the pesticides recommended in some cases.

However, the absence of the entomologists and/or extensionists made the situation more severe and consequently resulted in crop (s) failure.

Bad management is also considered by many farmers as a major factor in loss of produce, (27%) ranked this 1st and (14%) ranked it 2nd and 3rd. However, other

[9] No compensation is given by the SGB in such incidence.

important factors mentioned by many farmers (36%) ranked 1st, (21%) ranked 2nd and (6%) ranked 3rd include; some irrigation canals are not fully opened, full of weeds and not completed to the end of the block which results in water shortage or uneven distribution of water and flooding mostly during the raining season. Farmers claim that they have been complaining about this problem for years but nothing is corrected. According to some farmers, the nearest farms normally receive about twenty irrigation units, three for the moderately located and just one for the farms located further away.

However, a few farmers lost their produce due to poor fertility and others lost produce because of animal invasion of their farms despite SGB security guards.

The difficult climatic conditions prevailing during the growing season particularly the very hot weather are also considered one of the factors resulting in loss of produce.

The inefficient management of the SGB also resulted in some farmers failing to perform the different cultural operations on time as some farmers' fields receive bad or delayed land preparation and/or delayed Wheat plantation (sowing date), (11%) ranked 2nd, (5%) ranked 1st and (5%) ranked 3rd and 4th.

Some farmers attributed the loss of their produce to the bad or inferior seeds supplied, particularly Wheat seeds as (6%) ranked 1st, (4%) ranked 2nd and (3%) ranked 3rd.

And while only (3%) of the farmers related the loss of their produce to the shortages of input materials (ranked this as 1st, 2nd and 3rd), one farmer has attributed the loss of his produce to theft of the crops; some farmers could not say exactly why they lost their produce.

The survey also reveals that (40%) of the farmers surveyed are full members of the farmers' union, the majority of them (83% - 100%) stated that the union "*played a very negative role in their life and did nothing for them*". In the past the union used to help farmers with land preparations, played a vital role in advising them and determining the prices of the different crops particularly the cotton and wheat as well as helping farmers purchase subsidised fertilisers and other inputs.

Moreover, the union has established some business activities such as a Milling factory and a Pharmacy but for many years farmers received their share just once and currently (1999) the farmers union has a very poor relationship with its members.

From Table 5.16, the farmers' union helped (16%) of the farmers surveyed in solving some problems and defending their rights, (6%) were helped with purchasing input materials, (8%) were helped to market their products and only one farmer has received technical advice from the union. No support is given as to product prices nor any credit and/or financial facilities.

(Table 5.16) Facilities Provided by Farmers Union

Type of Facilities	First (%)	Second (%)
Technical advice	2	0
Inputs materials	4	2
Credit	0	0
Competitive prices	0	0
Marketing	6	2
Other facilities	12	4

Source: Field Survey Data, Appendix-F1.

Finally, the marketing channels for the different crops for all farmers surveyed are similar. Cotton and wheat are taken (by force) by the government and the farmers have to accept the prices given. Farmers market their sorghum[10], ground nuts[11] and all other crops personally.

However, according to many farmers, the government charge high prices for fertilisers (above the market price) which makes their produce less profitable and farmers are forced to take these very expensive fertilisers only because they have no cash to buy it from the market at low prices, therefore, for many of them it is better to buy the sorghum needed for domestic use from the market rather than grow it on their farms.

[10] Sorghum is normally kept for the farmers' families domestic use.

[11] Farmers normally store ground nuts till the price increases as village traders give low prices during the harvesting period. Farmers depend mostly on their Groundnuts to pay their debts.

5.6 Technology Adoption Model

The field survey data set (F1) was used for modelling the adoption of technology. For modelling purposes, the "adoption" variable was selected as the dependant variable and the explanatory variables include;

- farmer's education level and age, additional job(s), farm ownership, farm location, lack of finance, frequency of visits by extensionists as well as lost of produce by farmers (Farmers Survey, Q2, Q3, Q4, Q5, Q6, Q12, Q15 and Q21). Another set of variables tested was the reasons stated by farmers as to why they did not implement the technology and/or advice delivered to them i.e. technology and advice characteristics perception by farmers (Farmers Survey, Q18).

The results from the two linear and logistic regression models (Table 5.17, table 5.18 and Table 5.19) reveal the following;

(Table 5.17) Farmers Technology Adoption Linear Regression

	Unstandardised Coefficients		Standardised Coefficients		
Variables	B	Std. Error	Beta	t	Sig.
(Constant)	.949	.411		2.311	.024
Age	4.476E-02	.045	.134	1.002	.320
Education	1.477E-03	.036	.006	.041	.967
Job	4.541E-02	.115	.050	.395	.694
Ownership	.260	.155	.203	1.671	.099
Location	-7.350E-03	.069	-.013	-.107	.915
Finance	-8.311E-02	.168	-.062	-.493	.623
Time	4.675E-03	.022	.026	.208	.836
Produce	-.126	.173	-.086	-.731	.467

Source: Field Survey Data, Appendix-F1.

(Table 5.18) Farmers Technology Adoption Logistic Regression							
Variable	**B**	**S. E.**	**Wald**	**df**	**Sig**	**R**	**Exp (B)**
Age	.2765	.2518	1.2063	1	.2721	.0000	1.3185
Education	.0020	.1941	.0001	1	.9916	.0000	1.0021
Job	.2615	.6005	.1897	1	.6632	.0000	1.2989
Ownership	1.3181	.7611	2.9990	1	.0833	.1041	3.7363
Location	-.0548	.3608	.0231	1	.8792	.0000	.9466
Finance	-.4952	.9758	.2576	1	.6118	.0000	.6094
Time	.0359	.1198	.0899	1	.7643	.0000	1.0366
Produce	-.9097	1.1427	.6338	1	.4260	.0000	.4026
Constant	-2.5925	2.2550	1.3218	1	.2503		

Source: Field Survey Data, Appendix-F1.

(Table 5.19) Farmers Technology Adoption Linear Regression (Data Set 2)					
	Unstandardised Coefficients		**Standardised Coefficients**		
Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	1.810	.092		19.613	.000
Irrelevant	1.392E-16	.531	.000	.000	1.000
Scientific	-1.336E-16	.694	.000	.000	1.000
Expensive	-7.610E-16	.976	.000	.000	1.000
Won't Work	-4.565E-17	.715	.000	.000	1.000
Not Popular	-4.187E-17	.582	.000	.000	1.000
Problems	2.700E-16	.563	.000	.000	1.000
Other4	.190	.927	.079	.205	.838

Source: Field Survey Data, Appendix-F1.

However, as mentioned in earlier Chapters with regard to the nature of the problem investigated in this research and the type of field data collected it was not possible to develop a workable model for technology adoption with such data as the data is cross sectional with inadequate variations. For more details on other modelling strategies see Chapter Eight (8.5 Areas for Further Research).

5.7 Summary

Various factors influencing farmers' adoption decision of any new technology and/or advice have been examined in this Chapter. Also in this Chapter modelling the technology adoption has been attempted. A number of findings emerge which indicate the nature of technology adoption determinants in Sudan. This Chapter has examined the constraints regarding technology adoption in Sudan. However, the role of the extension services in the efficient and timely transfer of the technologies and advice will be explored in the next Chapter.

CHAPTER SIX

Technology Transfer

CHAPTER-6

THE TRANSFER OF TECHNOLOGY

6.1 Introduction

In Chapter 5, a number of factors impacted the adoption of the technologies and advice by farmers were identified. However, enabling the proper and timely adoption of these technologies and advice is the aim of this Chapter which will focus on the role of the extension services in the efficient and timely transfer of these technologies and advice from the research and academic institutions to the farmers.

6.2 Farmers Field Schools (FFSs) and Rural Women Schools (RWS)

Farmers Field Schools were chosen as an IPM extension and training model and became a part of the extension program in the Gezira Scheme in the 1994/1995 season with the objective of introducing farmers to topics that would enable them to be aware of the basic principles of IPM, farm management practices and the skills necessary to take the right decisions regarding crop management and control of pests and diseases.

One FFS was established in the Centre group in 1993/1994 season where some vegetable farmers were selected and exposed to an extensive extension training program conducted by the FAO/ARC IPM staff and extension and entomology staff of the SGB. Extension methods included general meetings, panel and group discussions, workshops, demonstrations, visits, tours, presentation of posters, leaflets and magazines. The results obtained were encouraging in the Centre group where farmers were very interested and the trainers were well prepared to run the FFS (Dabrowski, 1997). This experience (1993) was then used to implement the idea of FFSs as a system for training farmers and dissemination of IPM options for the major vegetable crops, onion and tomato.

Twenty farmers from adjacent villages were selected for each school to be involved in different FFS activities. Each group of five farmers was headed by a leader and the training was conducted every week in subjects which were chosen by the participating farmers themselves according to the specific conditions of their fields. According to Sid Ahmed, a total number of 59 weekly training sessions were conducted, and the attendance of farmers and trainers was fairly good (Table 6.1).

(Table 6.1) FFSs, Centre Group of the SGB During 1994/1995 Season			
Month	**Sessions**	**Number of Farmers**	**Participation (%)**
September 1994	2	75	100
October 1994	2	75	100
November 1994	4	65	100
December 1994	3	80	100
January 1995	3	75	100
February 1995	2	70	0*
March 1995	1	55	100
April 1995	3	65	100
Total	20	560	700
Average		70.0	87.5

* Farmers did not come the school.

Source: Dabrowski, 1997.

However, the major change in the 1995/1996 season was that the responsibility for running the FFS was transferred to one organiser, with other specialists or experts attending as needed. Two SGB technical officers were assigned to support the school organisers in extension, entomology and pathology. Moreover, the 1995/1996 growing season was the third for the FFSs in the Gezira and the first time for the Rural Women Schools (RWSs). The idea of the RWS was introduced and adopted in Sudan for the first time during the 1995-1996 season in Gezira State. These schools are organised to help increase agricultural production by knowledge of the recommended technical packages as well as developing skills in application of these technical packages for all field and horticultural crops. Table 6.2 below shows the number of RWSs which were established in Gezira State and the Gezira Scheme during 1995-1996 to 1997-1998 (IPM, 1998).

(Table 6.2) Rural Women Schools in the Gezira During 1995-1998 Seasons				
Area	**1995-1996**	**1996-1997**	**1997-1998**	**Total**
Gezira State	5	12	4	21
Gezira Scheme	1	6	6	13
Total	6	18	10	34

Source: IPM, 1998.

Meanwhile, in its evaluation of the success and sustainability of FFSs and RWSs in Sudan, IPM (1998) assumes the importance of keeping schools cost at minimum, the application of participatory approach at all levels and in carrying out various teaching and learning activities, considering schools as vital educational instruments. Twenty three different subjects were covered in FFSs and RWSs (Table 6.3).

In addition, the performance of the FFSs is satisfactory and the Gezira Scheme's management has realised the importance of IPM and has sponsored four training courses on IPM extension and training of farmers for its 250 field inspectors. Moreover, the model of FFs and RWSs in the whole Gezira State is considered a successful one by all parties involved, and it encouraged the State Government and Farmers Unions to support the FFSs and RWSs financially (Dabrowski, 1997).

(Table 6.3) FFSs and RWSs Activities in Gezira State During 1993-1996 Seasons			
Activities	**1993/1994**	**1994/1995**	**1995/1996**
Normal FFSs	2	7	4
Pilot FFSs	-	-	4
RWSs	-	-	5
Selected farmers	57	140	221
Non-selected farmers	20	54	86
Selected women in RWSs	-	-	203
Non-selected women in	-	-	52
Cadres managing and supervising the schools	8	16	16
Training subjects	21	24	29
Average farmer attendance (%)	73.1	82.4	77
Average women attendance (%)	-	-	89
Nurseries	-	5	24
IPM demonstration plots	-	1	8
On-farm trials	-	2	8
Field days	1	2	4
Weeks of training sessions	48	92	316
Technical tours	3	12	18
Home gardens	-	-	13

Source: Dabrowski, 1997.

6.3 Linkages with Farmers

Table 6.4 reveals farmers' responses to three questions that attribute three scales as to the information sources used for the different farming practices and techniques.

Table (6.4) Information Sources Available to Farmers			
Transfer (n=120)	**First (%)**	**Second (%)**	**Third (%)**
Own Experience	81	10	0
Extension Services	13	12	0
Other Sources	5	9	5

Source: Field Survey Data, Appendix-F1.

Each question has a total of 120 responses which are converted to percentages in order to aid in the interpretation of the data. The most trustworthy source of information available to the majority of the farmers is their own personal knowledge where (81%) ranked this 1st and (10%) ranked it 2nd, followed by the extension services (25%), ranked 1st and 2nd, and closely followed by other sources of information received from friends working in the agricultural sector, farmers' son(s) and/or daughters(s) studying agriculture as well as from old people in their villages, ranked 1st, 2nd and 3rd with the percentages (5%, 9%, and 5%) respectively.

Although a few farmers have reported very little impact of the FFSs as a source of communication and problem solving, the majority (74%) stated that extension services have no significant role in advising and educating them about their farming problems. Radio and TV extension programs are also mentioned by some farmers as another facility provided by the extension services.

The extension services are also criticised for being completely absent from farmers' fields particularly during the raining season[1] and they are only available during the growing season of cotton and wheat. Also a keen criticism is made of the fact that extensionists are not participating directly in the farmers' farming activities.

However, despite all the criticisms above, almost (66%) of the farmers have been visited by a person from the extension services during the last year (Table 6.5), only one farmer acknowledged a visit made to his farm by people from the ARC, another farmer claimed that the only visit he received took place during the British management period[2] and many farmers still think there is no extension services actively operating within the SGB.

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[1] The raining season (July-October) is the most demanding period for farmers as water flooding, plantation and many other cultural practices usually take place during this season and the farmers get no access to tractors and all need equipment without the extension services and/or field inspectors intervention.

[2] Few farmers mentioned the good link and regularity of visits by extensionists and other officials until the mid fifties when the scheme was under British management. During the British management period, however, extensionists mobilised all resources to reach every single farmer they even used horses during the raining season as witnessed by farmers. However, despite the language problem during that period, farmers said they were very well informed and looked after compared to the present situation (1999).

Table (6.5) Frequency of On-Farm Extension Services Visits	
Time (n=80)	**Percentage (%)**
Every 3 months	21
Other	21
Every week	20
Every month	17
Every year	15
Every 6 months	5

Source: Field Survey Data, Appendix-F1.

The frequency of these visits varies from every week (20%), every month (17%), every three months (21%), every six months (5%) to every year (15%). Many farmers (21%) argued that these visits are always associated with an outstanding agricultural event such as; unexpected disease appearing in a crop(s), the application of fertilisers(s) mainly for cotton and the harvesting of crop(s) particularly sorghum to collect the water charges.

Farmers also argued that the extensionists only came to look after the government crops (Cotton and wheat) in the farmers' fields but otherwise they "*just talked from their cars*" outside the farm. As many farmers have become de-motivated to communicate with the extensionists, the Samad[3] is still the linkage between the farmers and the extensionist. A few farmers surveyed did not know how regular these visits are as they spend most of their time away from their farms doing other jobs.

More than half of the farmers (54%) have met the extensionists away from their fields (Table 6.6). Other meeting places stated are: along the road just by chance, in a social event in the village or while shopping in the local village market (67%), during the production committee meetings or with the Samad in the village (29%) or at the extensionist's office (24%).

[3] The Samad is a farmer appointed by the extensionist from the village with whom he/she can communicate easily and the Samad is supposed to transfer the extensionist's messages to farmers.

Table (6.6) Off-Farm Farmers/Extension Services Meeting Places	
Meeting Places (n=65)	**Percentage (%)**
Other	67
Village meetings	29
Extension office	24
Education session	6
Demonstration farms	3
Farmers' Union Hall	0

Source: Field Survey Data, Appendix-F1.

In a very few cases the extensionist meets the farmer in his/her demonstration farms (3%), in the education sessions (6%) and none of the farmers have considered the farmers' union meeting halls as a place to meet the extensionist. However, in most of these places, farmers reported that no significant advice and/or facility was provided by the extensionist. And while some extensionists mentioned considering the low productive farmers more, the majority of extensionists reported visiting all farmers' fields at the same frequency.

However, in addition to farmers' fields, these visits also take place in all other appropriate and accessible places including; houses (*for farmers and/or extensionists*), village meeting(s), local market(s), FFSs. Facilities provided during these visits include; technical advice, demonstration as well as solving farmers' problems associated with irrigation and flooding, however, particular attention is always given to the critical harvesting period.

Consequently, extensionists reported concentrating their efforts on the areas that have difficulties in performing their basic cultural operations e.g. places with irrigation problems, bringing farmers together to help each other and strengthen their resources particularly for cash crops (for a similar argument on the social capital and resource exchange/combination see Ghoshal, 1998) and again most focus is given to small scale low yielding farmers.

And while only (5%) of the farmers ranked on-farm demonstration by the extensionists as 1st, 2nd and 4th, technical advice is considered the most important service delivered by extensionists during their visit(s). Seventy six percent ranked this 1st and (5%) ranked it 2nd and 3rd (Table 6.7).

Table (6.7) Facilities Provided by Extension Services

Type of Facilities (n=80)	First (%)	Second (%)	Third (%)	Fourth (%)
Technical advice	76	3	1	0
Input materials	1	3	0	0
Credit facilities	0	1	0	0
Demonstration	1	1	1	1
Listening	11	37	1	0
Feedback	0	5	6	0
Other facilities	6	2	1	0

Source: Field Survey Data, Appendix-F1.

Listening to the farmers' problems comes second as (11%) ranked this 1st and (37%) ranked 2nd and finally taking notes on farmers feedback on previous trials comes third as (11%) ranked this 2nd and 3rd.

No significant advice however, is delivered to the farmers regarding the purchasing of input materials where (5%) have ranked this 1st and 2nd and only (1%) have ranked credit/financial facilities 2nd. For some farmers extensionists are always keen on the outside image of the farm i.e. to look free from weeds and green rather than the inner side (particularly those located near the major irrigation canal) to give a good impression during the officials visit(s) to the block, (6%) ranked this 1st and (3%) ranked it 2nd and third.[4]

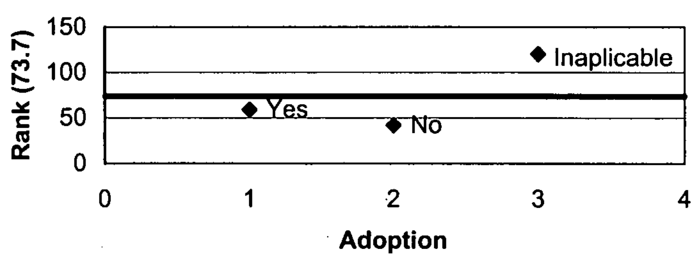
Farmers were then asked why they did not implement the advice received, and the majority reported that these technologies are very expensive, most of them need cash and that funds are lacking (Table 6.8 and Figure 6.1).

[4] One farmer mentioned that a tour of researchers from ARC visited his field and did not speak to him about anything but just took some samples.

Table (6.8) Reasons Stated by Non-Adopter Farmers	
Nature of Problem (n=21)	**Percentage (%)**
Funding unavailability	100
Very expensive	100
Irrelevant and inappropriate	28
Too scientific	23
Not popular	19
Associated with problems	19
Won't work	19

Source: Field Survey Data, Appendix-F1.

Figure 6.1 Technology Adoption



Source: Field Survey Data, Appendix-F1.

However, extensionists also reported the following reasons with regard to farmers not implementing the advice given to them;

-some farmers reported some new problems have appeared to be associated with certain technology and/or advice.

-some just rejected them and with the poor linkages with farmers it is very difficult for extensionists to find out why as 10-15% of the farmers[5] are still using their own very traditional farming systems.

[5] This percentage was given by a number of extensionists during interviews.

-funding problems where recommended packages are very expensive to implement and the difficulties experienced by many farmers in performing the different farming activities within the required time recommended by researchers.

-unavailability of the necessary inputs.

-low produce prices.

-marketing problems.

-problems with land ownership.

-most farmers are completely absent from their farms doing other jobs.

6.4 Linkages with the Research Institutions

According to Elahmadi[6];

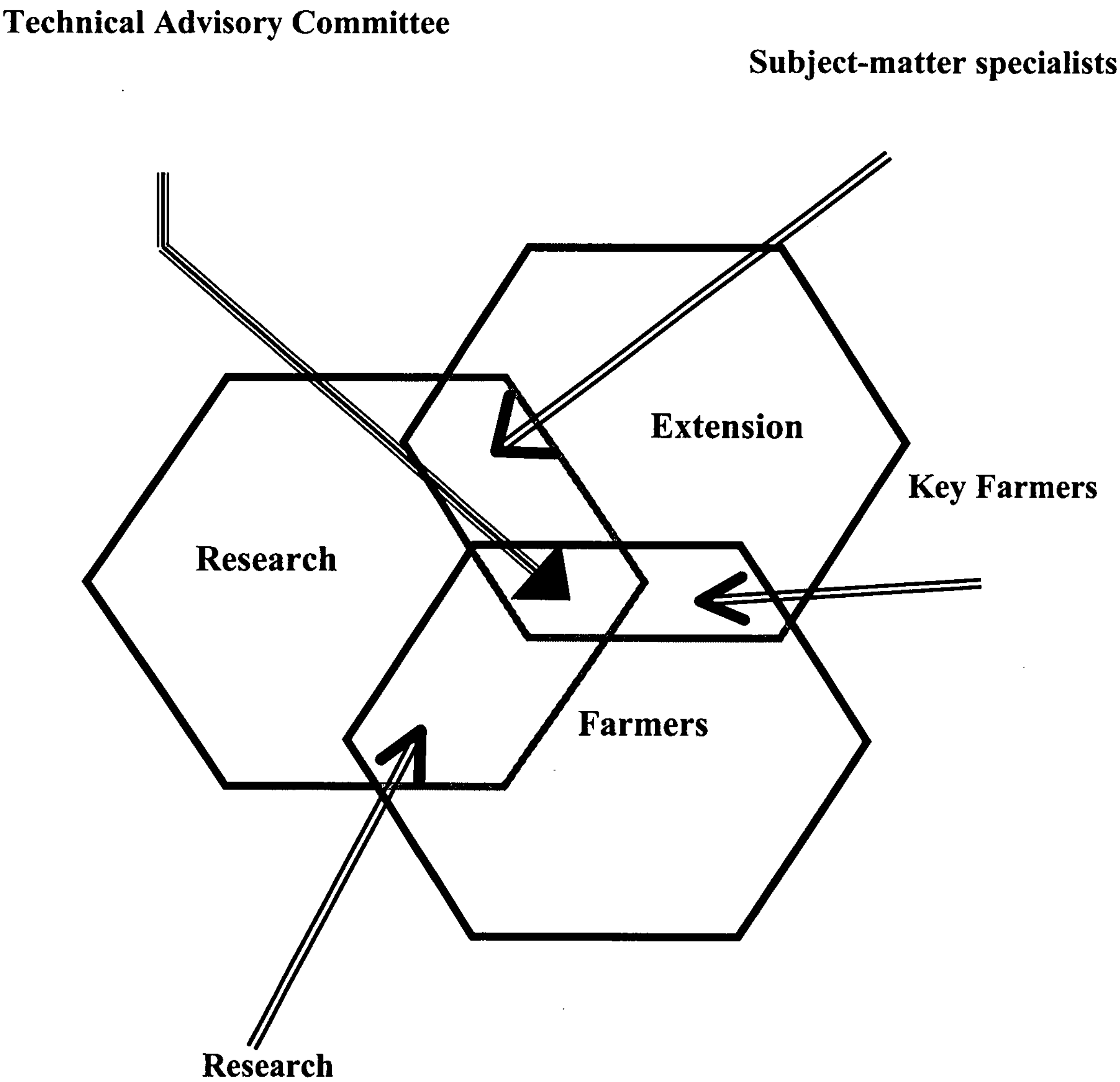
"*linkages between ARC and extension services are not stable activity, before 1985 there is no linkage activity, between 1985 and 1995 there were very strong extension linkages such as demonstration plots, on-farm research, field days, farmers schools sessions as well as participation in training courses but after 1996 linkage activities with the extension services divided and now (1999) there are only very few on-farm verification yield trials*".

Linkages between research institutions and extension take place in different ways including; TV and Radio messages, newspaper articles, direct meetings of farmers and extension services, meeting SGB farmers at FFSs organised by extensionists, membership of higher steering committees (*mainly for senior staff and research professors*), conferences, field days, the IPM training unit, on-farm researcher-farmer

[6] Quoted from an informal interview with Professor Abdalla Babiker Elahmadi, the ARC National Co-ordinator for Wheat Research, ARC – Sudan, July 1999.

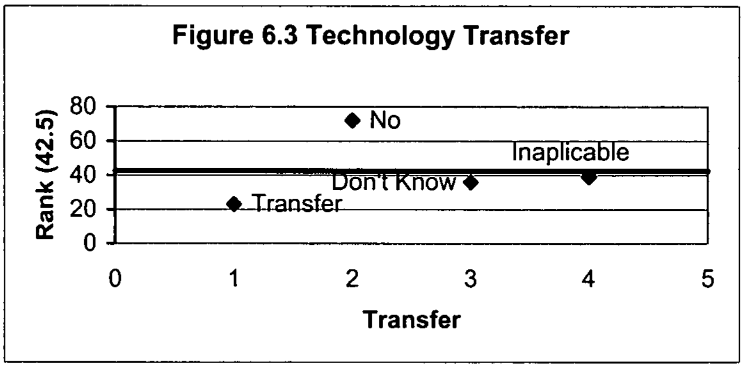
managed trials as well as demonstration of improved technologies. Figure 6.2 indicates the linkages between research and extension.

Figure 6.2 Agricultural Research-Extension Linkage System



Source: Adopted from AgREN No.106, ODI, 2000.

The survey (Figure 6.3 and Table 6.9) reveals that only (36%) of the ARC researchers have reported that their research findings and advice are actually transferred to the farmers, (49%) reported no and the remaining (15%) did not know whether their findings reach the farmers or not.



Source: Field Survey Data, Appendix-F2.

Table (6.9) ARC Research Findings Transferred to Farmers	
Transfer (n=55)	**Percentage (%)**
No	49
Yes	36
Don't Know	15

Source: Field Survey Data, Appendix-F2.

Different reasons were given by ARC researchers as to why their findings are not transferred to farmers (Table 6.10). Supporting the poor linkages reported above between research and extension services (59%) of the ARC researchers (ranked 1st) agreed that poor linkages have resulted in many of their findings and advice not reaching the farmers.

Some ARC researchers argued that extension services lack logistics and they face difficulties visiting the farmers and that extension services are organised to serve only the irrigated schemes (*governmental*) while some research (e.g. *horticultural crops research*) is oriented towards the private sector and therefore has low priority.

Table (6.10) Reasons for ARC Research Findings not Transferred to Farmers							
Reasons (n=27)	**1st (%)**	**2nd (%)**	**3rd (%)**	**4th (%)**	**5th (%)**	**6th (%)**	**7th (%)**
Lack of effective linkage between researchers and extension services	59	3	11	0	0	0	0
Extension surfaces are not efficient and effective in technology transfer	11	29	11	3	0	0	0
Other reasons	14	0	0	0	0	0	3
Poor linkage between extension services and the farmers	3	25	18	3	0	0	0
Recommended packages are too scient. for extensionists to absorb	3	0	3	11	0	0	0
Extension services rejected them for other reason(s)	3	0	0	3	0	11	0
Extension services view them as irrelevant for farmers' needs	0	0	0	0	11	0	0

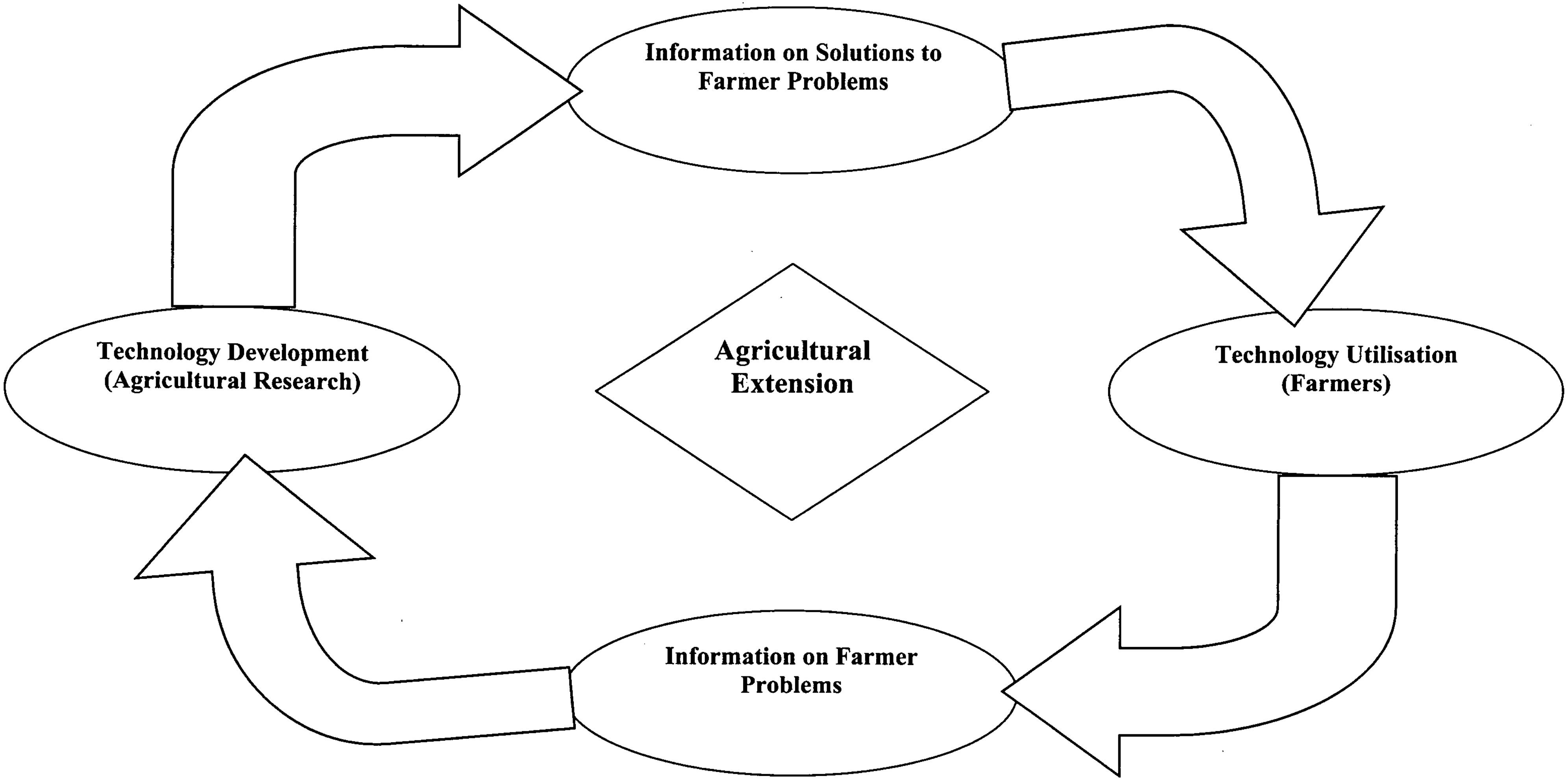
Source: Field Survey Data, Appendix-F2.

Furthermore, researchers also criticised the extension services as being inefficient and ineffective in the transfer of technology where (22%) ranked this 1st and 3rd and (29%) ranked it 2nd. Figure 6.4 shows the extension strategies for technology utilisation which are not well established.

And while (6%) of the researchers reported that extension services rejected their findings for other reasons (ranked 1st and 4th), others admitted that some of their research findings and recommended packages are too scientific for extensionists to absorb where (3%) have ranked this 1st and 3rd and (11%) ranked it 4th.

Some ARC researchers reported the lack of facilities and funds to transfer these technologies to extension services and farmers.

Figure 6.4 Extension Strategies For Technology Utilisation

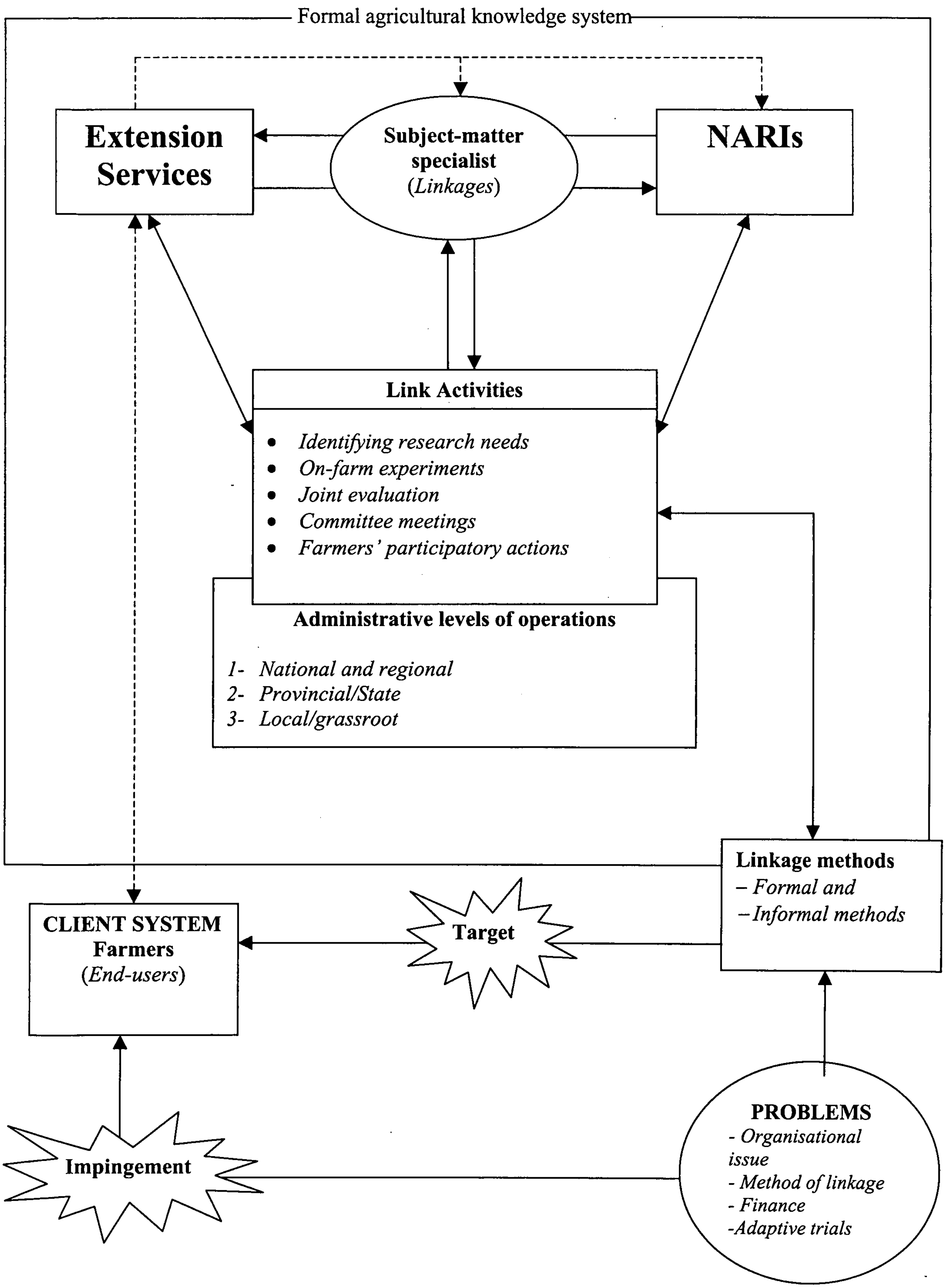


An entomologist argued that he has made recommendations for some insecticides to be used against major cotton pests but the decision on using them is usually taken by the Plant Protection Unit and he has no role in that.

However, poor linkages between extension services and farmers are also mentioned by some researchers as a reason for this problem where (3%) ranked this 1st and 4th, (25%) ranked 2nd and (18%) ranked 3rd.

For the conceptual framework for an effective research-extension linkages see Figure 6.5 (Source: Adopted from AgREN No.106, ODI, 2000).

Figure 6.5 Conceptual Framework for an Effective Research-Extension Linkages



6.5 Linkages with the Academic Institutions

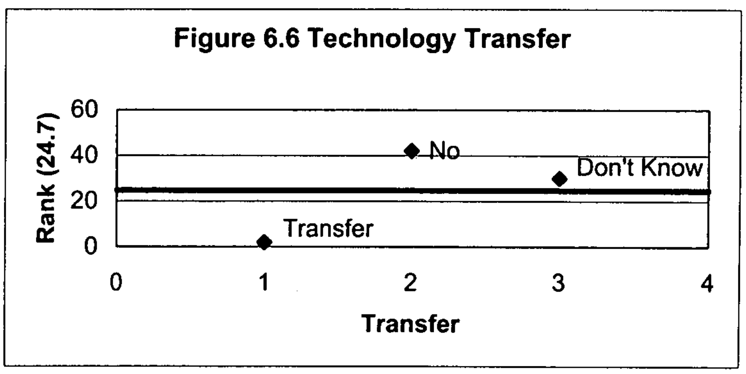
"*Extension services were not given their due attention and in my opinion, a lot of work and support is required to strengthen the extension role in the country*", argues El Jack[7] and according to Bashir[8], "*extensionists are not available in suitable numbers, very busy, some are not interested and a few think that they have chosen the wrong profession*".

However, academic staff do have some linkages with extension services in the form of corporate trainers giving lectures in FFSs and short TV programmes (*e.g. TV messages explaining how to produce poultry especially for small families producers*).

The survey (Table 6.11 and Figure 6.6) reveals that only two of the GU academic staff (6%) had reported that their research findings and advice were actually transferred to the farmers, (64%) reported no and the remaining (30%) did not know whether their findings have reached the farmers or not!

Table (6.11) GU Research Findings Transferred to Farmers	
Transfer (n=33)	**Percentage (%)**
No	64
Don't Know	30
Yes	6

Source: Field Survey Data, Appendix-F3.



Source: Field Survey Data, Appendix-F3.

[7] Professor Ali Al Amin El Jack is a Professor at the Horticultural Sciences Section, University of Gezira.
[8] Professor Nabil Hamid Bashir is an entomologist professor at the Crop Protection Section, University of Gezira.

Different reasons were given by academic staff with regard to why their findings were not transferred to farmers (Table 6.12).

Table (6.12) Reasons for GU Research Findings not Transferred to Farmers							
Reasons (n=21)	**1st (%)**	**2nd (%)**	**3rd (%)**	**4th (%)**	**5th (%)**	**6th (%)**	**7th (%)**
Lack of effective linkage between universities and extension services	74	19	0	5	0	0	0
Poor linkage between extension services and the farmers	19	14	29	9	5	0	0
Extension services are not efficient and effective in technology transfer	5	29	19	0	5	0	0
Other reasons	5	9	0	0	0	0	0
Extension services view them as irrelevant for farmers needs	0	9	5	5	9	5	0
Recommended packages are too scientif. for extensionists to absorb	0	0	5	14	5	0	0
Extension services rejected them for other reason(s).	0	0	0	0	5	5	5

Source: Field Survey Data, Appendix-F3.

Supporting the argument above regarding the poor linkages between universities and extension services (74%) of the staff (ranked 1st) reported that poor linkages had resulted in many of their findings and advice not reaching the farmers as extension services were completely absent.

Nineteen percent of the staff reported the poor linkage between extension services and farmers although some of them agreed that extension services lack logistics, any means of transportation and material.

Some staff members also criticised the extension services as being inefficient and ineffective in the transfer of technology where (5%) ranked this 1st and 5th, (29%)

ranked it 2nd and (19%) ranked it 3rd and that ARC and extension services consider their research findings as purely academic.

Furthermore, academic staff also reported the lack of facilities and funds to transfer technologies to extension services and farmers. The survey also reveals the very poor linkages between universities and extension services and that extensionists criticised universities as being inefficient in updating their curricular teaching manuals as well as being more theoretically oriented towards rural development and small-scale farmers and criticised both ARC and GU for only having linkages with farmers located near to their testing stations and offices.

6.6 Technology Transfer Model

The field survey data sets (F2 and F3) were used for modelling the technology transfer. For modelling purposes, the "transfer" variable was selected as the dependant variable and the explanatory variables include;

- linkages with extension services and academic institutions as well as the frequency of on-farm visits by researchers (Researchers Survey, Q6, Q7 and Q8).

- linkages with extension services and research institutions as well as the frequency of on-farm visits by academic staff (Academic staff Survey, Q7, Q8 and Q9).

The results from the two linear regression models (Table 6.13 and Table 6.14) reveal the following;

(Table 6.13) Researchers Technology Transfer Linear Regression					
	Unstandardized Coefficients		Standardised Coefficients		
Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	.816	.467		1.747	.084
Linkage	.503	.228	.249	2.207	.030
Linkage1	.182	.234	.085	.779	.438
Time	4.572E-02	.048	.107	.948	.346

Source: Field Survey Data, Appendix-F2.

(Table 6.14) Academic Staff Technology Transfer Linear Regression					
	Unstandardized Coefficients		Standardised Coefficients		
Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	2.075	.526		3.944	.000
Linkage	-2.418E-02	.250	-.020	-.097	.924
Linkage1	-5.020E-03	.219	-.004	-.023	.982
Time	2.974E-02	.044	.132	.672	.507

Source: Field Survey Data, Appendix-F3.

However, as mentioned in earlier Chapters with regard to the nature of the problem investigated in this research and the type of field data collected it was not possible to develop a workable model for technology transfer with such data as the data is cross sectional with inadequate variations within the data. For more details on other modelling strategies see Chapter Eight (8.5 Areas for Further Research).

6.7 Technology Transfer Problems and Constraints

The survey reveals the following problems and constraints which have contributed to the difficult and ineffective transfer of technologies between extension services and farmers, in summary;

-car maintenance (*spare parts*).

-the administrative work over load needed alongside the extension activities negatively impact the extensionists' activities.

-shortage of extension staff (*currently 2-3 field inspectors per block*).

-delay of inputs, fertilisers, and improved seeds deliveries that negatively impact the timely adoption of the recommended technical advice.

-irrigation problems (*flooding, weeds, delay summer maintenance*), which impact the 1st irrigation intake (*vital for the sowing date*).

-low prices and poor marketing of produce which discourage farmers from the proper adoption of the advice given for a particular crop.

-a permanent funding problem for the different agricultural operations for all crops.

-difficulty of performing the recommended operations on time.

-termination of the rural development programmes all over the scheme during the last period.

-poor linkages between extension services and farmers.

-bad relations between extensionists and farmers as extensionists become responsible (*new scheme policy*) for tax collection and other charges as well as enforcing farmers to pay if necessary (*using police*).

Moreover, the survey also reveals a high number of weaknesses and constraints related to food deficit and hunger problems, training (*pre-service, induction or in-service training*), and increasing spatial coverage and resource problems. However, the problem is not only of magnitude but also its inverse effect. While the urgency and the expected coverage are increasing, the resources that are available for agricultural extension are decreasing.

Training

The participants of the first informal Consultation of the International Supporters of Agricultural Extension Systems in Africa[9] (ICISAESA), identified a common problem of extension services in African countries (*including Sudan*), which is the low level of education and inadequate training of extension staff at all levels. To a great extent, the effectiveness of any agricultural extension service is determined by the competence and qualifications of its staff (Qamar, 1997).

Studies have shown that the improvement in farmers' knowledge, skills, attitude, efficiency and productivity are positively correlated to the training level and quality of extension staff (Qamar, 1997). According to Rogers, (1996, p. 86);

"*poor training of agricultural extension staff has been identified as part of the problem of the relative ineffectiveness of much of extension in the field*".

This applies not only to extension staff, but also to agricultural professionals in general. Unfortunately, the study reveals that training of extension staff is often not a high priority in Sudan development plans. As a result, curricula and teaching programmes are not particularly relevant to the production needs and employment demands of the extension services. The situation has become serious in recent years (the nineties) due to the economic crisis in the public sector in Sudan.

These and other factors, such as environmental degradation, rapid changes in technical knowledge and the increasing marginalisation of rural areas, all call for changes in the current systems of education in agriculture in Sudan.

The survey also reveals a positive relationship between training of extension personnel and their performance, both in office and in the field, a fact raised by both researchers

[9] The first ICISAESA held at Neuchatel, Switzerland in July, 1995.

and academic staff in their surveys. Also there is a lack of agricultural extension policy, policy makers and programme managers do not appreciate the importance of extension which is an essential part of any productivity improvement at the national level. That is why national agricultural development policies lack policy on extension, while national level political commitment is necessary for the success of extension programmes.

Along side this, there is also a lack of long-term and comprehensive planning for extension as well as a low budget allocation to extension activities (*in addition, extension component suffers from further budget cuts in times of austerity*).

The lack of such appreciation of the extension role in the national agricultural policies resulted in relatively low priority for training, as human resources development in extension is not considered as a high priority compared to the case of research or academic personnel.

Meanwhile, poor linkages among these institutions (the affiliation of agricultural institutions to the MOA and the academic institutions to the Ministry of Education) has led to insufficient technical preparation of extension candidates due to an unsatisfactory curriculum, lack of emphasis on practical training, and lack of proper exposure to the importance of a careers in extension (*although some efforts are currently explored in the GU*) and consequently, low salaries and status of especially field extension staff.[10]

Furthermore, there is a lack of knowledge about he latest developments in extension (*resulting in lack of competence and undermining the need for new knowledge and skills*), low quality training staff (*mostly good technical subject-matter specialists but without any knowledge and experience in training approaches and methodologies*), lack of incentives for well trained manpower (*resulting in the loss of trained persons, especially those at high level, to more attractive jobs overseas or with the private sector)*, lack of logistic facilities such as transportation, equipment, proper training centres (*resulting in inadequate training both in terms of frequency and quality*),

[10] According to FAO (1998), the lowest salaries of extension staff in the world are in Africa.

imbalanced curriculum at academic institutions with more technical agricultural subjects and less extension education (*leading to the need for lengthy and costly in service training)*,

Coverage

The large number of farmers in the Gezira Scheme (114,000) spread over the wide geographical area of Gezira has been a common problem for extension managers since the establishment of the extension department in 1969. Therefore, if the extension services were to reach effectively these farmers, at 500 farmers per extension agent ratio for example, the department would require more than 200 well trained extension agents.

Currently (1999), the extension department is staffed with only 13 extensionists and according to Hashim, the extension services since its establishment has succeeded in approaching only (55%) of the total Gezira scheme farmers.

Furthermore, different kinds of farmers (*small-scale, men and women farmers and rural youth*) have different demands for training (*human resource development and technology adaptation and adoption*). The large geographical area of the Gezira with many remote parts, coupled with a lack of or inadequate road and telephone systems, difficult terrain and different ecological and access situations, contributes to the coverage problem of extensionists.

Another problem however, is subject matter coverage where the extension department is faced with an increasing variety and complexity of subject matters that are needed by farmers in modern, competitive and sustainable farming. In the past the responsibility of extension was only to teach farmers the fundamentals of crop and animal production and post-harvest handling.

Today (1999) and more so in the future, the responsibility of extension, concerns not only the quantity of production but also the quality, profitability and the sustainability of the resource base (*IPM strategy*). Hence, currently (1999) and in the future agricultural extension systems need to include farm management (*including farm* *planning, credit and marketing education among farmers*) and concern for the environment and sustainable agriculture.

Resources

The survey reveals that, a common complaint of extensionists is the shortage of funds, personnel and other resources for an adequate, functional and responsive agricultural extension service. The immediate impact of the limited budget and limited extension staff in the Gezira is the wide and remote geographical area expected to be covered by each extension agent.

6.8 Summary

In this Chapter the roles of the extension services in the efficient and timely transfer of any new technology and/or advice from NARIs to farmers have been examined. Various findings have been identified which indicate the nature of technology transfer determinates in Sudan. This Chapter also attempts to develop the technology transfer model. This Chapter has examined the constraints regarding technology transfer in Sudan. However, without proper and timely transfer of these technologies to farmers, the productivity gap will continue to be a persistent problem facing the small-scale farmers in Sudan. The analysis of this productivity gap will be explored in the next Chapter.

CHAPTER SEVEN

Productivity Gap

CHAPTER–7

THE PRODUCTIVITY GAP IN SUDAN

7.1 Introduction

In earlier Chapters, technology transfer determinants have been defined to include both the movement of technology from the research institutions (*site of origin*) to the farmers (*site of use*) and issues concerning the ultimate acceptance and use of the technology by the farmers (*end user*).

However, this does not provide information on the exact reasons behind the productivity gap in Sudan as the technology will not be considered successfully transferred until it has been accepted and used by the farmers.

In this Chapter, this context of technology transfer will be used to identify the reasons behind the productivity gap in Sudan as well as to explore several issues that can provide solutions to close this gap.

7.2 NARIs and the Productivity Differences

The survey reveals that none of the ARC researchers (55) who have already developed new technologies and recommended technical packages and advice to increase and/or improve farmers productivity[1] reported no productivity differences between what he/she has achieved so far and what farmers have achieved in their farms.

"Definitely research findings result in productivity improvement but I am not sure about the percentages", said one researcher and according to Mukhtar[2];

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[1] Some ARC researchers reported that they have not yet developed and recommended technical packages to farmers as their research programs are still under investigation, screening and re-testing particularly the breeders where a long time is needed to release new varieties.

[2] Quoted from an informal interview with Professor Nuri Osman Mukhtar, the ARC National Co-ordinator for Groundnuts Research, ARC – Sudan, July 1999.

"productivity increases could achieve up to 100% if the packages are fully adopted by farmers as any negligence of any item in the recommended package could bring a decrease in productivity".

However, while GU staff (79%) don't know whether their research findings have resulted in a productivity increase and/or improvement to farmers' products[3], ARC researchers (35%) (*including senior staff and research professors*) were not able to quantify the difference in productivity they achieved. The main reasons given are:

- Some research findings are either used by other researchers within a specific research program or tested in relation to another research program which in any case is not directly delivered to farmers e.g. soil science, biochemistry, chemistry, ...etc. where only basic tests and analysis are carried out.

- Released varieties need definite technological packages which if farmers don't follow out properly will result in difficulty in estimating the difference in productivity.

- Pathological research programs for example, emphasise quality rather than quantity and therefore, sometimes lower productivity is accompanied by good and healthy quality of produce. Moreover, according to Ali[4], insecticides recommended generally are known not to increase yield, but to prevent losses, and if not used, yield would be decreased by 21 percent.

- According to Elahmadi[5], productivity difference estimations in wheat research could only be done in areas where both improved and local (non-improved) varieties are grown but in the majority of the wheat growing areas only improved varieties are grown and it is therefore very difficult to estimate.

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[3] Some soil scientists argued that most of their research deals with land evaluation for agricultural purposes and therefore, there is no direct influence on yield to be quantified.
[4] Dr. Tag Elsir Elamin Ali is assistant professor in the ARC Entomology Research Unit.
[5] Quoted from an informal interview with Professor Abdalla Babiker Elahmadi, the ARC National Co-ordinator for Wheat Research, ARC – Sudan, July 1999.

- According to Mohamed Kheir[6], forages are not playing an important role in Sudanese agriculture due to the lack of proper mixed farming so the productivity difference is very difficult to quantify as there is no comparison to be made.

Table 7.1 reveals productivity difference achieved by ARC and GU research farms compared to traditional farmers where (65%) and (21%) of ARC researchers and GU staff respectively have achieved a productivity difference ranging from (0-10) percent to a difference of more than 50 percent.

Table (7.1) Productivity Gap between ARC and GU and Farmers

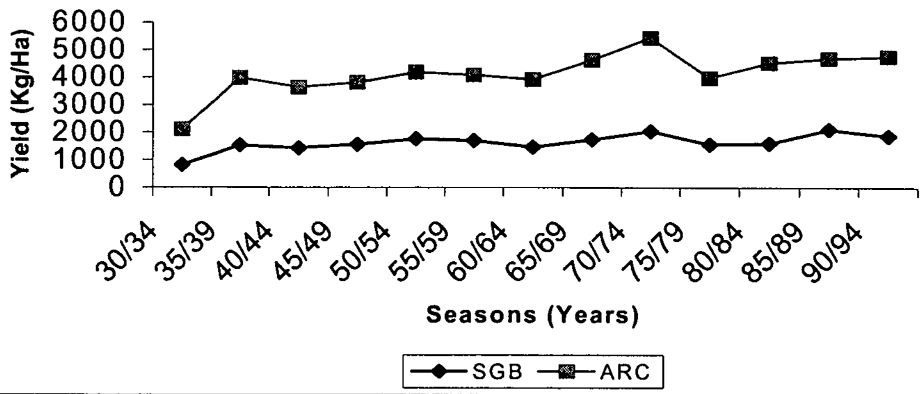
Productivity Gap	**ARC (n=56)**	**GU (n=33)**
Don't know	35%	79%
Gap of more than 50%	19%	9%
Gap of (40-50%)	12%	6%
Gap of (30-40%)	5%	3%
Gap of (20-30%)	14%	-
Gap of (10-20%)	9%	-
Gap of (0 – 10%)	3%	3%

Source: Field Survey Data, Appendix-F2 & F3.

Figure 7.1 below illustrates this productivity gap for Cotton production between ARC researchers and farmers of the Gezira Scheme. As mentioned in earlier Chapters (1 and 3) Cotton is the main crop grown in the Gezira Scheme for which different technical packages have developed by ARC and transferred to the farmers for their adoptions. Therefore, most of the studies carried on the productivity gap have focused on Cotton. In his analysis for the reasons behind the productivity gap in the Gezira, Elsiddig (1997) reported that farmers in the SGB were able to achieve only (4-5 Kr/Fed) compared to (10-12 Kr/Fed) achieved by the ARC researchers.

[6] Professor Mohamed Ahmed Mohamed Kheir is the ARC National Co-ordinator for Range and Forage Crops Research.

Figure 7.1 Researcher/Farmer Cotton Productivity Gap



Source: Elsiddig, 1997.

7.3 Farmers and the Productivity Gap

From Table 7.2 there is a high correlation coefficient (.622) between the education level and the productivity increase.

Table 7.2 Productivity Increases and Farmers Education Level		
Correlations		**Productivity**
Pearson Correlation	**Education Level**	.622

Source: Field Survey Data, Appendix-F1.

And although education level is a key influencing factor in farmers' adoption of technology and in productivity increases according to the survey (Table 7.3) achieving any level of education particularly higher levels within the farmers' community has encouraged them to leave farming and find another (or additional) job in the nearby town or city.

Table (7.3) Education Level and Productivity Changes					
Productivity (n=59)	**Illiterate**	**Primary**	**Secondary**	**Higher**	**Total**
None	1	4	1	1	7
Increase	16	7	16	5	44
Decrease	1	1	2	0	4
Don't know	1	3	0	0	4
Total	19	15	19	6	59

Source: Field Survey Data, Appendix-F1.

Table 7.4 below also supports this argument as farmers for whom farming is the only job in general achieve productivity increases more than other groups of farmers performing additional job(s) alongside farming.

Table (7.4) Farmers Activities and Productivity Changes			
Productivity (n=59)	**Farming**	**Other**	**Total**
None	3	4	7
Increase	30	14	44
Decrease	2	2	4
Don't know	3	1	4
Total	38	21	59

Source: Field Survey Data, Appendix-F1.

From Table 7.5 there is also a high correlation coefficient (.719) between the job and the productivity increase.

Table 7.5 Productivity Increases and Farmers Job		
Correlations		**Productivity**
Pearson Correlation	**Farmer Job**	.719

Source: Field Survey Data, Appendix-F1.

Moreover, productivity increases achieved by illiterate farmers (Table 7.3) can be explained on the basis that this group of farmers could not find any alternative (additional) job and therefore farming receives their full focus and efforts.

However, the information in Table 7.6 shows that none of the farmers surveyed located near the irrigation canal have reported decreases in productivity and that the majority of farmers who achieved productivity increases are mostly located near the irrigation canal.

Table (7.6) Farm Location and Productivity Changes

Productivity (n=59)	**Near**	**Moderate**	**Far**	**Total**
None	4	1	2	7
Increase	23	11	10	44
Decrease	0	1	3	4
Don't know	1	2	1	4
Total	28	15	16	59

Source: Field Survey Data, Appendix-F1.

The survey (Table 7.7) also reveals that almost (74%) of the (59) farmers in the sample who are actually visited by extensionists and have implemented the technology and/or advice delivered to them have increased productivity. However many of them do not attribute the productivity increase to the technology itself and/or the extensionists transfer efforts but instead argue that this increase is entirely due to their own efforts.

Some farmers (12%) have not achieved any productivity increase, for (7%) productivity has decreased and the remaining (7%) do not know if there is a real increase in their productivity or not as a result of their implementation of the advice delivered.

For many farmers finance is the major problem hindering them from implementing or in several cases delaying the implementation of the technologies and advice delivered to them.

Productivity changes for farmers are very difficult to quantify as SGB gives the farmers their net earnings after all the deductions (water charge, land preparation, seeds, fertilisers and tax), a procedure complicated for farmers to understand.

However, according to all farmers, the implementation of the technical advice delivered is generally very expensive[7].

Table (7.7) Implementation and Productivity Changes

Productivity (n=59)	**Percentage (%)**
Increase	74.5
None	11.9
Decrease	6.8
Don't know	6.8

Source: Field Survey Data, Appendix-F1.

Moreover, the survey (Table 7.8) also revealed that frequent visits every three months are always accompanied by productivity increases. This can be supported by the fact that every three months there is either the start of growing a new crop or its harvesting, two important periods when the technical assistance is needed. So the presence of the extensionists at this time can make a significant change to the farmers' productivity.

[7] For many farmers the high productivity during the British management period is mainly due to the fact that SGB is very keen to have proper land preparation for each farm (to specific depth) and it used to make sure that all irrigation canals are cleaned, free of weeds and well opened particularly *Abu Ishreen*, Abu Ishreen is the watercourse leading the water from the field outlet pipe of a minor canal to smaller field channels. In the Gezira, an Abu Ishreen usually carries water to 90 feddans of cultivation on a night storage system or up to 180 feddans on a continuous watering system (Abdel Gadir, 1989).

Table (7.8) Frequency of Visits and Productivity Change							
Prod. Change (n=59)	**Weekly**	**Monthly**	**3 Months**	**6 Months**	**Yearly**	**Other**	**Total**
None	3	1	0	1	1	1	7
Increase	9	7	15	0	3	10	44
Decrease	0	0	0	0	1	3	4
Don't know	1	1	0	1	0	1	4
Total	13	9	15	2	5	15	59

Source: Field Survey Data, Appendix-F1.

7.4 Factors Influencing the Transfer of Technologies

From the analysis in Chapters 4, 5 and 6 the following factors appear to influence the transfer of technologies from NARIs to the farmers;

Transfer Models

The process that is used to transfer a technology influences the success of the transfer (Johnson, 1999). This process is described in terms of "models of transfer" described in Chapter 2.

Linkage Policy

Regardless of the degree of technology development within any research and/or academic institution, it is clear that the institution needs a "linkage policy" that defines its degree of commitment to interaction with the farmers, extension services and with other NARIs as well as the institutional objectives in engaging in these linkages (Eponou, 1996).

The survey results (Table 7.9) support this argument as a strong correlation coefficient of (.920) does exists between the productivity increases and the linkage(s) between research institutions (ARC) and the extension services.

Table 7.9 Productivity Increases and ARC/Extension Linkages		
Correlations		**Productivity**
Pearson Correlation	**Extension Linkages**	.920

Source: Field Survey Data, Appendix-F2.

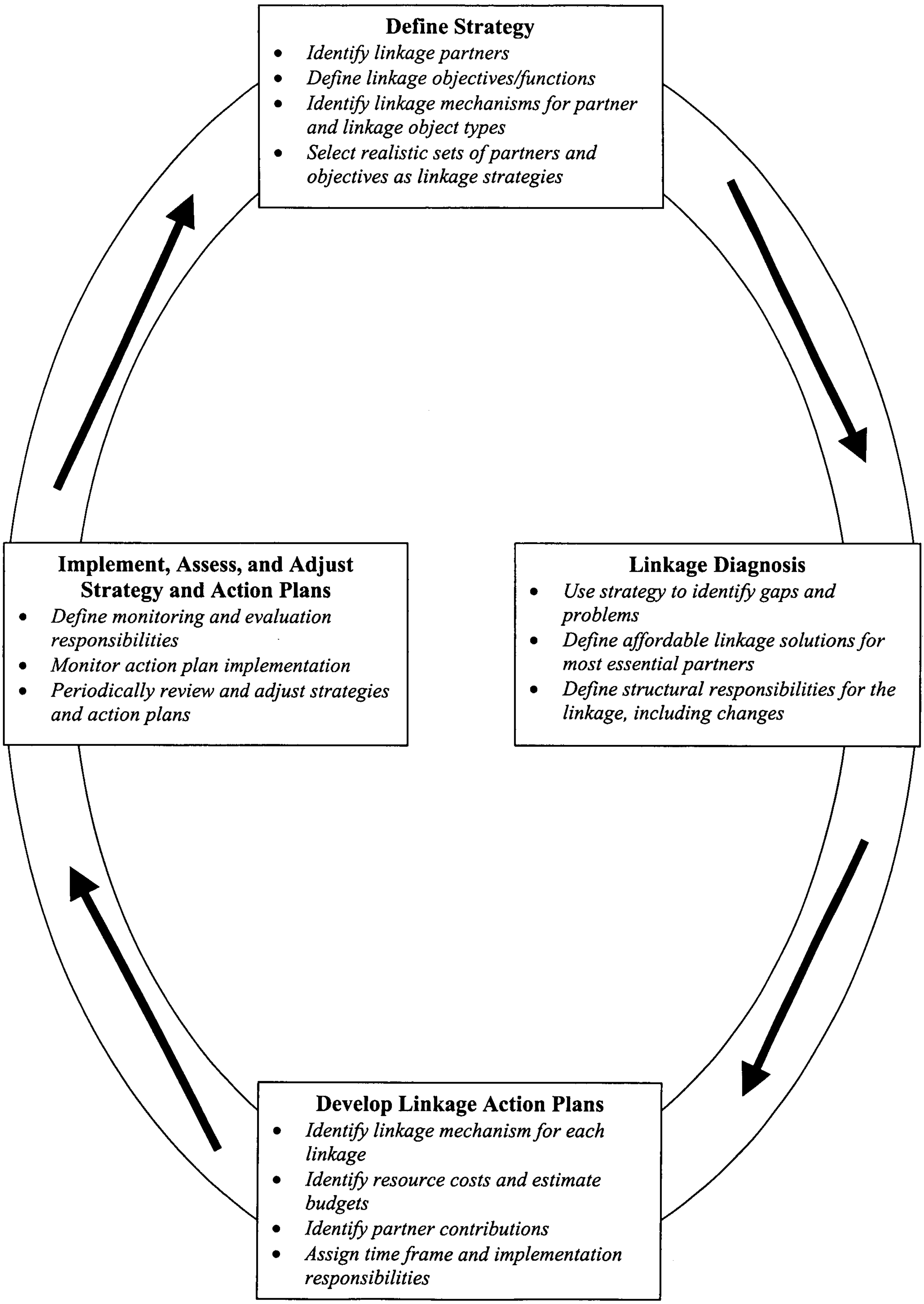
A high correlation coefficient (.695) also exists between the productivity increase and the linkage(s) between the academic institutions and the extension services. See Table 7.10 below.

Table 7.10 Productivity Increases and GU/Extension Linkages		
Correlations		**Productivity**
Pearson Correlation	**Extension Linkages**	.695

Source: Field Survey Data, Appendix-F3.

In addition poor linkages between NARIs and the extension services were reported by the majority of the researchers and the academic staff as one of the main factors which has led to their research findings not reaching the farmers as well as a reason behind the productivity gap. Therefore, strengthening the linkages with extension services will no doubt play a major role in effective technology transfer and closing the productivity gap. However, similar suggestions for organising the linkage process, together with linkage concepts is well illustrated in Figure 7.2. (ISNAR, 1999).

Figure 7.2 Linkage Planning Cycle



Farmer First

The farmer should be the "principal consideration" in the design of technologies. Through early and regular contact with the farmers, technologies can be developed that suit their needs. This interactive development becomes even more important when differing cultural and social values are involved.

Without a sensitivity to the needs of the farmers and a recognition of the environment in which the technology will ultimately be used, the transfer of technology will be a difficult process.

Moreover, any level of education particularly higher levels achieved within the rural farmers' community have encouraged farmers to rapidly leave farming activity to find another job in the near by town or city, mainly Wad-Medani[8]. As a result farming is left for the older group (aged above 50 years) with minimum levels of education but good farming experience.

Furthermore, productivity decreases as a result of any additional job(s) undertaken by farmers alongside with farming. Such factors should be considered by NARIs before developing any new technology.

Technology Barriers

Technology does not stand alone, but encompasses political, social, economic, and cultural values that can serve as "barriers" that impede the diffusion or transfer of technology. The barriers to technology transfer exist for all innovations, but some transfers are more affected by these barriers than others.

Technology Appropriateness

The "appropriateness" of technology appears to have a significant impact on its ability to overcome the transfer barriers.

[8] Wad-Medani is the second big city in Sudan after the capital Khartoum.

The assumption is that characteristics of a technology underlying user's agro-ecological, socio-economic and institutional contexts play the central role in the adoption decision and diffusion process (Biggs, 1990; Scoones and Thomson, 1994).

Research impacts the productivity of farming systems by generating new technologies which, if appropriate to farmers' circumstances, will be rapidly adopted (King, 1999). In order to develop relevant and appropriate technologies to the farmers, researchers and academic staff should consider farmers involvement in their research agenda as a top priority as well as the extension services feedback on the research findings previously developed.

The survey results indicate that farmers rely on economic criteria for making an adoption decision. Many farmers base their assessment of the technologies' economic usefulness on observable results, such as "*saving money*" or "*inexpensive to use*".

The technology delivered rarely provides immediate and observable economic results in the field as it needs full and timely adoption of all its recommended packages. Inappropriate and irrelevant technologies result in poor credibility and reliability ratings (lack of technical efficiency) of the technology and adversely impact the adoption decision. Poor linkage between agricultural research (ARC) and farmers has contributed to this.

Communication and Information

Successful technology transfer is not achieved through the simple movement of technology to a new environment; it requires the development of a process and infrastructure that will help the technology "break through" the different barriers which exist.

Communication is a key element in the transfer process. If a new variety is developed by NARIs but the farmers are not made aware of it, this new variety will never reach its intended clients (farmers). Farmers lack information about the technology and technical support and this adversely impacts on productivity. The research reveals that farm location does affect productivity of farmers with regard to accessibility to irrigation water, information, labour, and machinery.

Technology transfer requires human intervention for a technological innovation to become part of a larger system. Extension services are therefore the most important communication channels that support the transfer process and hence linkages between research institutions and extension services are vital for the whole transfer process.

Communication networks impact the adoption decision, therefore, farmers tend to seek a variety of information sources before and during the adoption decision.

Previous research (King and Rollins, 1999) indicates that information sources tend to significantly impact a farmer's adoption decision. The survey reveals that farmers' own experience is deemed as the most trustworthy source of information and plays a critical role in the implementation of the technology.

Furthermore, the research reveals a close link between productivity changes and the frequency of visits by extensionists and researchers to farmers' farms.

Funding

Funding availability greatly influences the transfer of technology. This research clearly demonstrates that farmers cannot implement the technology due to the lack of finance and the difficulty of funding. Therefore, finance and funding problems appear to have a significant role in the proper implementation of the technologies transferred. The research also reveals farmers' lack of finance and access to funding for even basic agricultural operations.

New technologies resulted in "farm" effects that necessitated major changes in traditional production practices for many farmers, therefore, farmers have to be either engaged in compatible practices or make significant changes to adopt the technology.

The research results in Table 7.11 below support this argument as a very high correlation coefficient does exist between productivity increases and the availability of finance and funding.

Table 7.11 Productivity Increases and Farmers Finance		
Correlations		**Productivity**
Pearson Correlation	**Farmer Finance**	.819

Source: Field Survey Data, Appendix-F1.

Due to the timing requirements of the technology, labour for implementation is scarce and unavailability of funds make it almost impossible for many farmers to implement the advice delivered, a fact which tends to be largely ignored by researchers.

Timing

The "timing" of the transfer is critical. From the study, the frequency of farm visits to farmers appears to have a direct influence on the adoption of technologies transferred to farmers and on productivity.

7.5 Reasons behind the Productivity Gap

Although extensionists reported productivity increases of more than 50 percent for farmers as a result of the advice transferred, the research reveals the existence of a productivity gap between what NARIs researchers have achieved in their experimental farms compared to what farmers have achieved in their farms. ARC researchers and GU staff were asked to identify the different reasons behind this productivity gap.

From Table 7.12, the majority of ARC researchers (69%) and GU staff (66%) reported the difficult economic situation of the country over the last ten years as Sudan is currently (1999) experiencing a severe economic situation and this has adversely impacted the development and transfer of technologies.

Table (7.12) Reasons behind the Productivity Gap	
ARC (n=84)	
Reason	**Percentage**
The difficult economic situation of the country	69
Changing of policies and objectives	53
Inefficient and ineffectiveness technology transfer	44
Extension services are not involved in NARIs research strategy	44
Inadequate farmers' absorption capacity for technology	36
Poor linkage between NARIs and farmers	35
No incentives for farmers to increase productivity	34
No incentives for extension services to transfer the technology	33
Poor linkage between NARIs and the extension services	33
Farmers are not involved in NARIs research strategy	33
Implementation system failure	33
Socio-political factors	32
Poor linkage between NARIs and universities	21
Inadequate extension services' absorption capacity for technology	20
Inefficient and ineffectiveness technology development	7
Divergence between NARIs goals and orientation	3
Other reasons	3
GU (n=33)	
Reason	**Percentage**
Poor linkage between universities and farmers	72
Farmers are not involved in universities research strategy	66
The difficult economic situation of the country	66
Extension services aren't involved in universities research strategy	63
Poor linkage between universities and the extension services	57
Implementation system failure	54
Inefficient and ineffectiveness technology transfer	45
Changing of policies and objectives	42
Inefficient and ineffectiveness technology development	39
Poor linkage between universities and NARIs	36
Inadequate farmers' absorption capacity for technology	30
Socio-political factors	30
No incentives for farmers to increase productivity	27
No incentives for extension services to transfer the technology	24
Divergence between universities goals and orientation	21
Other reasons	9
Inadequate extension services' absorption capacity for technology	6

Source: Field Survey Data, Appendix-F2 & F3.

In connection with this difficult situation, many ARC researchers (53%) and GU staff (42%) mentioned the impact that continuous changing of policies and objectives have on the whole agricultural sector, (33%) ARC researchers and (54%) GU staff reported the failure of the implementation system to recognise the fundamental economic constraints facing traditional farming systems in Sudan[9]. Thirty two percent of ARC researchers and (30%) of GU staff gave other socio-economic and political factors as reasons behind the productivity gap.

Approximately (33%) of the ARC researchers and (57%) of GU staff admitted having poor linkages with the extension services and (44%) of ARC researchers and (63%) of GU staff admitted that extension services are not effectively involved in their research strategies. GU staff also report that extension services have no incentive to transfer the technology and advice to farmers as they operate with very limited resources under severe working conditions.

Twenty percent of ARC researchers and (6%) of GU staff reported that extension services' absorption capacity for their technologies is not adequate. Moreover, (36%) of ARC researchers and (30%) of GU staff also argued that the farmers absorption capacity for their technologies is not adequate which resulted in lower productivity as these technologies need full understanding of their technical requirements.

Thirty four percent of ARC researchers and (27%) of GU staff stated that farmers have no incentive to increase productivity, (35%) of ARC researchers and (72%) GU staff agreed their linkages with farmers are very poor and that farmers' awareness of the packages developed by researchers is very limited. Thirty three percent of ARC researchers and (66%) of GU staff also agreed that farmers are not effectively involved in their research strategies.

However, while Ali[10] has argued that the productivity gap is mainly due to low soil fertility caused by the extractive nature of the adopted cropping system, some ARC researchers[11] argued that the war in the southern part of the country exhausted most of

[9] The farming system in Sudan is weak and based on randomised short term objectives.
[10] Professor Elnaiem Abdallah Ali is a research professor at the Plant Nutrition Unit of the Land and Water Research Centre of ARC.
[11] This argument was raised mainly by forestry researchers.

the natural resources and hindered the development of this area which in turn affected productivity negatively at the national level.

Twenty one percent of ARC researchers and (36%) of GU staff reported poor linkages between research institutions and universities as a reason behind the productivity gap, (7%) of ARC researchers and (39%) of GU staff admit that their institutions are not efficient and effective in technology development. Three percent of ARC researchers and (21%) of GU staff agreed that there is a divergence between their institutions goals and objectives. However, other reasons behind the productivity gap stated by ARC researchers and GU staff include;

- wrong economic policies that tended to heavily tax the farmers.

- poor credit facilities and unavailability of loans.

- poor marketing systems and price instability.

- inadequate roads in rural areas and inadequate storage facilities.

- inputs are poorly manipulated.

- unfair production relationship between farmers and the SGB.

- the impact of the climatic changes, i.e. annual rainfall and temperature.

7.6 Modelling the Productivity Gap

The field survey data sets (F1, F2 and F3) were used for modelling the productivity gap in Sudan. For modelling purposes, the "productivity gap" variable was selected as the dependant variable and the explanatory variables include;

- farmer's education level, additional job(s), farm ownership, farm location, lack of finance, frequency of visits by extensionists, technology and advice implementation as well as lost of produce by farmers (Farmers Survey, Q3, Q4, Q5, Q6, Q12, Q15, Q18 and Q21).

- the different reasons reported by researchers behind the productivity gap (Researchers Survey, Q15).

- the different reasons reported by academic staff behind the productivity gap (Academic Staff Survey, Q18).

The results from the three linear regression models (Table 7.13, Table 7.14 and Table 7.15) reveal the following;

(Table 7.13) Farmers Productivity Gap Linear Regression					
	Unstandardised Coefficients		**Standardised Coefficients**		
Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	1.279	.590		2.166	.032
Education	-3.397E-02	.050	-.038	-.675	.501
Job	.128	.180	.039	.709	.480
Ownership	-.137	.230	-.031	-.594	.554
Location	1.079E-02	.106	.006	.102	.919
Finance	-.128	.259	-.027	-.495	.621
Time	-3.864E-02	.041	-.058	-.946	.346
Implementation	1.495	.103	.871	14.520	.000
Produce	-.101	.295	-.018	-.342	.733

Source: Field Survey Data, Appendix-F1.

(Table 7.14) Researchers Productivity Gap Linear Regression					
	Unstandardized Coefficients		**Standardized Coefficients**		
Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	5.095	.704		7.238	.000
Divergen	-3.068	2.113	-.181	-1.452	.151
Effecti2	-.362	1.705	-.030	-.212	.833
Strateg	-1.083	.957	-.162	-1.132	.262
Strateg1	-.642	.968	-.101	-.664	.509
Inadequ	-1.045	.890	-.160	-1.174	.245
Inadequ1	-.282	1.077	-.036	-.262	.794
Incenti	-1.763	.928	-.266	-1.900	.062
Incenti1	5.233E-02	.918	.008	.057	.955
System	1.181	.879	.177	1.344	.184
Effecti3	.224	.838	.035	.267	.790
Linkage2	-1.140	1.162	-.149	-.981	.330
Linkage3	1.007	1.130	.151	.891	.376
Linkage4	1.028	1.163	.156	.884	.380
Difficul	.460	.987	.068	.466	.643
Policy	-.327	.916	-.052	-.357	.723
Social	.709	.981	.105	.722	.473
Other4	-.235	2.273	-.014	-.103	.918

Source: Field Survey Data, Appendix-F2.

(Table 7.15) Academic Staff Productivity Gap Linear Regression					
	Unstandardized Coefficients		Standardized Coefficients		
Variables	B	Std. Error	Beta	t	Sig.
(Constant)	.898	1.131		.794	.440
Divergen	-2.077	1.370	-.345	-1.517	.150
Effecti2	.330	1.346	.066	.245	.810
Strateg3	.183	1.363	.035	.134	.895
Strateg4	-2.528	2.225	-.495	-1.136	.274
Inadequ	.930	1.984	.174	.469	.646
Inadequ1	-8.593E-03	4.389	-.001	-.002	.998
Incenti	-2.588	1.592	-.484	-1.626	.125
Incenti1	1.311	1.566	.229	.837	.416
System	.472	1.394	.096	.339	.740
Effecti3	-.454	1.542	-.092	-.294	.773
Linkage2	-3.544	2.500	-.693	-1.417	.177
Linkage3	-.429	1.802	-.086	-.238	.815
Linkage4	4.479	1.615	.811	2.774	.014
Difficul	3.189	1.921	.611	1.660	.118
Policy1	-1.030	2.232	-.207	-.462	.651
Social1	.725	1.463	.135	.495	.628
Other5	-4.236	3.894	-.495	-1.088	.294

Source: Field Survey Data, Appendix-F3.

However, as mentioned in earlier Chapters with regard to the nature of the problem investigated in this research and the type of field data collected it was not possible to develop a workable model for the productivity gap with such data as the data is cross sectional with inadequate variations. For more details on other modelling strategies see Chapter Eight (8.5 Areas for Further Research).

7.7 Closing the Productivity Gap

During the survey different proposals, suggestions, comments and opinions were gathered from ARC researchers as well as GU staff with regard to how the productivity gap can be closed in the future i.e. practical solutions at the national level. The responses include the following;

- Adoption of the right micro and macro economic policies. National policies should be changed from very high taxes and very expensive inputs to consider raising output prices, lower input prices, offering loans to farmers, credit facilities, proper funding for all agricultural operations, improving storage facilities, solving key socio-economic problems such as health problems as well as improving infrastructure (*irrigation channels, roads, and other necessary and vital services*).

- Politicians must refrain from interference in agricultural policy, stable agricultural and marketing policies as well as the formulation of a fair production relationship with farmers is required.

- Better management to make inputs (*fertilisers, chemicals, ..etc.*) available at the needed time and fully understanding the timely application of these inputs, timely land preparation, availability of irrigation water at the needed time, good soil-plant management (*according to Ali, recycling of crop residues will improve soil fertility*) as well as the adoption of mechanisation and the recommended technological packages.

- Addressing the most important problems affecting yield as well as intensive socio-economic studies on the factors responsible for the adoption rate of the new technologies and advice by farmers.

- Strengthening the technology development, transfer and dissemination continuum; research strategy should focus more on problem oriented applied research, training of technicians, intensification of on-farm research which calls for more intensive involvement of researchers in technology transfer, intensive research fully backed by the government and other international organisations and more funds for research.

- The implementation of the IPM strategies and the new concepts of participatory approaches where the socio-economic factors are considered, development of appropriate technologies coupled with agricultural policies that encourage their adoption as well as the diversion of researchers' minds from personal benefits to national and public benefits.

- Involvement of farmers in research trials as experience showed farmers would normally follow and adopt the recommendations when fully convinced by the return; research strategies should consider the feedback of farmers and extension services and inadequate absorption capacities of the extension services and farmers could be overcome through training and farmers education, excessive and intensive training to farmers to erase their illiteracy (*learning by doing*) through farmers field schools and training the master trainers in the technology to be transferred.

- Effective co-operation between extension, farmers, researchers and donors (*government*).

- Vertical and horizontal extension. Vertical extension could be achieved by introducing high yield varieties to obtain high productivity, utilise areas not under utilisation in the different poor rural areas and plan to make use of all lands and water in the Sudan.

- Good planning and funds, appropriating enough funds for production at the right time, alleviating financial constraints of farmers and making the agricultural sector more rewarding for those who have their "hands on the soil", proper maintenance of the infrastructure.

- Effective role of extension services to provide farmers with techniques which make them able to find good markets for their products, e.g. small-scale oil milling in rural areas which can control the ground nuts price.

- Changing the traditional farming systems, changing economic policies concerning agriculture as well as the agricultural systems used, more agricultural mechanisation, improvement of the production systems, improvement of storage facilities, better husbandry practices and natural resources conservation methods, a sound and a self-reliant land use system.

7.8 Summary

This Chapter identifies different factors contributing to the productivity gap with regard to the nature of the technologies and advice developed by research and academic institutions. This Chapter also attempts to develop the technology transfer model. It also illustrates the weak linkages between these institutions and farmers and extension services as one of the critical factors that have hindered the effectiveness of agricultural research in Sudan. The findings are consistent with those in earlier Chapters. In the following Chapter the major findings and conclusions of this study are discussed.

CHAPTER EIGHT

Conclusions

CHAPTER-8
CONCLUSIONS

8.1 Introduction

To identify factors influencing the transfer of technology from research and academic institutions to the farmers in Sudan an analysis has been conducted (using data collected in the Field Survey in Sudan 1999) in order to evaluate and analyse the implementation system constraints in Sudanese traditional farming. In this study, investigations of the determinants of the productivity gap and technology transfer in Sudan have been carried out to determine the reasons behind the productivity gap as well as to formulate solutions to this major problem facing agriculture in Sudan.

The aim of this Chapter is to present a review of the major findings and results as well as to identify certain policy implications. This Chapter also highlights the contribution this study makes to knowledge of technology transfer and productivity enhancement including the different aspects of technology development, transfer and adoption. Suggested areas for further research are presented at the end of the Chapter.

Several findings concerning internal technology transfer in Sudan have been generated in this research. These findings fall into three distinct categories:

(i) The nature of the technologies and advice developed by research and academic institutions in Sudan are observed to have a significant role in the transfer and adoption of them and consequently contribute to the productivity gap in Sudan. Weak linkages between the relevant institutions and farmers and extension services were observed to be one of the critical factors that have hindered the effectiveness of agricultural research in Sudan.

(ii) The effect of the key technology adoption determinants in Sudan such as education level, age, farming activities, farm location, farm ownership, finance and funding availability, loss of produce and on-farm visits by researchers, academic staff and extensionists on the adoption of technology and productivity increases have been confirmed.

(iii) The impact of the technology transfer determinants in Sudan such as transfer models or approaches, linkage policy, farmer participation in research, technology barriers, technology appropriateness, communication and information, funding as well as timing has been clearly illustrated. Moreover, the vital roles of the extension services in the efficient and timely transfer of any new technology and/or advice from NARIs to farmers have been clearly demonstrated.

8.2 Contribution to the Technology Transfer Literature

This study contributes to the knowledge of the role played by these systems as they interact with each other in the whole technology transfer process as defined in the literature. The findings are therefore of new and significant relevance to agricultural development strategy and policy reform in Sudan and similar countries. The recommendations and policy implications of the study will be discussed in section 8.3.

In relation to the above and unlike other studies previously conducted this research addresses a very important issue related to the growing technological gap not between the South and the North but within the South itself. Most of the studies carried out on this subject (in Sudan and similar countries) either investigated the adaptation of technologies and the eventual generation of new technology or focused on the speed or adoption rate of a very specific chosen technology, this study has investigated the whole transfer and implementation system in Sudan. Unlike other studies, this study has examined the three technology linkages; *technology developers, technology users and the technology transfer agents* as a single indivisible system.

In addition to the above new findings, this research has developed a new analytical framework in the context of internal technology transfer in Sudan. There has been also a contribution made to the national research strategy, updating universities curricula and their role in the economic development of Sudan, clearly demonstrating the vital role of the extension services in the efficient and timely transfer of any new technology as well as the identification of systemic failure.

The knowledge gained aids a clearer understanding of the constraints facing internal technology transfer in Sudan and other developing countries which face similar socio-economic and development problems. Moreover, it demonstrates that economic analysis alone will not provide a satisfactory solution to the type of problems investigated as these issues and problems also have political and socio-cultural dimensions. Therefore, the proposed solutions simply seek to change the behaviours of both individuals and institutions. To do this it is necessary to recognise all the dimensions of the problem.

8.3 Discussion of the Major Findings

In Chapter 1, the agricultural and economic potential of Sudan was demonstrated. In this, Sudan has huge agricultural potential in terms of the amount of arable land and pasture, as well as plentiful water resources. From a total land area of 250.4 million ha, 84.0 million ha is cultivable, 24.0 million ha is natural range and pasture and 91.5 million ha is natural forests which produce more than (80%) of the country's fuel and one of its most important exports: Gum Arabic. While cultivable land constitutes (35%) of the total land area only a maximum of (20%) of this is cropped in years of good rainfall (ISNAR, 1994). Water resources are enormous and are contributed by the Nile System, underground water supply and rainfall.

In Chapter 4, the factors related to the effective and efficient technology development within the agricultural research and academic institutions were examined. Agricultural research in Sudan plays a key leadership role in developing and adapting technology required to meet the needs of agricultural development. However, despite the importance of agricultural research to the development of Sudan, several problems can be noted; the limited impact on farmers, particularly in the rainfed sector (see ISNAR, 1994), the lack of attention to livestock relative to cropping, the weakness of linkages among organisations working in the sector, particularly between the universities and the research institutions, and the lack of a research strategy from which a long-term research program can be established.

It has been observed that there are real problems in technology development, assessment and the transfer system that impinge on the dissemination and adoption of technologies in Sudan. All research linkages are very poor. Research facilities are moderate, but heavily utilised. Inadequate national funding to operate the public agricultural research and academic institutions is a critical constraint. Efficiency and effectiveness have suffered as a result, and institutional sustainability has become doubtful.

However, in addition to the funding problem, research (particularly universities) is also hampered by poor libraries (*some are reasonable*), absence of a documentation centre, poor computer facilities, inadequate laboratory equipment and very poor maintenance, insufficient farm machinery and vehicles, poor maintenance of research facilities, lengthy administrative procedures hampering the timely availability of supplies and materials, irregular electricity and water supply and the lack of supplies and other research inputs.

The analysis of the academic institutions revealed that National universities in general, including GU, are not considered as integral elements of NARIs. And although GU represents one of the largest concentrations of highly trained scientists capable of conducting research on topics of national importance, they are, however, under-utilised for agricultural research and they are largely occupied by teaching (*almost 90% of their time*). However, research policies in the universities are generally incoherent and research objectives and projects are largely derived and chosen on a personal interest basis and rarely reflect the priority needs of agricultural sector objectives and national development and society goals. Generally, the research structure of the universities is very weak. The bulk of research conducted so far by the university has been linked to the graduate studies programs in partial fulfilment of the MSc and PhD degrees.

Moreover, the policies which guide collaboration between agricultural research and higher education are lacking. Despite this, informal linkages do exist between ARC and nearby universities, mainly Gezira University. Formal joint research programs and scientific activities are generally limited in magnitude or lacking. Most of the universities have seconded and absorbed scientists from ARC, but no reciprocal arrangement for exchange are effected. Facilities and/or equipment in the research institutions are to a large extent used by post-graduate students where the research is jointly supervised. Almost all the academic staff (96%) are using their research findings in their teaching and/or demonstration manuals and (51%) of the researchers have some or all of their research findings included in universities curricular teaching/demonstration manuals.

However, farmers' feedback and involvement in research strategies is not a top priority for NARIs but universities research strategies consider it the top priority in setting their research strategy. Moreover, extension services feedback and reports are not highly considered in NARIs and universities research strategies.

The key factors associated with technology adoption in Sudan were discussed in Chapter 5. The analysis of these key factors shows there is a serious finance problem facing farmers resulting from low profitability of the different crops grown, delays of payments, high taxes, water charges as well as the very expensive Hybrid seeds. Meanwhile, disease is considered one of the most important factors resulting in many farmers losing their produce. Many reasons have contributed to this problem including; inefficient pesticides delivered to farmers or unavailability of the recommended pesticides as well as the existence of a variety of lethal weeds.

In addition, any level of education particularly higher levels achieved within the rural farmers' community have encouraged farmers to rapidly leave farming activity to find another job in the near by town or city.

New technologies result in "farm" effects that have necessitated major changes in traditional production practices for many farmers, therefore, farmers have to be either engaged in compatible practices or make significant changes to adopt the technology. Due to the timing requirements of the technology, labour for implementation is scarce and unavailability of funds make it almost impossible for many farmers to implement the advice delivered, a fact which tends to be largely ignored by researchers.

In addition, farmers do not normally implement the technologies and advice provided by research as they finding them expensive to adopt and of no significant returns compared to their traditional practices. Also the irrigation problems make it impossible for farmers to adhere to the recommended packages and priority is always given to cotton rather than other crops.

In Chapter 6, the interaction of the different factors associated with the proper and timely transfer of technology was examined. It has been found that communication networks impact the adoption decision, therefore, farmers tend to seek a variety of information sources before and during the adoption decision. Farmers' own experience is deemed as the most trustworthy source of information and plays a critical role in the implementation of the technology. Furthermore, there is a close link between productivity changes and the frequency of visits by extensionists, researchers and academic staff to farmers' farms.

In addition, farmers lack information about the technology and technical support and this adversely impacts on productivity. Farmers rely on economic criteria for making an adoption decision. The technology delivered rarely provides immediate and observable economic results in the field as it needs full and timely adoption of all its recommended packages. Inappropriate and irrelevant technologies result in poor credibility and reliability ratings (*lack of technical efficiency*) of the technology and adversely impact the adoption decision. Poor linkage between agricultural research and farmers has contributed to these results.

In this Chapter however, the influence of the government on technology transfer is evident. The government is interested solely in increasing the production of exportable cash crops, mainly cotton and hence the political agenda largely ignores the needs of the small-scale farmers. To make best use of available resources, program design must give primary consideration to the needs of research users.

The agricultural extension task is focused on increasing the efficiency and productivity of the farmer. Provision of linkages between farmers' problems and agricultural research institutes is a major task of an agricultural extension organisation which requires two-way communication. Farmers' experiences are an important source of extension information. The return on investments in agricultural extension however are often high when extension and research are well organised and co-ordinated.

The analysis in Chapter 6 found that linkages between NARIs and extension services are not stable, before 1985 there was no linkage activity, between 1985 and 1995 there were very strong extension linkages such as demonstration plots, on-farm research, field days, farmers schools sessions as well as participation in training courses but after 1996 linkage activities with the extension services declined and now (2000) there are only very few on-farm verification yield trials. Universities also have some linkages with extension services in the form of corporate trainers giving lectures in FFSs and short TV programmes.

However, the potential developmental contributions of agricultural extension in Sudan are hampered by two basic problems, namely: an increasing coverage problem and the resources problem. Technology transfer problems and constraints include; car maintenance (*spare parts*), shortage of extension staff (*currently 2-3 field inspectors per block*), the administrative work over-load needed alongside the extension activities, delay of inputs, fertilisers and improved seeds deliveries, irrigation problems (*flooding, weeds, delay summer maintenance*), low prices and poor marketing of produce, the chronic funding problem, termination of almost all the rural development programs over the last period as well as poor linkages between extension services and farmers.

The twin problems of coverage and resources are complex and require creative policy and management remedies. In Sudan there is a serious shortage of funds, personnel and other resources for an adequate, functional and responsive agricultural extension service. In a big country like Sudan, the coverage problem cannot be addressed effectively by a single central agency, be it public or private. In the first instance this twin problem requires extension managers to pursue management and extension approaches that are efficient and increase effective coverage such as the use of participatory approaches, use of support communication and mass media and reduction of the non-extension type of assignments to extension workers.

This Chapter clearly demonstrated the lack of agricultural extension policy; policy makers and programme managers do not appreciate the importance of extension which is an essential part of any productivity improvement at the national level. There is also a lack of long-term and comprehensive planning for extension as well as a low budget allocation to extension activities (*in addition, extension component suffers from further budget cuts in the times of austerity*). The lack of such appreciation of the extension role in national agricultural policies has resulted in a relatively low priority for training.

As a result, curricula and teaching programmes are not particularly relevant to the production needs and employment demands of the agricultural extension services. The situation has become more serious in recent years (the nineties) due to the economic crisis in the public sector in Sudan. These and other factors, such as environmental degradation, rapid changes in technical knowledge and the increasing marginalisation of rural areas, all call for changes in the current systems of education in agriculture in Sudan.

Meanwhile, poor linkages among these institutions (the affiliation of agricultural institutions to the Ministry of Agriculture and the academic institutions to the Ministry of Education) has led to insufficient technical preparation of extension candidates due to an unsatisfactory curriculum, lack of emphasis on practical training, and lack of proper exposure to the importance of careers in extension (*although some efforts are currently explored in the GU*) and consequently, low salaries and status of especially field extension staff.

Furthermore, there is a lack of knowledge about the latest developments in extension (*resulting in lack of competence and undermining the need for new knowledge and skills*), low quality training staff (*mostly good technical subject-matter specialists but without any knowledge and experience in training approaches and methodologies*), lack of incentives for well trained manpower (*resulting in the loss of trained persons, especially those at high level, to more attractive jobs overseas or with the private sector*), lack of logistic facilities such as transportation, equipment, proper training centres (*resulting in inadequate training both in terms of frequency and quality*), imbalanced curriculum at academic institutions with more technical agricultural subjects and less extension education (*leading to the need for lengthy and costly in-service training*),

Another serious problem identified is subject matter coverage where the extension department is faced with an increasing variety and complexity of subject matters that are needed by farmers in modern, competitive and sustainable farming. Hence, currently and in the future agricultural extension systems need to include farm management (*including farm planning, credit and marketing education among farmers*) and concern for the environment and sustainable agriculture.

In Chapter 7, the causal factors associated with the productivity gap in Sudan were examined. Although it is very difficult to estimate exactly the percentage of any productivity increase and/or improvement as a result of agricultural research, researchers and academic staff agree that their research findings definitely result in productivity increase and/or improvement.

The analysis in this Chapter attributed the low productivity achieved by farmers to many factors including; the heavy tax on farmers, poor credit facilities and unavailability of loans, poor marketing systems and price instability, inadequate roads in rural areas and inadequate storage facilities, inputs are poorly managed and an unfair production relationship between farmers and the SGB. In addition, the analysis in Chapter 7 also found that farm location does affect productivity of farmers with regard to accessibility to irrigation water, information sources, labour and machinery.

From the above discussion it can be argued that through early contact and involvement of farmers in the research strategy in Sudan and with regular visits to the farms the problems of the development of relevant and appropriate technologies for farmers can be solved. However, at this stage farmers will need adequate funding and easy access to finance to implement the technology which is supposed to be inexpensive. Linkages between NARIs, extension services and farmers will help to close this productivity gap.

8.4 Recommendations and Policy Implications

The findings of this study may help policy makers to take appropriate and immediate measures to close the productivity gap in Sudan. This is important in that Sudan is considered to be facing serious food shortage problems vis-à-vis socio-economic development. The recent FAO Crop Assessment Mission to Sudan has estimated that Wheat output this year (214000 tonnes) is about (60%) below the previous five years' average of about (532000 tonnes), Sorghum output this year (2.35 million tonnes) is about (24%) below the average for the previous five years and that the overall aggregate production of cereals in 1999/2000 estimated at (3.14 million tonnes) represents a drop over last year and the previous five years of some (39%) and (24%) respectively.

All research and technology-transfer organisations involved in the transfer process must see themselves as part of a single agricultural knowledge and information system.

Explicit linkage policies are required from the research, extension, farmers and universities, these policies should be backed by sound linkage strategies and by the financial, human, and physical resources required. However, these linkages are not usually effective if they are imposed by decree or administrative circular and therefore, it is important to stress the fact that these linkages can improve only if there is a real consensus and commitment among managers at all levels of all the organisations involved to make improvements.

The relationship between research and education deserves more attention. Improved facilities, postgraduate training opportunities, and improved planning and review procedures provide not only a capacity for more relevant research but also an incentive for staff to stay in the public research institutions. Helping other researchers understand farming systems and their requirements arguably has the highest priority for use of scarce socio-economic expertise in NARIs.

Farmers' socio-economic environment plays a key role in technology transfer and the decision-making process with regard to setting up and implementing the research agenda and evaluating its results. In many cases, the research conditions where the technology is developed are different from farmers' conditions where it is ultimately used. Thus, it is important for researchers to communicate with and understand the farmers' culture. This communication will help assure a solution that is appropriate for the farmers' culture and acceptable to their social and economic conditions. Research should also consider the characteristics of the labour force and the resources available in the farming community.

A good way to ensure that the targeted farming community quickly adopts developed or adapted technology is to ensure that it addresses a clearly identified problem. Therefore, there is a need to make research more relevant to the needs of small-scale farmers, especially in the more difficult production environments. Researchers should consider the small-scale farmers' requirements; cheap, easy to understand and require minimal training for successful adoption. However, interventions should include adjustments in resource allocations to correct imbalances, and a range of techniques to improve research-extension-farmer linkages. The latter should be designed to inform researchers of the real constraints facing farmers, and to derive practical recommendations on new technology for extension services and farmers. Organisation of regular meetings between research and extension personnel to achieve these objectives has had mixed results. On-farm research capacity has been expanded, although it has suffered from a number of problems, the most important of which is that it is often the first program to suffer in times of funding shortfalls.

The process is not complete however unless the adoption of technology resulting from research is measured in the targeted communities. The development of a monitoring, evaluation, and socio-economic analytic capability in research institutions deserves greater policy makers' attention. The policy needs to put more effort into developing, with clients, *ex ante* and *ex post* economic evaluation of programs and practical research performance indicators are both required; defining which research programs will be measured for economic impact; and ensuring that arrangements are in place to identify whether the skills are available for such analysis.

Inadequate national funding to operate the public agricultural research institutions is a critical constraint. In Sudan agriculture's contribution is important enough to warrant strong budgetary support of an efficient research system. Unfortunately, while the staffing of public sector components of NARIs has increased, the financing of research operations has not kept pace with staff expansion. Consequently, the funding per researcher has declined with salaries consuming an unhealthy share of recurrent funding. Efficiency and effectiveness have suffered as a result, and institutional sustainability has become doubtful.

There is an urgent need to improve farmers' trust in extension advice, to increase public and private support for extension services, and to raise confidence among staff to face technical challenges. Given the severe restrictions on financial resources, the Sudanese government needs to determine levels of continued support to extensionists training based on the ability of the different national universities and colleges to carry out curricular modifications that reflect need. This will require moving from a single-disciplinary approach to an inter-disciplinary systems approach that incorporates a wide range of new topics, including gender, environmental and population issues.

To achieve production targets the Sudan will need to strengthen its present agricultural research capabilities for planning and implementing system-building strategies in agricultural research policy, organisation and management. This requires the involvement of farmers in research trials as experience shows farmers would normally follow and adopt the recommendations when fully convinced by the return; research strategies should consider the feedback of farmers and extension services and inadequate absorption capacities of the extension services and farmers could be overcome through training and farmers education.

8.5 Areas for Further Research

From this study some suggestions for areas of further research are made and these are as follows:

1. As mentioned in Chapter one, the Gezira Scheme's sheer size made the sampling structure very difficult. The study focused on the Central Group for sampling purposes which has resulted in a small sampling unit for farmers (120) compared to the total number of farmers (114000) in the whole scheme. Further studies should be carried out on the Northern and Southern Groups to give a clearer picture of the whole scheme. Therefore, by designing specific questions one can make a comparative study with the findings made here..

2. In the survey the Farmers Questionnaire, Q9 - *Labour Inputs* and Q10 - *Cost of Production*, contained many missing values as farmers either didn't know how exactly to estimate their cost of production due to the very complicated financial procedures of SGB or they did not want to divulge such information in order to avoid any further tax based on their answers. Due to a large amount of missing data these variables were omitted from the present analysis. Therefore further study is needed to explore the effects of these missing variables.

3. As this study has clearly demonstrated the impact of finance and availability of funding on the productivity gap, further research is required to examine all the possible immediate sources of finance and how to make them accessible to farmers and to examine the different ways in which government can act as a main participant in funding farmers.

4. The study has also confirmed the vital role of (the absence) of effective linkages between the three technology partners. It is therefore very important that further research into how these linkages can be improved is undertaken, preferably in the near future.

5. An important area for future research would be an examination of the net effect of farmers' socio-economic and cultural environments on their productivity. This would be a major piece of research.

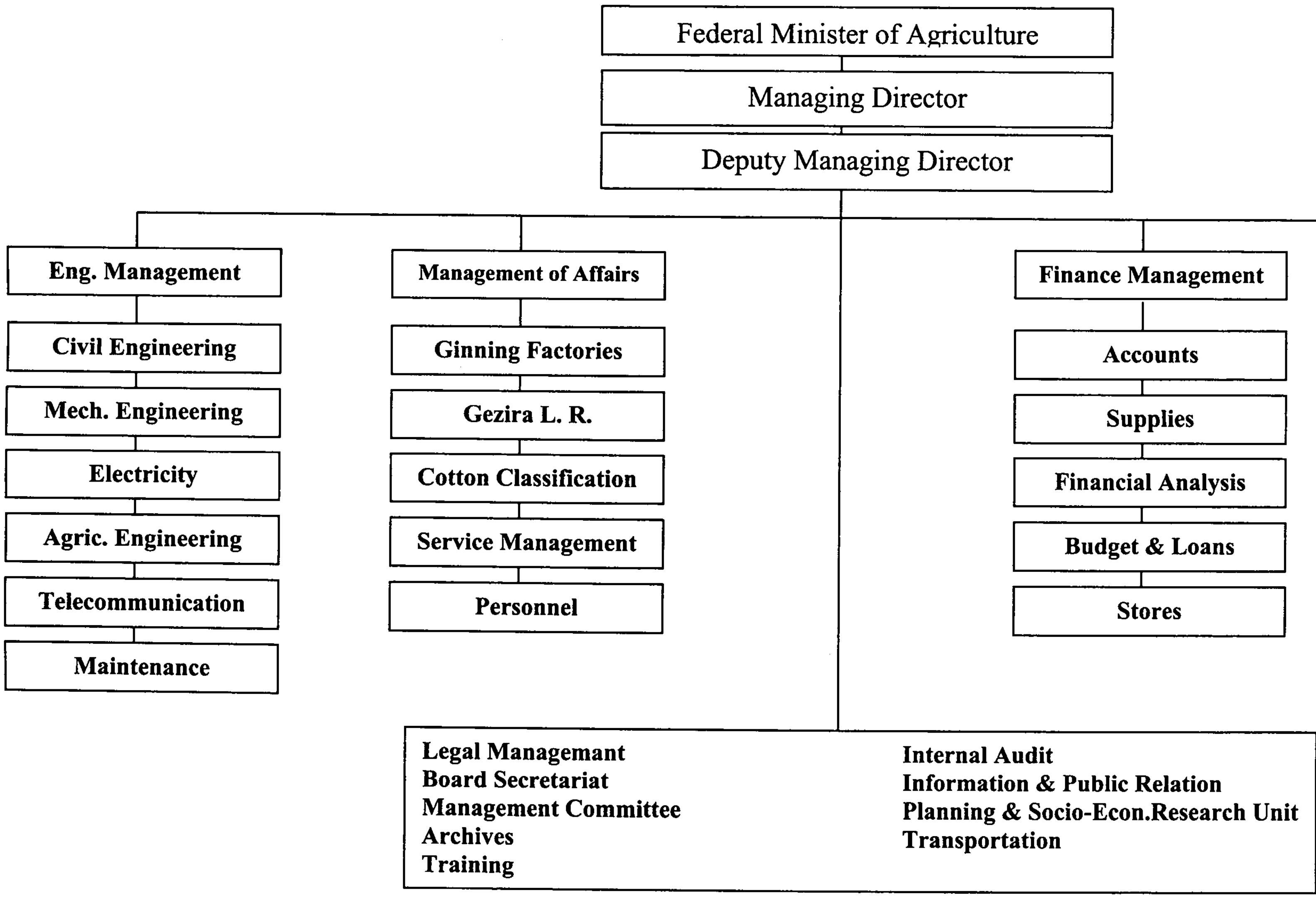
6. Another important area of research, again requiring major work, is a statistical analysis of the productivity gap aimed mainly at generating an analytical model of the key variables involved.

In conclusion, this thesis has identified some of the key determinants of the productivity gap in Sudan. It has also provided a better understanding of the implementation system constraints in Sudan within a framework of demographic, socio-economic, technical, cultural and decision-making variables. In addition, the path of closing the productivity gap in the future in Sudan has been suggested in the above policy recommendations. It is concluded that by implementing the recommendations based on the findings of this study, the future productivity gap in Sudan can be substantially reduced.

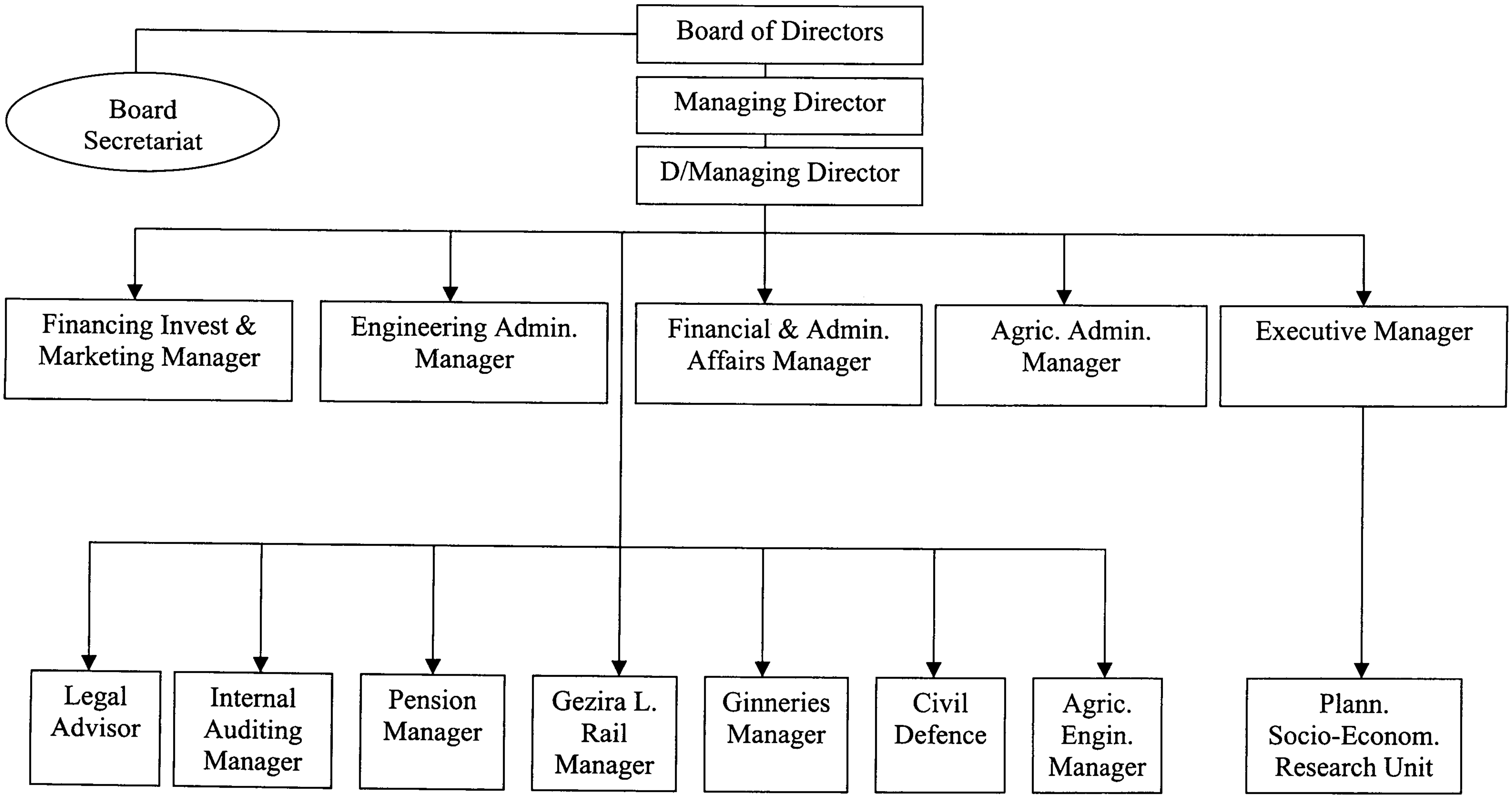
APPENDIX-A

Organisational Charts

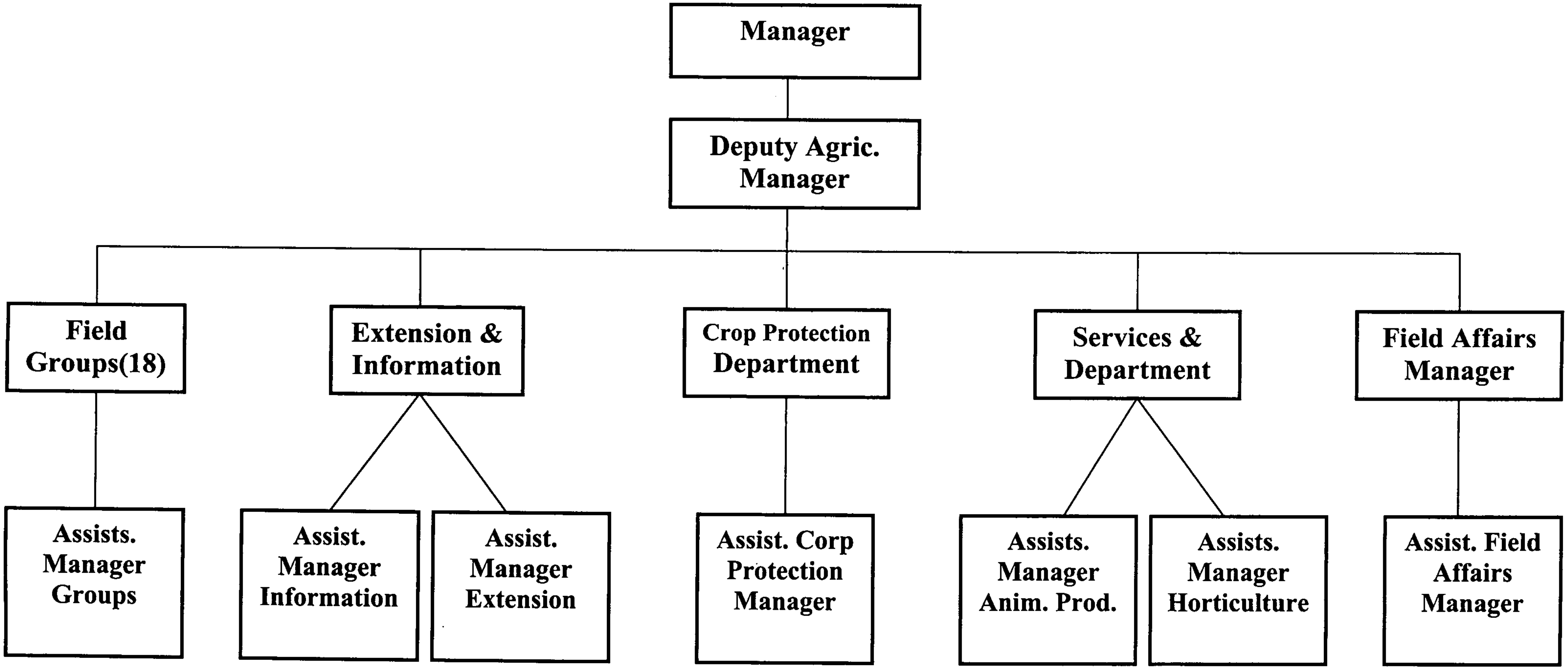
Appendix A1 Former Organisational Structure of the Gezira Scheme



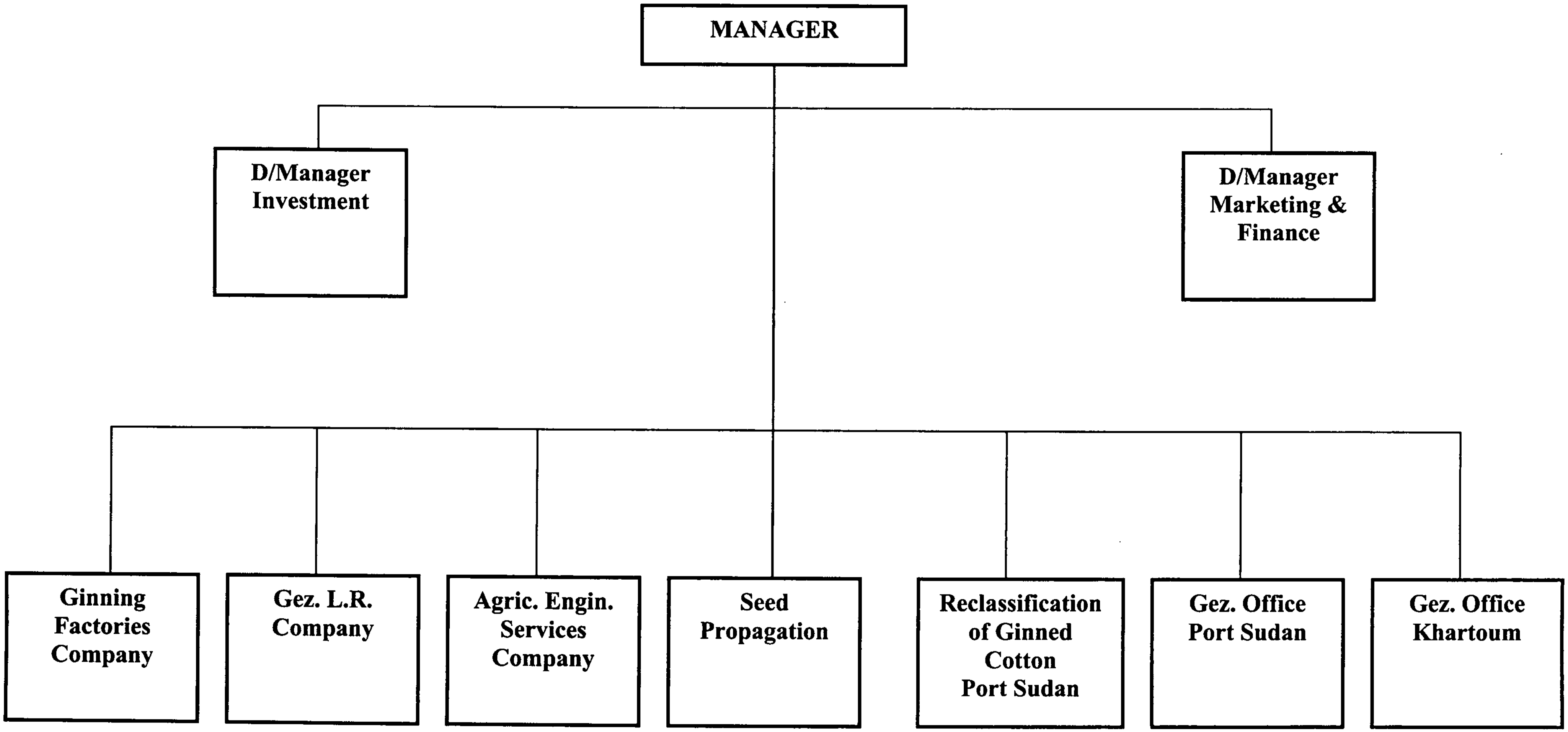
Appendix A2 New Organisational Structure of the Gezira Scheme



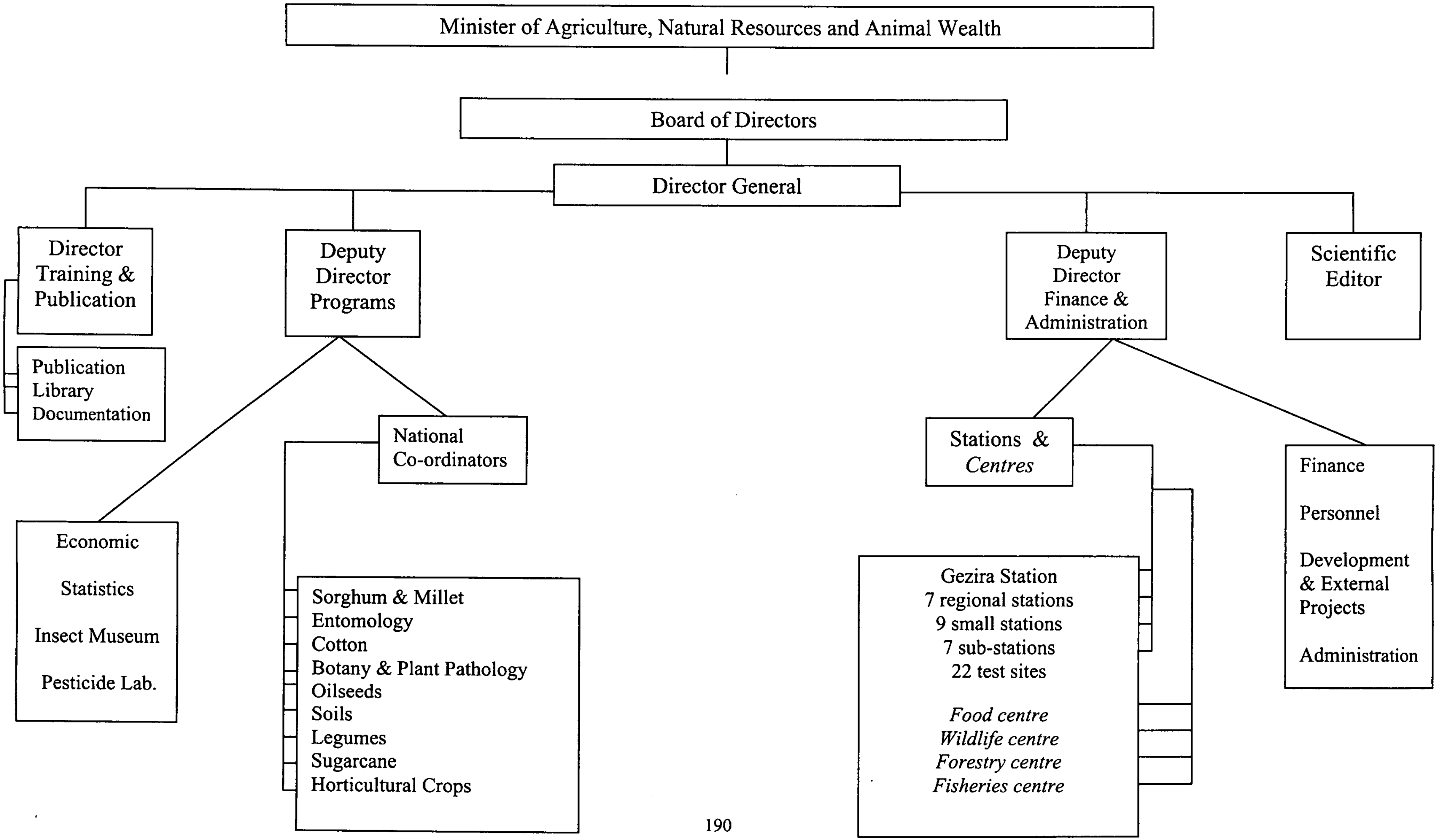
Appendix A3 Organisational Chart of the Gezira Scheme Agricultural Administration



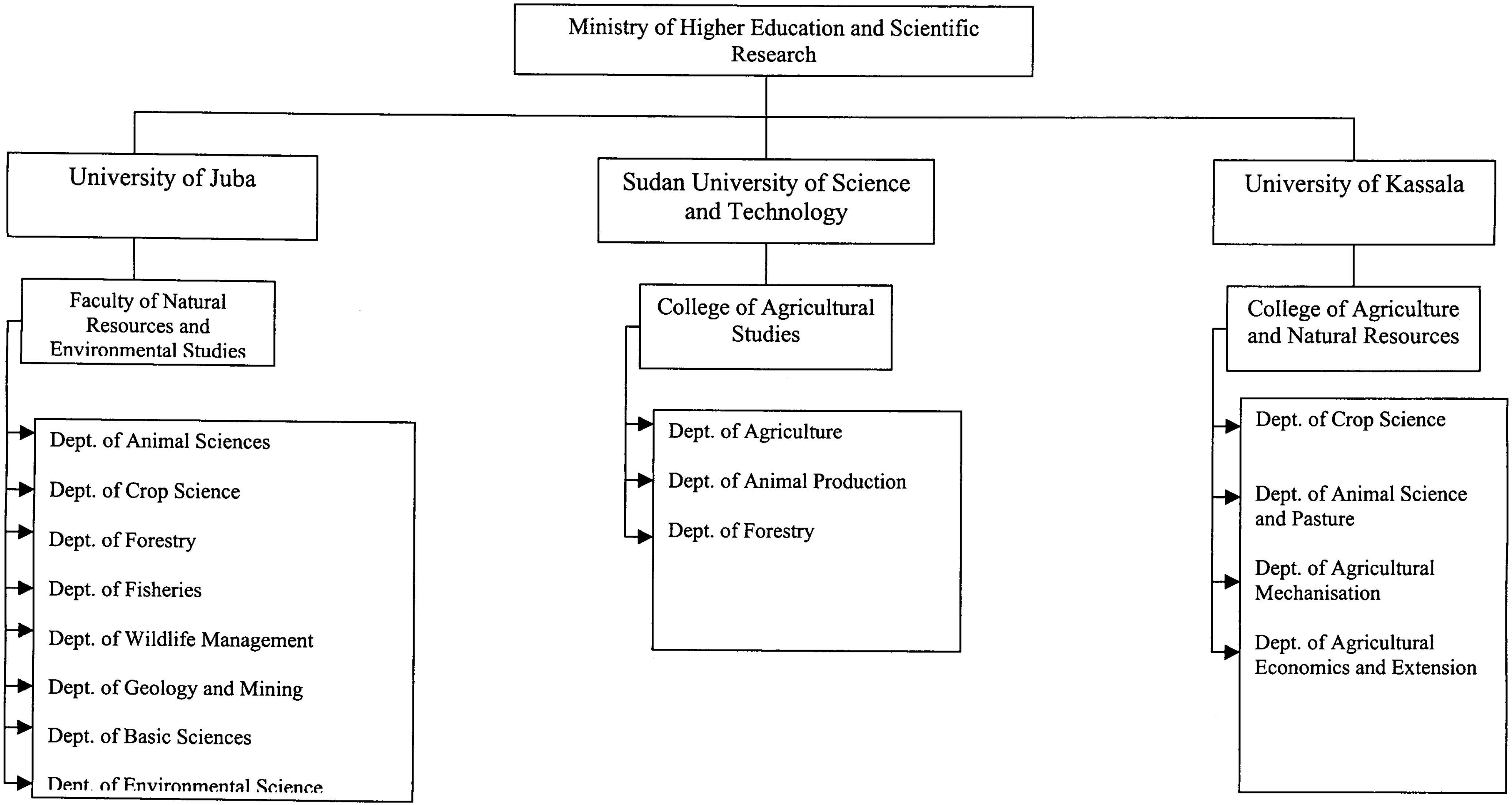
Appendix A4 Finance, Marketing and Investment Administration



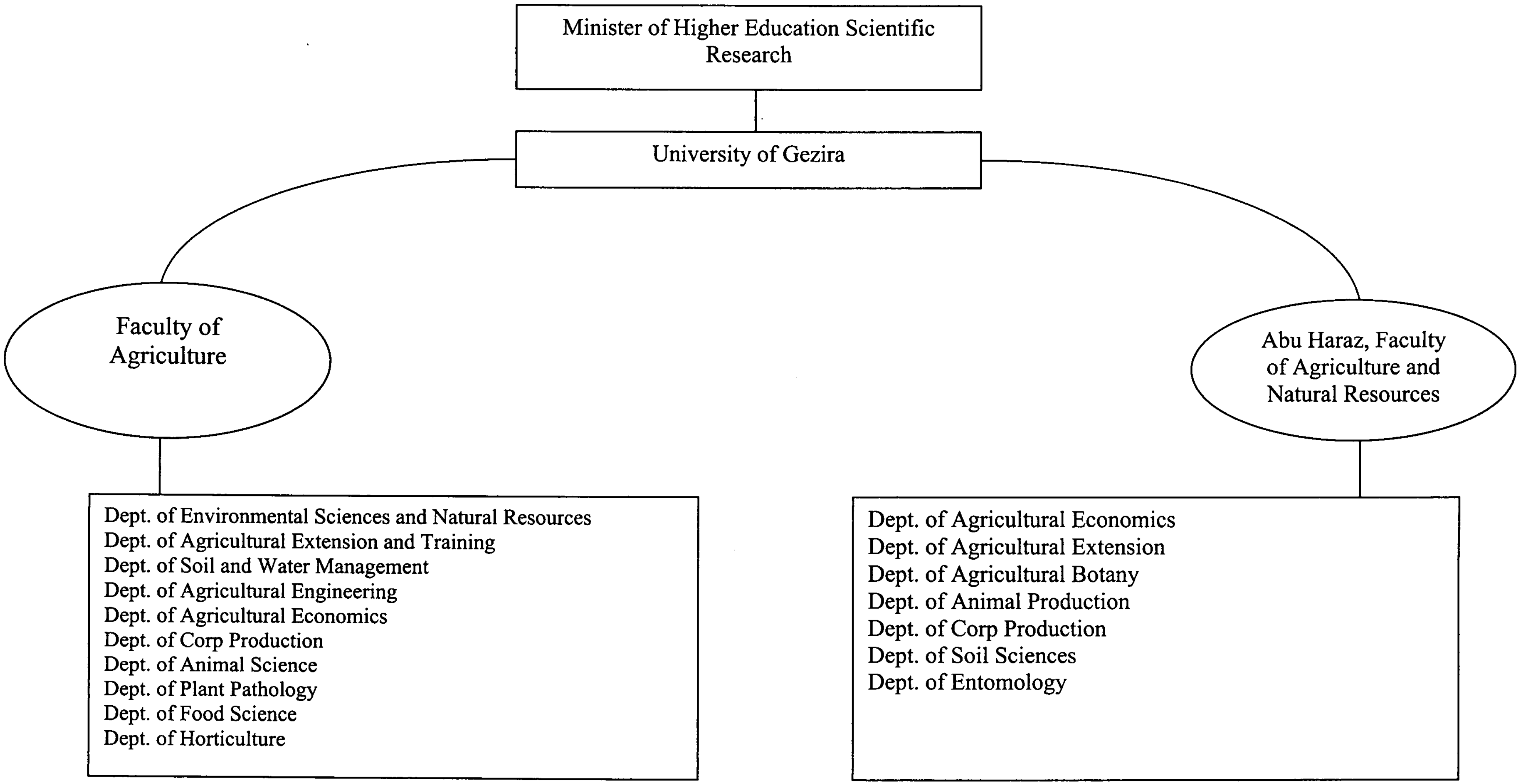
Appendix A5 Organisational Chart of the Agricultural Research Corporation



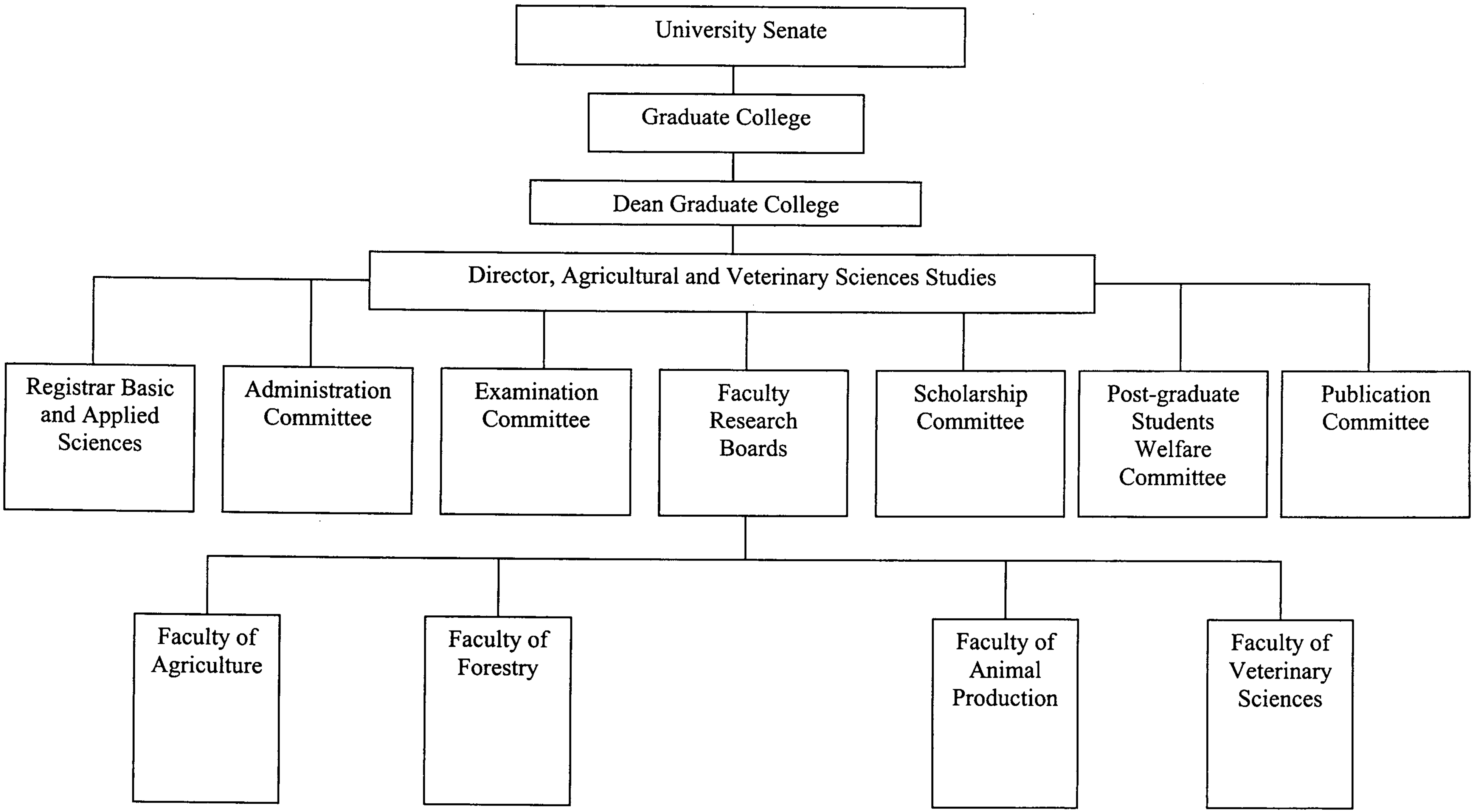
Appendix A6 Organisational Chart of the Academic Institutions



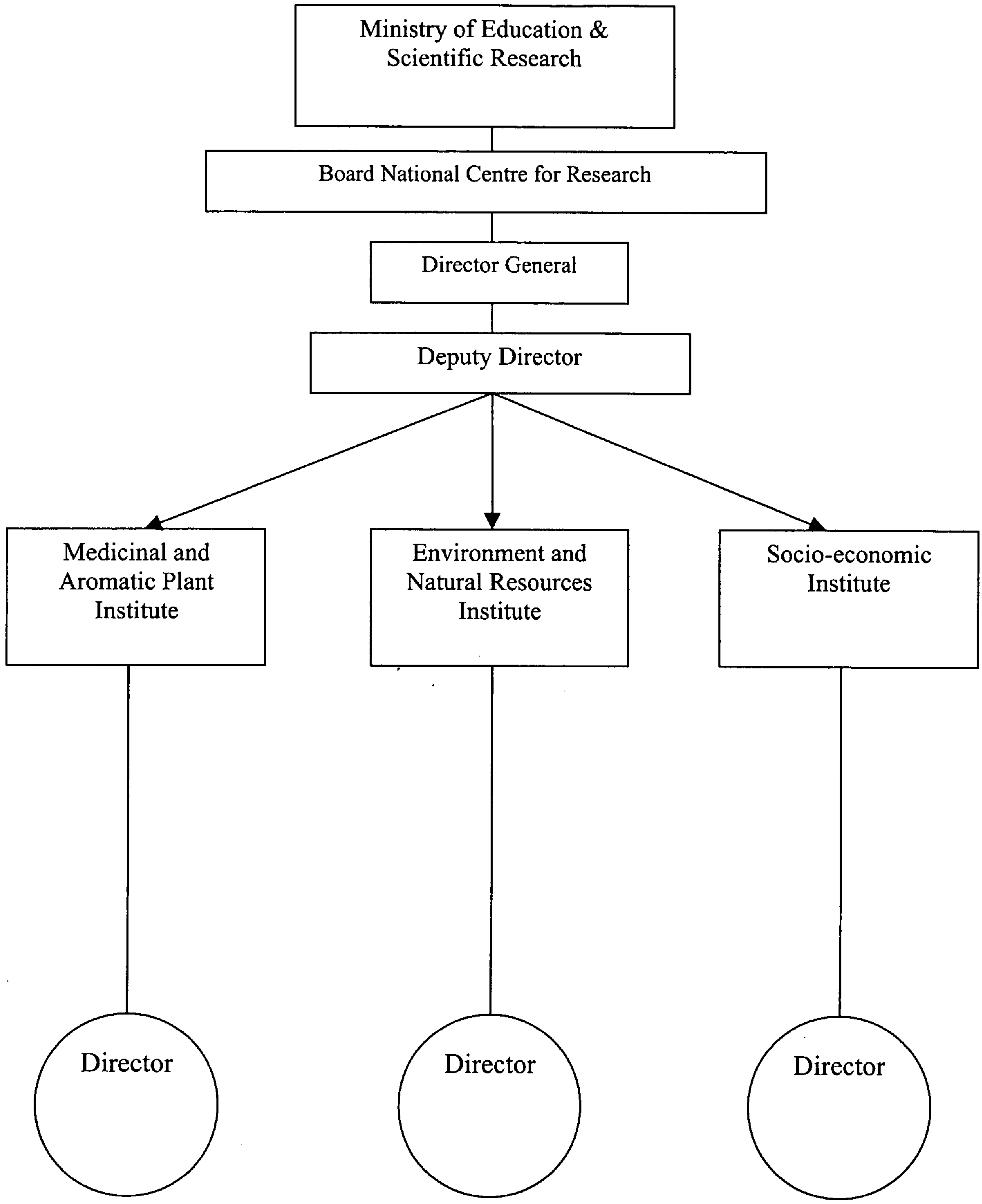
Appendix A7 Organisational Chart of the University of Gezira



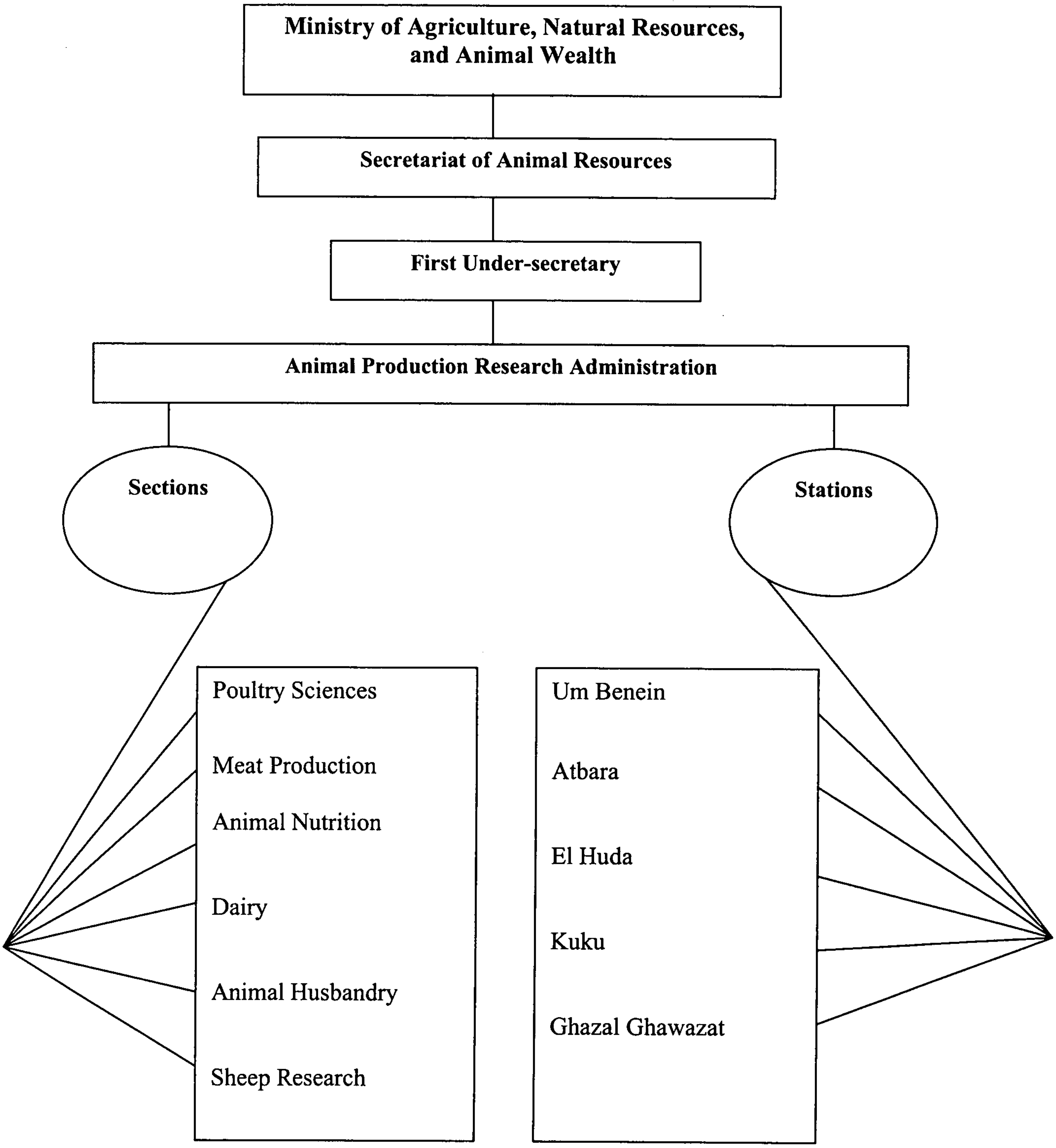
Appendix A8 Organisational Chart of the Graduate College, University of Khartoum



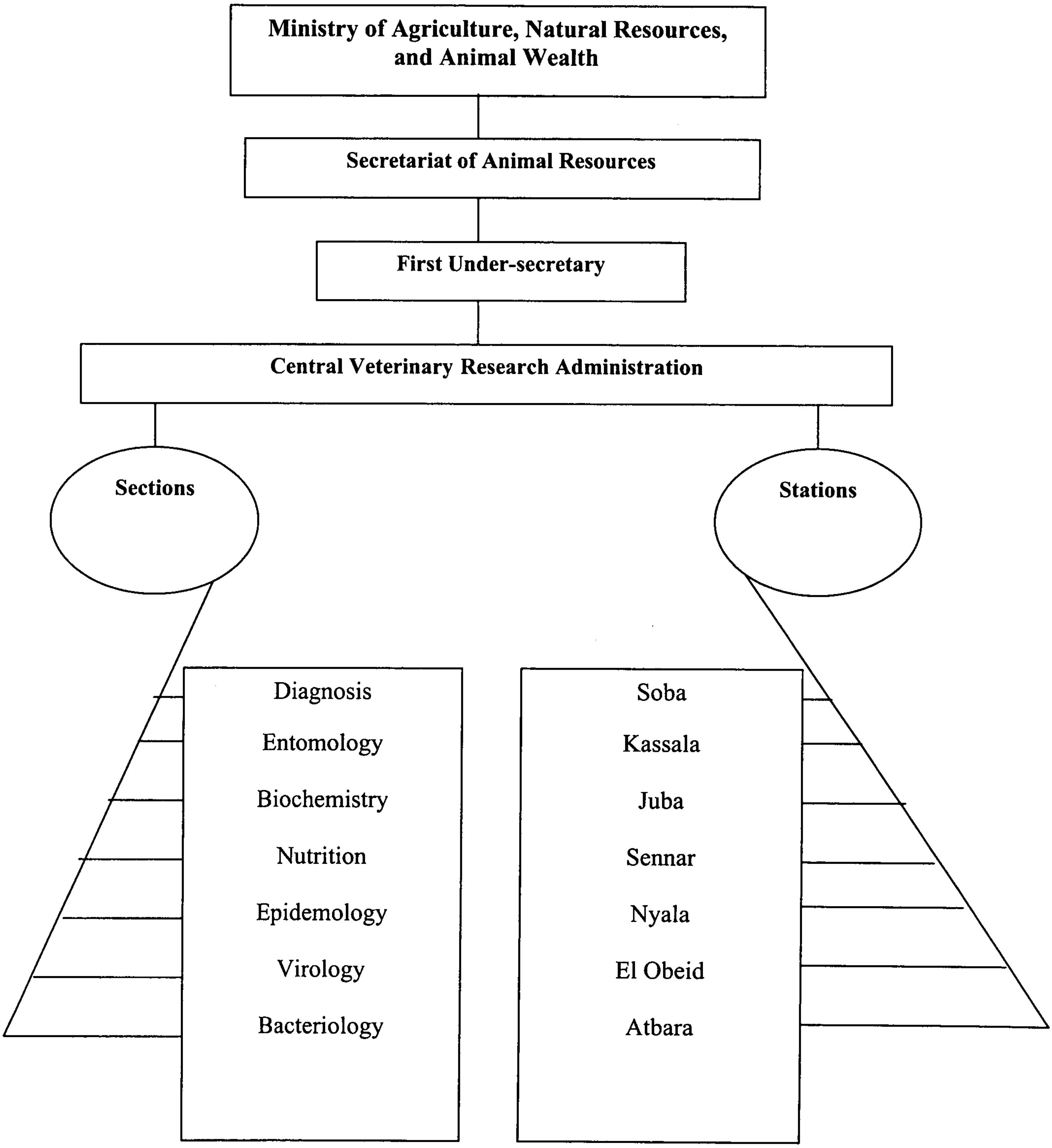
Appendix A9 Organisational Chart of the National Centre for Research



Appendix A10 Organisational Chart of the Animal Production Research Administration



Appendix A11 Organisational Chart of the Central Veterinary Research Administration



APPENDIX-B

National Agricultural Research Institutions

APPENDIX-B
NATIONAL AGRICULTURAL RESEARCH INSTITUTIONS

B1 Agricultural Research Corporation

The mandate of the ARC is to carry out research in response to the needs of various agricultural production systems. The research is to contribute to a sustainable improvement in crops, livestock, forests, range, fisheries and wild life in various agro-ecological zones. This contribution is to help in improving the socio-economic conditions of the Sudanese. Stakeholders of research are:

- Agricultural product producers and consumers.
- Extension and services departments in the MOA and production corporations.
- Agricultural policy and decision makers.
- Higher agricultural and veterinary educational institutions in the Sudan.
- Other research institutions in the country and in the region and regional and international research organisations.

B1.1 Research strategies for the nineties and beyond

The response to the challenges identified in the analysis of production systems includes the translation of agricultural development goals into operational research objectives. Each objective will be dealt with in crop/forestry, fisheries and livestock thrusts. In each of these, production constraints, and research areas to solve them, will be identified and prioritised. This process is dynamic in nature to respond to the changing agricultural environment.

Resources will then be allocated according to priorities and strategic options. An organisational adjustment will be proposed to assist in a more efficient implementation.

B1.2 Operational research objectives

The operational research objectives are:

- To improve agricultural production in various production systems, in a sustainable way, through identifying production constraints at system and commodity levels and developing appropriate technologies to solve them.

- To increase the output of food commodities including cereals, cotton, sugar, oilseeds, horticultural crops, gum Arabic, livestock and livestock products.

- To improve farming systems in the traditional sector and to provide equity in income distribution among the States.

- To improve management and maintenance of natural resources including forests, range, soil and water, to stabilise sand dunes, control desertification and rehabilitate the gum Arabic belt.

B1.3 Guiding values of ARC

The ARC has set guiding values for its research programs and strategic options. These values are:

- Orientation of programs towards solving problems in keeping with NARIs mission to improve and sustain agricultural performance.

- Programs will be identified towards farming system approach.

- Programs will be co-operative and multi-disciplinary.

- Participation of clients, scientists and top management in development of programs.

- Allocation of funds and facilities will be based on priorities.

- Socio-economic analysis will be an integral part of the research.

B1.4 Research programs and strategic options

Challenges facing agricultural production have been identified in the analysis of the agricultural sector. At ARC, twelve researches programs have been identified to respond to these challenges and develop appropriate technologies to attain agricultural development goals and operational research objectives. In each program research thrusts are identified, weighted and prioritised. A systematic judgement based on experience and weighted criteria including economic importance of the crop, export potential, food security and available information has been used for setting priorities and developing strategic options.

Organisational and structural adjustments

To achieve the production targets set in the 10 years National Strategic Plan; a research strategy was prepared and approved. The strategy emphasised on strengthening the present agricultural research capabilities, for planning and implementing system-building strategies, in agricultural research policy, organisation and management.

To implement this strategy, and its programs, there is a need for organisational and structural adjustments, to consolidate the limited human and financial resources. This will rest in the implementation of a cost-effective research that will have an impact in the shortest time frame.

A program

A research program is focused on either a crop e.g. cotton, a group of crops e.g. cereals, forests and wildlife, livestock and feed, fisheries or soil, land and water resources. A program dealing with a group of crops has a sub-program for each crop with each sub-program having its own projects. However, the strategy has identified the following programs; cereals, cotton, oilseeds, sugarcane, grain legumes, root crops, vegetables and medicinal plants, fruit, livestock and feed, forestry and wildlife, fisheries and soil, land and water resources.

A project

A project is the operational unit of a program or sub-program, which is made up of research projects. The research project has an operational objective to achieve program goals, time frame (short from 1-3, medium from 3-6 and long from 6-10 years), allocation of researcher time (person/month), budget, locations (on-station and/or on-farm) and expected outputs.

An Experiment/Study

An experiment/study is the fundamental unit of a project, which is made up of experiments/studies. An experiment is carried at the laboratory and/or field. A study is a desk research.

B1.5 Organisation

To implement this strategy there is a need to develop a detailed program plan in which projects are identified and prioritised within each of the 12 programs. Scientists at the station/centre level will propose their relevant detailed projects to program leaders. Each proposed project will be reviewed and approved at headquarters level firstly, followed by an approval by the station/centre level. The table below shows the proposed new agricultural research stations by ARC according to the national strategy (Phased out 1992 - 2001).

1992 – 1994	1995 – 1997	1998 – 2001
Gedarif	Marawi	Awiel
Samsam	Dueim	Torit
Kassala	Nyala	Maridi
Kosti	El Nuhud	Yei
Soba	Malakal	
Dongola	El Tonj	
Zalingei	Wau	

Source: ARC Scientific Staff & Senior Administrators, Sudan 1997.

B1.6 Monitoring and Evaluation

A systematic monitoring and evaluation will be carried out to ensure that research experiments/studies are efficiently implemented. This is the responsibility of the program leaders, assisted by directors of stations. An annual in-house review at program level will be introduced to present and evaluate results and discuss new projects proposals. Program leaders will present the proposal to the program committee for review and approval. The program committee consists of program leaders led by the Deputy Director General. A periodic external program review will be introduced to improve program outputs. This will be carried out by a panel of experts from outside ARC.

B1.7 Achievements

The following illustrations are some of the ARC's technological development and transfer achievements as indicated by most ARC reports (see ARC, 1992, 1993 & 1994, Ageeb & Salih, 1995, Ageeb & Elahmadi, 1995 and Ahmed, 1998).

Fibre Crops

Cotton, being the major export crop and has many production problems has received top priority for research. The research has led over the years to a pool of important outputs, which were to a large extent implemented by production schemes.

Improved cultivars with resistance to the prevailing diseases (bacterial blight, leaf curl and Fusarium wilt) were developed and adopted. Improved cultural practices pertaining to crop nutrition, water requirement, weed control and integrated pest management and techniques to improve lint quality were recommended and implemented in the irrigated cotton. Technologies for improving rainfed cotton have also been developed. ARC has developed Kenaf[1] improved technologies, which were the base for the establishment of Kenaf Factory in Abu Naama.

Cereals

Sorghum is the traditional staple food for most of the Sudanese. Wheat consumption, however, has tremendously increased during the last two decades due to urbanisation and increased income. Thus wheat became a major component for the cropping system in irrigated sector. Improved technologies for irrigated and rainfed sorghum cultivars were developed. Cultural practices for successful production of sorghum in the different production systems were recommended. Achievements in millet are limited as compared to sorghum mainly due to erratic rainfall in the sands of Western Sudan. In the Sudan, wheat is produced in the low land tropics under very hot climatic conditions. Thus, ARC was subjected to increasing pressure to respond to these challenges. International efforts were focused on the Sudan to break these climatic barriers and extend the wheat belt into the low land tropics so that experience gained could be transferred to similar areas. Adopted cultivars, improved cultural practices and integrated pest management were recommended to the farmers. These recommended technologies in conjunction with policies have resulted in a tremendous expansion of the areas and improved yield. Wheat is now produced under such conditions in Sudan.

Oilseeds

Sudan is a major producer of oilseeds for internal consumption and export. Research was focused on groundnuts, sesame, and recently introduced sunflower. Developing improved technologies was for these various production systems.

[1] Kenaf is a fibre crop used in Sudan for the production of ropes and sacs.

Groundnut improved cultivars and cultural practices including ploughing, weed control and density were recommended for the irrigated system. Sesame improved cultivars and cultural practices recommended to farmers. Sunflower hybrids were introduced and are currently under evaluation with the appropriate cultural practices. It is expected that new improved technologies will be recommended in the future. However, some farmers have adopted chemical weed control recommendations.

Grain Legumes

Cool season grain legumes (faba bean, chickpea, lentil and field beans) are receiving external support, which has helped in production, and transferring improved technologies to farmers. These include improved cultivars, cultural practices and diseases and insect control.

Vegetables

ARC has conducted research mainly on onions, tomatoes, eggplants, potatoes, sweet potatoes, cucurbits and okra. Onion and tomatoes received more attention and accordingly technological production packages were developed and successfully extended to farmers.

Fruit

Research has produced tangible results on cultivar improvement for grapefruit and oranges. It has also an impact on improving mimicry techniques and developing foundation blocks for the major crops in most fruit growing areas in the country.

Medicinal and Aromatic

Research has improved local varieties of rosette, coriander and fenugreek through field selection. Cultural practices were developed for rosette and coriander. In addition a survey of the natural medicinal and aromatic plants covering distribution and chemical composition was implemented.

Sugar Cane

ARC is collaborating with Kenana Sugar Company Research and university of Gezira to develop cultivars, cultural practices, and methods to control diseases, weeds and pests. This collaborative research has succeeded in controlling the introduced smut and ratoon stunting diseases and recommending cultural practices and control measures for pests, diseases and weeds.

Food Technology

Food technology research has successfully produced many techniques, methods and advises to industry, consumers and institutes engaged in specifications. Technologies included handling and packaging of fruit and vegetables, cold storage of citrus and potatoes, banana ripening, dehydrated onions, sorghum milling and mechanical bakeries. Methods developed included composite flour, picking and food recepies. The research has also advised on food quality specifications.

Forestry

Forest research has developed recommendations, produced materials and carried out studies for their main stakeholders: National Forestry Corporation and farmers, gum Arabic production and carried out studies on timber quality and processing and forest surveys.

Fisheries

Research has carried out studies on fish stocks in the fresh water. It has also developed advises and techniques on oysterculture (marine), fish culture (fresh water) and fishing.

Wildlife

The recommendations of Wildlife Research Centre have had an impact on the extension of the boundary of the Dinder National Park and the creation of Raad

National Park in Southern Darfur. In addition, surveys of wildlife in the Northern Sudan were carried out.

B2 Academic Institutions (Universities)

The University of Khartoum (Faculty of Agriculture, Faculty of Forestry, Faculty of Animal Production, Department of Agricultural Engineering and the Institute of Environmental Studies) and University of Gezira (Faculty of Agricultural Sciences) are the main universities which are involved in agricultural, forest, livestock, poultry and natural resources research.

Research policies in universities are generally incoherent. There is no evidence that the research carried out at the universities is being conducted as part of an agreed, co-ordinated and prioritised national research plan which links universities with basic and applied research capacities to make use of their comparative advantage. Research objectives and projects are largely derived and chosen on a personal interest basis and rarely reflect the priority needs of agricultural sector objectives and national development and society goals. Academic staff in these institutions is not fully occupied in research. Currently, graduate students mainly carry out the universities' research. Generally, research structure of these universities is very weak or lacking and accordingly management is weak. This is attributed to unavailability of funds for research.

B2.1 Post Graduate Research

The bulk of research conducted so far by academic institutions in the field of agriculture, forestry, animal sciences and natural resources has been linked to the graduate studies programs in partial fulfilment of the MSc and Ph.D. degrees. FAUoK is one of the main sources of skilled research workers in the Sudan followed by FASUG. Courses and thesis offer MSc and Ph.D. degrees. The students applying for higher degrees are either nominated by different governmental departments or they are private students and most of them apply for MSc degrees.

There is an informal linkage between university staff and qualified research scientists to co-supervise some of graduate students research programs.

B2.2 Funding for Universities' research

Research funds come from government, except for very few limited grants that are not sustainable. Lately, research funds have seriously declined to a level that restricted research activities. Research funds for postgraduate studies are insufficient whether they come from the government institutions supporting the students or from the private students who pay their own tuition fees.

B2.3 Research facilities in the Universities

Information obtained from WANA (1997) survey indicated the following:

- Libraries are updated in only one university (FAUoK).
- Absence of a documentation centre for agricultural research which can serve as communication centre to take full advantage of data banks and information communication network.
- Lack of computer facilities.
- Inadequate laboratory equipment and poor maintenance.
- Insufficient farm machinery and vehicles.
- Poor maintenance of research facilities.
- Inadequate land for research in some universities.
- Lengthy administrative procedures hampering timely availability of supplies a and materials.

- Irregular electricity and water supply …etc.

- Lack of supplies and other research inputs.

The survey (WANA, 1997) also revealed that universities' research suffer from the following constraints and limitations:

- Lack of sufficiently coherent universities' research policies.

- Poor research infrastructure.

- Inadequate financial allocations and unpredictable flow of funds.

- Inadequate trained and skilled support staff.

- Absence of a favourable research environment coupled with unattractive conditions of service, this jeopardises research leadership continuity.

- Low staff salaries result in brain drain of the most talented staff.

- Heavy teaching load limits adequate involvement in research.

- Recent and updated research findings and technologies developed are not utilised as teaching material due to lack of communication.

- Promotion criteria are too heavily biased toward research published in renowned international journals; irrespective to its relevance to local research problems which distracts academic staff from addressing local problems.

- Weak inter-university collaboration.

- Lack of formal and effective universities linkages with NARIs, extension, farmers and other stakeholders.

APPENDIX-C

Agricultural Research And Extension

APPENDIX-C

AGRICULTURAL RESEARCH AND EXTENSION: HISTORICAL BACKGROUND

C1 Agricultural Research

Eicher and Baker, 1982:113, have identified "five" major turning points or shifts in research strategies in sub-Saharan Africa. These turning points all represent attempts to move from a natural resources base to a science-based strategy of agricultural research and development.

The ***first*** turning point occurred in the 1920s when national research stations were established in several of the ten African colonial territories including Sudan.

The ***second*** turning point came in the 1950s with the introduction of regional research stations serving several countries in a common ecological zone. However, the performance of the global and regional research institutes in Africa over the 1920-1960 period was mixed, partially because many did not have a critical mass of scientific talent, a few were placed in poor locations, and harsh taxation policies in some countries dampened economic incentives to adopt new technology.

The ***third*** turning point in agricultural research came in the post independence era of the early 1960s when many of the regional institutes were nationalised.

The ***fourth*** turning point came in the mid-1960s with decisions to reactivate the colonial concept of a regional institute to serve a region such as West Africa. A second major decision in this period was to establish several International Agricultural Research Centres in Africa. The International Institute of Tropical Agriculture (IITA) in Nigeria 1969, followed by the International Livestock Centre for Africa (ILCA) in Ethiopia 1973; the International laboratory for research on Animal Diseases (ILRAD); and the International Centre for Insect Physiology and Ecology (ICIPE) in Kenya.

The ***fifth*** turning point came in the mid-1970s in response to the drought of the late 1960s and early 1970s and rising food imports. These problems brought forth crash programs to expand national and international research systems with emphasis on food crops.

However, this discussion of the fifth turning points of agricultural research demonstrates the gradual increase in the role of science and technical change in African agriculture. A major lesson to be learned from the history of agricultural research in sub-Saharan Africa is that long-term (25- to 50-year) investment will be necessary to develop effective national agricultural research services (Eicher and Baker, 1982:116). Idachaba's (1980) evaluation of Nigeria's agricultural research system points up the amount of time needed to develop strong national research programs (for Sudan see Ahmed, 1999b & c and 1998).

C2 History of Agricultural Research

Until the 1960s, social science research on Africa was dominated by anthropologists, historians, and geographers (Eicher and baker, 1982:8). Anthropologists -mostly European- were noted for their ethnographic studies which were largely financed by colonial offices in the 1930s, 1940s, and 1950s (Eicher and baker, 1982).

The Sixties

A handful of agricultural economists and economists started to pursue research in sub-Saharan Africa beginning in the 1950s and the number greatly expanded in the 1960s. But the technical and social science knowledge base for agriculture continues to be sparse and uneven. Except for a few countries in Africa such as Nigeria and Kenya, agricultural research is fragmentary and the scientific knowledge base -especially for food crops- is 10 to 20 years behind most Latin American and Asian countries (Eicher and Baker, 1982). However, despite the generally weak data base, a number of studies over the last 40 years have been extremely useful to policy makers, scholars, and donor agencies. Examples include:

- The history of agricultural research is documented by McKelvey (1965).

- The status of agricultural research in the late 1960s is reviewed in the proceedings of the Abidjan Conference on Agricultural Research Priorities (National Research Council, 1968[1]).

- The two-volume study co-ordinated by John de Wilde for the World Bank. De Wilde (1967) drew on information from thirteen agricultural projects; five in Kenya, two each in Uganda and Mali, and one each in Tanzania, Upper Volta, Chad, and the Ivory Coast. The first volume, the synthesis, contains information about the distinguishing features of agriculture, response of farmers to incentives, labor allocation, mechanisation, land tenure, extension, credit, and marketing institutions. Volume two includes case studies.

- A classic of the 1960s that unfortunately has received little attention is Jurion and Henry's (1969), "Can Primitive Farming Be Modernised?". This book summarised the extensive research of the Belgian scientists at the INEAC research station which was established in northern Zaire (formerly Belgian Congo) in the 1930s.

The Seventies

Standard references of the mid-1970s include:

- Yudelman, M. (1975). "Imperialism and the transfer of agricultural techniques". In Duignan and Gann, pp. 329-359.

- Michael Collinson's (1972) book "Farm Management in Peasant Agriculture", which draws on many years of farm level micro-economic research experience in Tanzania to show how practical farm management

[1] For the 1970 period, see National Research Council (1974, 1978).

studies can contribute to the needs of extension workers and local planners.

- Martin Upton's (1973) book "Farm Management in Africa". Upton's text stresses the application of production economics to the study of farming systems.

- John Cleave's (1974), "African Farmers", is the authoritative volume on labor use in African agriculture.

- Uma Lele's (1975), "The Design of Rural Development", which summarises problems encountered in 17 major rural development projects in Eastern and Western Africa.

- However, valuable sources on the diverse cropping systems and technical problems are Benneh (1972); Leakey and Wills (1977); and Morgan (1978).

- Agricultural development strategies and policy issues are covered in edited volumes by Bunting (1970); McLoughlin (1970); Amann (1973); and Ofori (1973).

- Anthony (1979), Agricultural Change in Tropical Africa. A policy orientation book includes a comparative study.

- The FAO's Regional Food Plan (FAO, 1978) which outlines the background to Africa's food crisis and steps to meet it. The Food Plan was endorsed by the Organisation for African Unity (OAU) in Arusha in 1978 and in Monrovia in 1979.

The Eighties

Standard references of the 1980s include:

- Ruthenberg (1980), Farming Systems in the Tropics.

- A collection of papers edited by Bates and Lofchie (1980) entitled Agricultural development in Africa; Rice in West Africa by Pearson, Stryker, Humphreys (1981); and a collection of 13 case studies edited by Heyer, Roberst, and Williams (1981), Rural Development in Tropical Africa.

However, until the 1980s, there were three basic reports that are now indispensable for examining the crisis in food and agriculture in sub-Saharan Africa:

- The first is the Lagos Plan of Action (OAU, 1980) which was endorsed by the African Heads of States when they met in Lagos in April 1980. The Lagos Plan calls for massive increases in foreign assistance and measures to increase food production.

- The second basic document is the USDA's Food Problems and Prospects in Sub-Saharan Africa (1981). The USDA report discusses trends in the demand and supply of food over the 1960-81 period.

- The third basic reading is the World Bank's Accelerated Development in Sub-Saharan Africa: An Agenda for Action (1981).

Moreover, the major contribution to the agricultural research on sub-Saharan Africa in this period was made by;

- Eicher and Baker (1982) in their book Research on Agricultural Development in sub-Saharan Africa: A critical Survey which reviewed most of the agricultural research on sub-Saharan Africa up to that date, its one of the most useful source of information in this field.

- Bernhard Glaeser's (1987), The Green Revolution Revisited: Critique and Alternatives. Looking at the Green Revolution, this multi-authored book is "a radical reappraisal of its objectives and evaluation criteria."

- John Howell's (1988), Training and Visit Extension in Practice. Overseas Development Institute in London. This synthesis gives balanced presentation of the impact and significance of the T&V System. Impact studies are reported on four African and Asian countries. Immediate concerns about costs and financing are less important than "the growing interest" in the research-extension linkage and the organisation of support systems of subject-matter specialists.

The Nineties

References of the nineties include:

- Willem C. Beets's (1990), Raising and Sustaining Productivity of Smallholder Farming Systems in the Tropics. This book present the knowledge of all the dominant farming systems of the developing world and to explicate "the need and potential for raising their productivity through various development interventions". It covers the interactions of a host of factors, from the physical to the social, the internal to the external, and the current status to future possibilities. Its intended audience is equally comprehensive: from students to policy makers, researchers to extensionists, and top to bottom public officials. He advocates development within existing systems instead of using "western-style,' keeping at a minimum imported inputs like fertilisers and borrowed technology; emphasising self-reliance and self-sufficiency; taking a long-run sustainability approach instead of the short-run; provision of a technical base first but awareness that henceforth more attention must be given to the political, economic, and institutional factors; and at every stage consideration of the centrality of the farmer, and, in the tropics, especially the small farmer.

- The Globalisation of Science: The Place of Agricultural Research (1997), edited by Christian Bonte-Friedheim and Kathleen Sheridan for ISNAR[2]. The focus of this book is on the expected changes on global agricultural research system as a result of globalisation and change in the global economy.

- Financing Agricultural Research: A source book (1998), is another ISNAR book which argued the agricultural research systems are coming under grave financing pressure. Political neglect, over-reliance on donor assistance, and ineffective use of existing resources have contributed to and are compounding the developing world funding dilemma. But funding problems are by no means confined to the agricultural research systems of the low-income nations. The book compiles experience, analysis, and advice for addressing the funding problems of agricultural research systems in the developing countries. It addresses a range of issues in financial policy, planning, and management. The list of topics covered is not exhaustive, and the lessons drawn from experience in one setting may or may not prove of value in another. However, urgent efforts are needed to resolve the financial crisis of the developing world national agricultural research systems.

Reports of this period include:

- The World Bank (1990), The Theory and Practice of Agricultural Policy. This report argued that policy making and implementation are at the heart of development; policy reform needs to take into account the often-neglected non-economic factors (i.e., the practical and political).

- Science and Food: The CGIAR and Its Partners (1991). This is the "*report card*" on the CGIAR and its related international agricultural research centres - on how well they "have affected food production and the welfare

[2] The International Service for National Agricultural Research (ISNAR) assists developing countries in bringing about lasting improvements in the performance of their national agricultural research systems and organisations. It does this by promoting appropriate agricultural research policies, sustainable research institutions, and improved research management.

of the poor". The grades are good, moderated by caution and modesty as perhaps befits a self-evaluation. They relate to the effect on national research systems (with their capacity to absorb research results and to modify them for local adoption) and to the often allegedly neglected poor farmers, poor customers, and women. Although the report says programs "must ultimately be judged by the results in farmers' fields", its index cites nine pages for treatment of "extension services" and five for "technological innovation". The main thrust of the report is that the successes of the international centres will be continued.

- Agricultural Biotechnology: The Next "green Revolution"? (1991). This report includes a discussion of how international donors and agricultural research centres, both national and international, can make sure that poor developing countries share in great potential benefits of bio-technology.

- However, one of the latest research reports published by ISNAR is "Planning linkages between research, technology transfer, and farmers' organisations" (1999). This report is the result of an Action-Oriented Project in Mali, Senegal, Tanzania, and Zimbabwe, armed with the insights obtained from earlier collaborative research with ISNAR on linkages. The report is a summary of the experiences and improvements gained from testing procedures and methods developed during the earlier phase of the research.

C3 Agricultural Extension

"*Possibly the first, modern, agricultural advisory and instruction service was established in Ireland during the great potato famine in the mid-nineteenth century*".

(INTERPAKS[3], 1984:1)

[3] This account of Professor Gwyn Jones of the University of Reading, England appears in a book co-edited with Maurice J. Rolls, Progress in Rural Extension and Community Development (INTERPAKS INTERCHANGE, March, 1984/Vol.1, No.2).

It began as a pilot scheme in 1847, with ten "instructors" to move in circuits among the areas worst afflicted by the potato blight. It was expanded to a peak of thirty-one instructors and continued for four years. Moreover, in its Guide on Alternative Extension Approaches, the FAO, broadly defined agricultural extension to include any non-formal education system whose clientele are rural people, and whose content is primarily agricultural (including crop and livestock production and marketing, as well as fisheries, forestry, and rural development). A similar argument raised by Abdalla[4]:

> "*The agricultural extension in its new concepts is a process to import technical knowledge to the tenants to help them acquire new skills and abilities to be utilised in advancing their rural societies financially, socially, and culturally*".

(Yousif, 1997:157)

However, all those engaged in agricultural extension agree that the technical knowledge is a practical method which the tenants must convincingly accept and adopt whenever conditions are favourable. Meanwhile, El Dirdiri[5] defines the agricultural extension as:

> "*one of the important methods to mobilise modern knowledge of agriculture to develop the rural areas and to change the behaviour and skills of the population to create an atmosphere of democratic dealings*".

(Yousif, 1997:157)

This however depends on the philosophy which view agriculture as away of life rather than a resource of living, and that was also the reason why the agricultural

[4] Dr. Hassan Abdalla Izz Al Dein is a lecturer at the University of Gezira, Wad-Medani, Sudan.
[5] An article by Dr. Ahmed El Dirdiri Abo El-Dahab in his book 'The past of agricultural service in the Gezira', abstracted by Yousif, 1997.

extension functions in collaboration with the rural population to promote their standard of living and possibly their life styles. This philosophy with its new ideas was first introduced in Sudan in 1953, built on the basis of applying technical and scientific methods to enrich the field work (Yousif, 1997).

The history of the agricultural extension can be summarised into the following periods:

The Colonial Period

Agricultural extension services were established throughout Africa during the colonial period. During this period, extension activities were primarily oriented towards promoting the production of export crops. In many cases, extension contact with African farmers consisted of little more than issuing improved seeds (Moris, 1973). Domestically, many of the industrialised countries used extension branches of government for similar purposes: to increase the productivity of rural people to ensure "cheap food in the cities", a supply of agricultural raw materials for urban industry, or exports to improve trade balances. Alternatively, in the cases where rural people had sufficient political power, agricultural extension was controlled by farmers' organisations and was designed to enhance the quality of rural life.

The Fifties

By the middle of the 1900s, both bilateral and multilateral international development assistance organisations recognised agricultural extension as one of the means for agricultural modernisation and rural development of co-operating countries (FAO, 1988).

The Sixties

During the post-independence period in the 1960s, the focus of extension services shifted from coercion to persuasion but the tendency to concentrate on export commodities, to formulate extension advice with little regard for farmer circumstances, and the bias in favour of progressive farmers, has continued to dominate extension in most countries (Eicher and Baker, 1982). The main focus was on interpersonal communication. It was the time of the diffusion of innovation theory, with attempts to categorise farmers on the basis of the speed with which they adopted new technology. However, being good communicators did not solve all of extension's problems. The poor performance of extension services in promoting change stimulated numerous empirical studies beginning in the mid-1960s on; the effectiveness of alternative extension approaches and the relationship between extension and the diffusion of innovations.

The Seventies

The seventies were the time of constraint identification. Farming Systems Research emerged because traditional research did not produce results farmers could use. Over the past 30 years, most extension services throughout Africa have been understaffed, ill-equipped, and under-trained relative to their counterparts in Asia or Latin America. Most sub-Saharan African countries have expanded the size of their extension staff but the ratio of agents to farmers varies widely within and between countries. The various field agents which together form the extension services often come from parastatals and several governmental departments and agencies, including agriculture, livestock, education, fisheries, forestry, health and community development. The activities of these field agents are rarely co-ordinated and they often present conflicting messages to rural households.

The Eighties

The eighties concentrated on the management side of extension services, with the Training and Visit system of extension as the major example.

The Nineties

During the nineties there is an interest in a more systemic approach to agricultural information. Demand and supply of information have been identified, as well as the application of the most effective and efficient ways to match these approaches. Another feature of the nineties is the formulation of policies that provide a level playing field to all information suppliers need and that many governments are reconsidering the role of the public sector with respect to agriculture.

APPENDIX-D

Agricultural Extension Approaches

APPENDIX-D
AGRICULTURAL EXTENSION APPROACHES

D1 General Agricultural Extension Approach

Advantages

Interpret national government policies and procedures to rural people. Assist in implementation of national agricultural development programmes. Covers the whole nation. Relatively easy to control by central government, especially when compared with other more participatory approaches. Provides relatively rapid communication from the ministry level to rural people.

Disadvantages

Lacks two-way flow of information. Communication about farmers' problems, needs, and interests tends not to flow up through the extension channels when this approach is used. Sometimes this approach, while reflecting national goals and targets, fails to adjust the message for each different locality. Field staff with this approach are not accountable to the rural people of the area in which they are working. Extensionists may ignore the priorities of local people while trying to satisfy supervisory personnel at higher levels. Expensive and inefficient.

D2 Commodity Specialised Approach

Advantages

Technology tends to "fit" the production problems, and therefore the messages, which extension officers send to farmers, tend to be appropriate. Focus on a narrow range of technical concerns, the higher salary incentives that may be provided to better-trained extension personnel, closer management and supervision, and fewer farmers for each extension worker than the GAEA. Being managed by smaller organisation than most general agricultural extension services, it can usually make more dynamic organisational performance. Easier to monitor and evaluate, and relatively more cost effective than some other approaches.

Disadvantages

Interests of farmers may have less priority than those of the commodity production organisation. Does not provide advisory service to other aspects of farming in the case of farmers who produce more than one commodity, or whose problems are not just in the use of one technology. Lack of attention to other aspects of the total farming system. On a larger scale, there are problems when the organisation promotes "its commodity" even in situations when it is no longer in the national interest to be increasing production of that particular commodity. The very success of the approach has a momentum, and that momentum leads to this disadvantage.

D3 Training And Visit Approach

Advantages

Put pressure on governments to reorganise a large number of small agricultural extension units into one more integrated service, and the pressure it puts on individual agricultural extension officers to actually get out of their offices and meet with farmers on their farms. Because of regular training, extension workers are supposed to be more up-to-date with information and technology which farmers need. Agricultural extension field staff receives closer technical supervision. Logistic support to extension work such as transport, office space, and instructional materials are more available to extension personnel. Also, if simple low-cost technology is available, and if farmers do not already have it, then this approach can achieve short-term success. And the density increase which typically accompanies the T and V approach enables potential contact with a larger proportion of the farm families. When the sheer number of field extension officers increases, their potential to contact higher numbers of farmers also increases.

Disadvantages

High long-term costs to governments of expanding the size of field extension staffs, the lack of actual two-way communication which is assumed in this approach between research personnel and extension staff, as well as between extension staff and farm people, and the lack of a large supply of "simple, low-cost" technology which is relevant to the farmers who are "targeted" with this approach. Lack of flexibility of the approach to change programmes as needs and interests of farming people change ... from place to place and from time to time. The messages themselves are a problem. If they are too simple and specialised, most farmers will already know about them. Those who do not are probably growing different combinations of crops and livestock. And although the specifications call for "subject matter specialists" to meet the village extension workers on a regular basis to train them, it takes training, experience, and time to produce a "subject matter specialist." Field staff tires of the vigorous patterned activity without appropriate rewards. Finally, this is a high costly approach to agricultural extension. It is especially so when the numbers of field personnel are increased greatly with funds from outside "donors", only to leave the ministry of agriculture with a major financial problem when the outside funds are no longer available.

D4 Project Approach

Advantages

Advantages of this approach are in the focus, which enables evaluation of effectiveness, and sometimes "quick results" for a foreign donor, especially in a particular small location where the project may be operating. Novel techniques and methods can be tested and experimented within the limits of the project. Sometimes these have no relevance "outside", and are forgotten when the project ends. However, some projects last, in whole or in part, long after the outsiders have gone. And the lessons learned from projects can have lasting value in the larger agricultural extension systems.

Disadvantages

One of the major problems with projects is that their time period is usually too short, and the amount of money provided tends to be more than is appropriate. Another disadvantage is that they usually anticipate a flow of the "good ideas" in the project area outside to other places. This flow outside the limited project area is rare. There is a tendency that when the money ends, so does the project extension programme. The assumption of continuity after the project life seems usually to be unwarranted. Another disadvantage is the "double standard" for personnel. Those serving within the project tend to have better transportation and housing, project allowances and better chance for foreign travel. If this is resented by non-project personnel, it becomes a problem after the project is completed. While costs within projects are typically high per unit of achievement, they are usually justified on the basis of the speed with which results are achieved or new techniques are demonstrated. They are usually justified only as short-term arrangements, not as a permanent approach to agricultural extension.

D5 Farming Systems Development Approach

Advantages

The overwhelming advantage of the FSDA is the relevance and "fit" of the message generated, and of the recommendations to be made by field agricultural extension personnel. In many ways, there is nothing more crucial for successful agricultural extension than the availability of messages to be shared with rural families, which actually "fit" their needs and interests! That is the strength of the farming systems approach. Another strength is the linkage between extension personnel and research personnel. And also evident with this approach is a commitment of farmers to the use of the technologies they help develop. It is a product of the partnership between farm people and their extension and research personnel.

Disadvantages

When teams of agricultural researchers, representing a range of disciplines are brought together to the co-operating farm, the cost can be quite high. Using farming systems research generalists is a promising alternative, but it has yet to be fully utilised. Also this approach brings results slowly. It takes time and patience to actually study the farm as a system, with all of its plant and animal and human components, in their natural ecosystem. For administrators who are in a hurry, this approach may be too slow. Other weaknesses in the approach, as used in most countries, stem from the heavy specialisation within the scientific agricultural disciplines. Professional agriculturists and their societies have generally not supported this approach. At best, they have had to settle for "cropping systems research", or "commodity based cropping systems research". Finally, reporting and administrative control is difficult with this approach. It may not fit the typical lists of crops or livestock used by many ministries of agriculture, and it may not fit the assumption that what is being counted is extent and yields of particular crops. Thus, this innovative approach to agricultural extension requires innovative administrative support.

D6 Cost Sharing Approach

Advantages

Some measure of local control of programme planning, which usually accompanies this approach, increases the relevance of the programme content and methods to the needs and interests of clientele. This tends to result in higher adoption rates. Also, local influence on personnel selection, for field extension officers, contributes to their ability to communicate effectively, and to win the confidence of rural people. Normally carries with it a lower cost to central governments, as costs are shared by lower levels of governments, and often by local people.

Disadvantages

More difficult for central governments to control either programme or personnel with this approach. To governments, which are unwilling to share this control, it may be a disadvantage. And, as with other more participatory approaches reporting, financial management, and other aspects of administration tend to be complex and difficult. This is the price, or the "trade-off" for the advantages listed above.

D7 Educational Institution Approach

Advantages

The relationship of specialised scientists to field extension personnel is good training for both. Academically prepared teachers at the school or college cannot treat agriculture as literature when they must also meet farmers and village extension workers, face-to-face. It builds the practical into the classroom, and the scientific into the field extension programme. Lower cost of the "specialist" function. Instead of an agricultural extension system having to maintain such personnel as part of their own professional staff, they are merely "borrowed" from the educational institution. This avoids duplication of expensive technical personnel. And an associated advantage is that the farming population are less likely to have the doubts about the technical competence of extension field personnel, which they express with some other approaches. A great advantage to the school is the access to on-going agricultural extension activities as a laboratory for the social science dimensions of the agricultural curriculum. This type of social laboratory especially enhances teaching of extension education.

Disadvantages

One disadvantage of having instructors out of the classroom as trainers of field extension staff, or of farm people directly is the tendency for them to speak too "academically". Their lectures and demonstrations may not be as practical and useful from a farmer's perspective. And if the extension system also has its own trained specialised personnel, sometimes there is competition. This can be a problem for administrators, and requires creative management. Another disadvantage of educational institution participation in agricultural extension relates to competition, which may develop, for example, between personnel of Ministry of Agriculture and a ministry of Education. While such competition is normal in any bureaucracy, it helps to have clear administrative understanding of which "territory belongs to whom". The approach has often been a critical adjunct to many of the other approaches mentioned above. The educational institution approach is applied or used differently in different countries. What distinguishes it is the active involvement of institutions whose primary function is formal agricultural education, in the different and additional non-formal education activities of agricultural extension.

D8 Agricultural Extension Participatory Approach

Advantages

A key strength is the relevance or fit of the programme. Another benefit often found with high levels of participation is the mutually supportive relationship, which develops among the participants. This is in evidence between first line extension personnel and the rural people they serve; between research personnel and extension staff; between agricultural credit and other input suppliers and both farmers and extensionists, as well as among others. Each can learn from the others how to do his or her own job more effectively. There is also a tendency for highly participatory approaches to cost less. That is because associations of local people facilitate communication and the whole system is more efficient. And this approach also stimulates increased confidence, awareness, and activity among farm people. It caters to the "human" side of the extension promise, as well as the technical side.

Disadvantages

One of the disadvantages, from the perspective of some governments, is that there is a lack of control of the programme from the centre. Sometimes it is not the Ministry of Agriculture which is given the mandate to organise farmers' groups but some other ministry. This may lead to competition and confusion. A highly participatory agricultural extension approach is less likely to be an efficient arm for any one ministry to use in conveying its policy messages to rural people. It may also be more difficult to manage central reporting and accounting for a participatory approach, since programme shifts from time to time as local conditions change. This very strength of the approach can also be seen as a weakness. And a similar phenomenon is the pressure which local people might try to bring to bear on central units with the participation approach. Also, to the extent that participating local people actually influence personnel management decisions, like selection, transfer and promotion of extension field workers, central government may see this as a problem. Viewed positively, it is an automatic quality control feature which is built into highly participatory approaches.

D9 Farmer First Approach: Scientist-Farmer Reversal

A new approach to agricultural research and extension has gradually emerged from criticism of the conventional method of technology development and transfer. The concepts behind "downstream" farming systems research, "bottom-up" and "participatory" approaches, "farmer-back-to-farmer" experience, and critical writings of some biological and social scientists have congealed into the "farmer first" approach now described in Farmer First: Farmer Innovation and Agricultural Research, edited by Robert Chambers, Arnold Pacey, and Lori Ann Thrupp, Intermediate Technology Publications, London, 1989. While in some respects a complete reversal of the researcher-to-farmer continuum, the intention is complementary use rather than complete substitution for the old methodology.

The starting point is the fact that the benefits from technological innovation have been much greater in the industrialised and green revolution areas than in Third World agriculture. Small, low-resource farmers have been slow or unable to adopt new knowledge and technology. In the 1950s and 1960s, ignorance was blamed; in the 1970s, farm-level constraints were at fault, and the remedy was to make the farm more like the research station. In and since the 1980s, a new conception sees the problem not as the farmer or the farm, but as the technology and the priorities and processes of its generation. Besides the conventional methods of agricultural research, new ways have been found to identify priorities and to develop technologies. They originate from a growing appreciation of the validity and usefulness of indigenous knowledge, what has been learned from going directly to farmers for the reasons for non-adoption, the insights provided by farming systems research, and the increasing recognition that farmers are themselves experimenting innovators. Thus while basic investigations in station and laboratory will always be needed, a complementary approach is also overdue. In it, "farmers are primary: it is they who come first and who identify their own priorities; and it is they who are the key actors, choosing, experimenting, and adapting in order to survive and do better."

The point is not that experts have nothing to say to farmers, but rather that farmers' knowledge and practical experience have been undervalued and not harnessed properly in partnership with the experts. Of course, farmers still need extension services, but extensionists and local people should interact, reverse the top-down communication, and produce "a 'basket' of technologies...instead of complete packages, with a range of alternatives from which farmers can choose...something more like a technology exchange." Professionals are often wrong in assuming they know farmers' wants and needs; hence research fixes on the wrong problems. One of the authors, Ronald Bunch, makes the case for small-scale experimentation among farmers, encouraging "a process by which people can develop their own agriculture," which also offers the best prospect of self-sustainability of development. As a result, such small-scale experimentation reduces the cost of adoption, spreads loan service farther with less debt and better repayment, educates program staff in their own technology and in the farmers' adaptation to local conditions, "increases villagers' dignity, (and) converts 'extensionism' into 'communication.'"

At the end, editor Robert Chambers discusses reversals and institutional change needed--reversal of roles of "scientists, extensionists, or workers in NGOs" and an "open, learning process approach...of a sort encouraged neither by the content of university curricula nor by the hierarchy and style of government bureaucracies." Likewise, the national and international research centres, following the old technology transfer model, "are still more of the problem than of the solution." But "they need not remain so" with the farmer-first approach. A pluralist strategy is best, combining different individual inclinations and different organisational potentials and putting to use special small-scale projects, non-bureaucratic NGO staffs, and the empowerment of farmers' organisations. Where to begin? First, "where it is easier, simpler and quicker," with action rather than exhortation, and with a "basic question of what farmers would like in their basket of choices." Then follow new demands, the reverse of top-down flow. "Whether a department of agriculture, a university, an NGO or combinations of these can handle such requests can then be put to the test."

D10 A Participatory-Oriented Approach: Strategic Extension Campaign

Dr. Ronny Adhikarya[1] of the FAO published this case study of experiences in 1994 as the need for the publication grew out of a decade of field experiences. It was observed that extension programs need to be oriented more directly to problem solving. They need to be based more on farmer needs. And programs need to be planned more strategically so as to achieve their objectives in a cost effective and efficient way. The publication summarises FAO experiences in applying an approach called the Strategic Extension Campaign (SEC), an extension method that addresses these issues[2]. The SEC methodology was developed by FAO and introduced in Africa, the Near East, Asia and Latin America. It emphasises the importance of people's participation. It starts with a farmers' Knowledge, Attitude and Practice (KAP) survey. Practical workshops are conducted to train extension personnel in the skills they will need to carry out the survey as well as in the other skills required. A goal is to have staff apply to their programs systematic, rational approaches to planning, implementing, managing, monitoring and evaluation. This SEC method has been replicated in many countries with FAO assistance with topics ranging from line sowing of rice, maize production, cocoa cultivation, tick-borne disease control, etc. In addition to the SEC replications in various countries, persons trained in SEC methods have served as consultants and resource people in a number of other countries. Key to success of SEC is its participatory planning approach.

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[1] Dr. Ronny Adhikarya is an Extension Education and Training Methodology Specialist at the Agricultural Education and Extension Service, FAO.

[2] See FAO (1994b).

SEC tries to understand farmers' local indigenous knowledge, values and beliefs and builds on what people already know. Its participatory approach ensures program relevance and helps make recommendations acceptable to farmers. Its success is attributed to the following points: It advocates a participatory planning approach, needs-based and demand –driven, uses an integrated systems approach, takes into account human and behavioural dimensions, oriented to solving problems, employs a cost-effective multi-media approach, provides specific support materials and training, provides for process documentation and evaluation and its method is applicable to other extension programmes.

The Strategic Extension Campaign is defined as an extension method that can reach large numbers of targeted beneficiaries in a short period of time. The SEC is strategically planned and directed at solving problems. SEC advocates the need to carry out extension activities in a systematic and sequential manner, but it is not seen as a separate undertaking. Rather it is viewed as only one part of a larger yet integrated process. The intent is increase awareness or knowledge of an identified target audience, and to alter attitudes and or behaviour. SEC uses specifically designed and pre-tested messages and cost-effective multi-media materials to support its intervention activities. However, there are ten steps to SEC include:

- Problem identification and needs assessment.
- Formulation of objectives.
- Development of strategy.
- Analysis of audience.
- Selection of medias, message design and pre-testing.
- Management planning.
- Staff training.

- Field implementation.

- Documentation of process and summative evaluation.

The last four steps in the above list should be supported by a management information system. That system provides answers to such questions as "who will do what and when". However, it should be noted that in developing countries where resources are, by definition, limited, the strategic planning approach can help to identify critical extension education intervention areas—the ones most likely to create significant impact. SEC is not a substitute for an agricultural extension system. Instead, it is an approach that may be followed for a portion of extension's work. It is a non-formal education method that should be an integral part of how extension organisations carry out some of their work. The SEC puts a premium on systematic procedure to determine needs of beneficiaries and identifying problems. This makes possible the development of precise objectives that are relevant and appropriate.

APPENDIX-E
Survey Questionnaires

APPENDIX-E

SURVEYS QUESTIONNAIRES

E1 FARMERS

Q1. **Male** **Female**

Q2. **What age group do you belong to?**

25 - 29
30 - 34
35 - 39
40 - 50
Over 50

Q3. **How many years did you spend in education?**

- None
- Pre-school education
- Primary school
- Intermediate school
- High secondary school
- Other
- If other please specify: ______________________________

Q4. **Is farming the only job you do?**

- Yes No
- If No, what else do you do? ______________________________

Q5. **Do you own this farm?**

- Yes No
- If No, to whom does it belong? ______________________________

Q6. **Where is your farm located relative to the main irrigation canal?**

- Farm near the irrigation canal ( )
- Farm of moderate distance from the irrigation canal ( )
- Farm away from the irrigation canal ( )

Q7. What crop (s) do you grow?

Crop	Cultivars	Area (fed)	Yield (ton*kan/fed)	Price (Ls/fed*Kan)

Q8. What agricultural operation (s) do you do on each month of the year?

Month	Agricultural Operations
July	
August	
September	
October	
November	
December	
January	
February	
March	
April	
May	
June	

Q9. Labour input: how many labour/day/feddan do you use on each month of the year?

Month	Total	Family Members	Paid Worker	Ls/labour/day/feddan
July				
August				
September				
October				
November				
December				
January				
February				
March				
April				
May				
June				

Q10. Cost of production (Ls/fed):

Crop					
Seeds					
Land preparation					
Plantation					
Cultural operation					
Water charges					
Land charges					
Material inputs					
Harvesting					
Transport					
Services					
Finance fees					
Other expenses					
Total					

Q11. From where do you finance all these farming expenses (you may tick more than one box)?

- Personal financing
- Bank loan
- Loan from other sources (merchant - friend - relative)

- Other
- If other please specify: ____________________

Q12. Do you have any problem with finance?

- Yes No
- If Yes please explain: ____________________

Q13. From where do you receive information and advice about farming practices (enter 1 for most important, 2 for next down to 3 for least important)?

- **Extension services** **( )**
- Your own personal experience **( )**
- Other **( )**
- If other please specify: ____________________

Q14. Have you ever visited by any person from the extension services?

- Yes No (If No please go to Q20)
- If Yes who was he/she? ____________________

Q15. How often he/she visits you?

- Daily
- Every few days
- Weekly
- Every 2-3 weeks
- Once per month
- Every 3 months
- Every 6 months
- Once a year
- Never
- Other
- If other please specify: ____________________

Q16. In his/her visit to your farm, what facilities does he/she provided (enter 1 for most important, 2 for next down to 7 for least important)?

- Technical advice **( )**
- Purchasing of input materials **( )**

- Credit/financial facilities ( )
- Make some on-farm demonstrations ( )
- Listening to your problem (s) ( )
- Taking note of all your feedback on previous trials ( )
- Other ( )
- If other please specify: ______________________________

Q17. Elsewhere does he/she meet you?

- Yes No
- If Yes where do you meet him/her (you may tick more than one box)?

- Extension service demonstration farm
- **Extension services** demonstration/education sessions
- Village meetings
- **Farmers** union meeting halls
- **Extension services'** offices
- Other
- If other please specify: ______________________________

Q18. Have you implemented all the advice he/she delivered to you?

- Yes No
- If No please specify why (you may tick more than one box)?

- Irrelevant and not appropriate to your farming needs
- Too scientific to understand
- Very expensive to implement
- Won't work
- Not popular
- Associated with many problems
- Other
- If other please specify: ______________________________

Q19. To what extent did the advice he/she delivered to you resulted in productivity increase?

- Not at all
- Increase
- Decrease
- Don't know

If decrease please explain why: ____________________

Q20. Are you member of the Farmers Union?

- Yes No
- If Yes what facilities does it provide (enter 1 for most important, 2 for next down to 6 for least important)?

- Technical advice ( )
- Purchasing of input materials ( )
- Credit/financial facilities ( )
- Competitive/ reasonable prices ( )
- Marketing of your crops ( )
- Other ( )
- If other please specify: ____________________

Q21. Have you ever lost your produce?

- Yes No
- If No please specify the three most important reasons (enter 1 for most important, 2 for next down and 3 for lest important)?

- Inferior seeds ( )
- Bad management ( )
- Theft of the crop (s) ( )
- Shortages of inputs ( )
- Unable to perform the different operations on time ( )
- Diseases ( )
- Others ( )

If others please specify: ____________________

Q22. How do you market your produce?____________________

E2 RESEARCHERS

Q1. **Male** **Female**

Q2. **What age group do you belong to?**

25 - 29
30 - 34
35 - 39
40 - 50
Over 50

Q3.	**Higher degree (s) obtained**	**Year**	**Country**
-	BSc	19 ____	________
-	Higher Diploma	19 ____	________
-	MSc	19 ____	________
-	PhD	19 ____	________
-	Other	19 ____	________

- If other please specify: ____

Q4. **Speciality**

-	Agricultural Economics	Food Science
-	Forestry	Agronomy
-	Plant Breeding	Animal Science
-	Entomology	Soil Science
-	Pathology	Agricultural Engineering
-	Horticulture	Weeds
-	Wildlife	Other
-	Fish Science	If other please specify: ______________

Q5. **How many (*days/month*) do you spend on:**

- Field/lab/Office research ( )
- Extension work/research ( )
- Teaching ( )
- Management ( )
- Discussion groups/meetings ( )

- Other ( )
- If other please specify: ______________________________

Q6. Do you have any linkage (s) with the (*extension services*)?

- Yes No
- If Yes please explain? ______________________________

Q7. Do you have any linkage (s) with (*universities/colleges researchers*)?

- Yes No
- If Yes please explain? ______________________________

Q8. How often, if ever, do you meet the (*farmers*) at their fields?

- Daily
- Every few days
- Weekly
- Every 2-3 weeks
- Once per month
- Every 3 months
- Every 6 months
- Once a year
- Never
- Other
- If other please specify: ______________________________

Q9. Where else do you meet the (*farmers*) (you may tick more than one box)?

- Your demonstration farm
- Demonstration/education sessions
- **Farmers** union meeting halls
- Your office
- Other
- If other please specify: ______________________________

Q10. In your visit to the (*farmer*) (s), what do you provide (enter 1 for most important, 2 for next down to 7 for least important)?

- Technical advice ( )

- Purchasing of input materials ( )
- Credit/financial facilities ( )
- Make some on-farm demonstrations ( )
- Listening to **farmer** (s) problem (s) ( )
- Taking note of all **farmer** (s) feedback on previous trials ( )
- Other ( )
- If other please specify: ______________________________

Q11. Have all your research/experiment/study findings transferred to the (*farmers*)?

- Yes No Don't know
- If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?

- Lack of effective linkages between **NARIs** and the **extension services** ( )
- Recommended packages are too scientific for **extensionist** to absorb ( )
- **Extensionists** view them as irrelevant and inappropriate to **farmers** needs ( )
- **Extension services** are not efficient and effective in technology transfer ( )
- Poor linkages between **extension services** and the **farmers** ( )
- **Extension services** reject them for other reason (s) ( )
- Other ( )
- If other please specify: ______________________________

Q12. Have the (*farmers*) implemented all your research findings that transferred to them?

- Yes No Don't know
- If No please specify why (enter 1 for most important, 2 for next down to 6 for least important)?

- Recommended packages have not been transferred exactly to **farmers** as they originally formulated by you ( )
- **Extension services** transferred only the packages which they think more relevant and appropriate to **farmers** needs ( )
- Packages are too scientific for **farmers** to absorb ( )
- Lack of effective linkages between your institution and **farmers** ( )
- **Farmers** rejected them for other reason (s) ( )
- Other ( )
- If other please specify: ______________________________

Q13. To what extent did your recommended research findings resulted in productivity increase and/or quality improvement to (*farmers*') products?

- Don't know
- Not at all
- Increase of 0-10%
- Increase of 10-20%
- Increase of 20-30%
- Increase of 30-40%
- Increase of 40-50%
- Increase of more than 50%
- If there is no increase, please specify why: ________________________________

Q14. What is the difference between the level of productivity increase and/or quality improvement you achieved by your research and that achieved by (*farmers*)?

- Don't know
- No difference at all
- Difference of 0-10%
- Difference of 10-20%
- Difference of 20-30%
- Difference of 30-40%
- Difference of 40-50%
- Difference of more than 50%
- If there is a difference, please specify why: ________________________________

Q15. At the national level, what is/are the reason (s) behind the productivity gap (please tick as many as you think apply)?

- There is a divergence between **NARIs** goals and orientation
- **NARIs** are not efficient and effective in technology development
- **Farmers** are not effectively involved in **NARIs** research strategy
- **Extension services** are not effectively involved in **NARIs** research strategy
- **Farmers'** absorption capacity for technology is inadequate
- **Extensionists'** absorption capacity for technology is inadequate
- There is no incentives for **farmers** to increase productivity
- There is no incentives for **extensionists** to transfer the technology
- The implementation system fail to recognise the fundamental economic constraints facing traditional farming systems in Sudan
- **Extension services** are not efficient and effective in technology transfer

- Poor linkage between **NARIs** and **universities**
- Poor linkage between **NARIs** and **extension services**
- Poor linkage between **NARIs** and **farmers**
- The difficult economic situation of the country
- Changing of policies and objectives
- Other socio-political factors
- Other
- If other please specify: ______________________________

Q16. Have you changed you research strategy as a result of this productivity gap?

- Yes No
- If yes how? ______________________________

Q17. What are the five most important issues upon which you prioritise and choose your research objectives (enter 1 for most important, 2 for next down to 5 for least important)?

- **Farmers** feedback ( )
- **Extension services** feedback ( )
- Your institution research strategy ( )
- National agricultural research strategy ( )
- Regional and international research strategy ( )
- Local funds available ( )
- Donors funds available ( )
- Media report (s) ( )
- Agricultural policy and decision makers directions ( )
- Book (s) you have read ( )
- Reports on research studies ( )
- Socio-economic factors ( )
- Agricultural corporations or any other client (s) ( )
- National higher agricultural and veterinary education strategy ( )
- Other ( )
- If other please specify: ______________________________

Q18. Have any of your research/experiment/study findings included in (*universities/colleges*') curricular teaching/demonstration manuals?

- Yes No Don't know

- If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?

- Lack of effective linkages between your institution and **universities** ( )
- **Universities'** staff view them as inappropriate for teaching purposes ( )
- **Universities' researchers** believe only on their own research findings ( )
- **Universities** are not efficiently updating their curricular teaching manuals ( )
- **Universities** are more theoretically oriented towards rural development ( )
- **Universities** reject them for other reason (s) ( )
- Other ( )

  If other please specify: ____________________

Q19. How can the productivity gap be closed in the future? ____________________

E3 ACADEMIC STAFF

Q1. **Male** **Female**

Q2. **What age group do you belong to?**

25 - 29
30 - 34
35 - 39
40 - 50
Over 50

Q3.	**Higher degree (s) obtained**	**Year**	**Country**
-	BSc	19 ____	________
-	Higher Diploma	19 ____	________
-	MSc	19 ____	________
-	PhD	19 ____	________
-	Other	19 ____	________

- If other please specify: ________________________________

Q4. **Speciality**

-	Agricultural Economics	Food Science
-	Forestry	Agronomy
-	Plant Breeding	Animal Science
-	Entomology	Soil Science
-	Pathology	Agricultural Engineering
-	Horticulture	Weeds
-	Wildlife	Other
-	Fish Science	If other please specify: ______________

Q5.	**How many (*days/month*) do you spend on**	**Term time**	**Out of term**
-	Teaching	( )	( )
-	Field/lab/Office research	( )	( )
-	Extension work/research	( )	( )
-	Management	( )	( )
-	Discussion groups/meetings	( )	( )

- Other ( ) ( )
- If other please specify: ____________________

Q6. Do you do any field work?

- Yes No
- If No please explain why? ____________________

Q7. Do you have any linkage (s) with the (*extension services*)?

- Yes No
- If Yes please explain? ____________________

Q8. Do you have any linkage (s) with (*NARIs researchers*)?

- Yes No
- If Yes please explain? ____________________

Q9. How often, if ever, do you meet the (*farmers*) at their fields?

- Daily
- Every few days
- Weekly
- Every 2-3 weeks
- Once per month
- Every 3 months
- Every 6 months
- Once a year
- Never
- Other
- If other please specify: ____________________

Q10. Where else do you meet the (*farmers*) (you may tick more than one box)?

- **University** demonstration farm
- Demonstration/education sessions
- **Farmers** union meeting halls
- Your office
- Other
- If other please specify: ____________________

Q11. In your visit to the(*farmer*) (s), what do you provide (enter 1 for most important, 2 for next down to 7 for least important)?

- Technical advice ( )
- Purchasing of input materials ( )
- Credit/financial facilities ( )
- Make some on-farm demonstrations ( )
- Listening to **farmer** (s) problem (s) ( )
- Taking note of all **farmer** (s) feedback on previous trials ( )
- Other ( )
- If other please specify: ______________________________

Q12. Have all your research/experiment/study findings transferred to the (*farmers*)?

- Yes   No   Don't know
- If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?

- Lack of effective linkages between **universities** & the **extension services** ( )
- Recommended packages are too scientific for **extensionist** to absorb ( )
- **Extensionists** view them as irrelevant and inappropriate to **farmers** needs ( )
- **Extension services** are not efficient and effective in technology transfer ( )
- Poor linkages between **extension services** and the **farmers** ( )
- **Extension services** reject them for other reason (s) ( )
- Other ( )
- If other please specify: ______________________________

Q13. Have the (*farmers*) implemented all your research findings that transferred to them?

- Yes   No   Don't know
- If No please specify why (enter 1 for most important, 2 for next down to 6 for least important)?

- Recommended packages have not been transferred exactly to **farmers** as they originally formulated by you ( )
- **Extension services** transferred only the packages which they think more relevant and appropriate to **farmers** needs ( )
- Packages are too scientific for **farmers** to absorb ( )
- Lack of effective linkages between your **university** and **farmers** ( )
- **Farmers** rejected them for other reason (s) ( )

- Other ( )
- If other please specify: ______________________

Q14. To what extent did your recommended research findings resulted in productivity increase and/or quality improvement to (*farmers'*) products?

- Don't know
- Not at all
- Increase of 0-10%
- Increase of 10-20%
- Increase of 20-30%
- Increase of 30-40%
- Increase of 40-50%
- Increase of more than 50%
- If there is no increase, please specify why: ______________________

Q15. What is the difference between the level of productivity increase and/or quality improvement you achieved by your research and that achieved by (*farmers*)?

- Don't know
- No difference at all
- Difference of 0-10%
- Difference of 10-20%
- Difference of 20-30%
- Difference of 30-40%
- Difference of 40-50%
- Difference of more than 50%
- If there is a difference, please specify why: ______________________

Q16. What are the five most important issues upon which you prioritise and choose your research objectives (enter 1 for most important, 2 for next down to 5 for least important)?

- **Farmers** feedback ( )
- **Extension services** feedback ( )
- Your **university** research strategy ( )
- National agricultural research strategy ( )
- Regional and international research strategy ( )
- Local funds available ( )
- Donors funds available ( )

- Media report (s) ( )
- Agricultural policy and decision makers directions ( )
- Book (s) you have read ( )
- Reports on research studies ( )
- Socio-economic factors ( )
- Agricultural corporations or any other client (s) ( )
- National higher agricultural and veterinary education strategy ( )
- Other ( )
- If other please specify: ______________________________

Q17. Do you use your research finding (s) in your teaching/demonstration manuals?

- Yes No
- If No please specify why: ______________________________

Q18. At the national level, what is/are the reason (s) behind the productivity gap (please tick as many as you think apply)?

- There is a divergence between **universities'** goals and orientation
- **Universities** are not efficient and effective in technology development
- **Farmers** are not effectively involved in **universities** research strategy
- **Extension services** are not effectively involved in **universities** research strategy
- **Farmers'** absorption capacity for technology is inadequate
- **Extensionists'** absorption capacity for technology is inadequate
- There is no incentives for **farmers** to increase productivity
- There is no incentives for **extensionists** to transfer the technology
- The implementation system fail to recognise the fundamental economic constraints facing traditional farming systems in Sudan
- **Extension services** are not efficient and effective in technology transfer
- Poor linkage between **universities** and **NARIs**
- Poor linkage between **universities** and **extension services**
- Poor linkage between **universities** and **farmers**
- The difficult economic situation of the country
- Changing of policies and objectives
- Other socio-political factors
- Other
- If other please specify: ______________________________

Q19. Have you changed you research strategy as a result of this productivity gap?

- Yes No
- If yes how? ____

Q20. How can this productivity gap be closed in the future? ______________________

E4 EXTENSION SERVICES

Q1. **Male** **Female**

Q2. **What age group do you belong to?**

25 - 29
30 - 34
35 - 39
40 - 50
Over 50

Q3.	**Higher degree (s) obtained**	**Year**	**Country**
-	BSc	19 ____	________
-	Higher Diploma	19 ____	________
-	MSc	19 ____	________
-	PhD	19 ____	________
-	Other	19 ____	________

- If other please specify: ____

Q4. **How many (*days/month*) do you spend on:**

- Field/lab/Office research ( )
- Extension work/research ( )
- Teaching ( )
- Management ( )
- Discussion groups/meetings ( )
- Other ( )
- If other please specify: ____

Q5. **Do you have any linkage (s) with the (*NARIs researchers*)?**

- Yes No
- If Yes please explain? ____

Q6. **Do you have any linkage (s) with (*universities/colleges researchers*)?**

- Yes No

- If Yes please explain? ______________________________

Q7. What extension activities (work) do you do on each month of the year?

Month	Extension Activities
July	
August	
September	
October	
November	
December	
January	
February	
March	
April	
May	
June	

Q8. How often, if ever, do you meet the (*farmers*) at their fields?

- Daily
- Every few days
- Weekly
- Every 2-3 weeks
- Once per month
- Every 3 months
- Every 6 months
- Once a year
- Never
- Other
- If other please specify: ______________________________

Q9. Where else do you meet the (*farmers*) (you may tick more than one box)?

- Your demonstration farm
- Demonstration/education sessions
- **Farmers** union meeting halls
- Your office
- Other

- If other please specify: ____________________

Q10. Considering farm location from the irrigation canal, which farm do you visit more (enter 1 for most visited, 2 for next down to 3 for least visited or tick appropriate box)?

- Farm near the irrigation canal ( )
- Farm of moderate distance from the irrigation canal ( )
- Farm away from the irrigation canal ( )
- All farms visited at the same frequent ( )
- Other ( )
- If other please explain: ____________________

Q11. In your visit to the(*farmer*), what do you provide (enter 1 for most important, 2 for next down to 7 for least important)?

- Technical advice ( )
- Purchasing of input materials ( )
- Credit/financial facilities ( )
- Make some on-farm demonstrations ( )
- Listening to **farmer** (s) problem (s) ( )
- Taking note of all **farmer** (s) feedback on previous trials ( )
- Other ( )
- If other please specify: ____________________

Q12. Have you succeeded in transferring to the (*farmer*) all the research/experiment/study findings that you received from (*NARIs*)?

- Yes No
- If No please specify why (enter 1 for most important, 2 for next down to 5 for least important)?
- Recommended packages are too scientific for you to absorb ( )
- Recommended packages are irrelevant and inappropriate to **farmers** needs ( )
- You have rejected them for other reason (s) ( )
- Poor linkages between **extension services** and the **farmers** ( )
- Other ( )
- If other please specify: ____________________

Q13. Have the (*farmers*) implemented all the research findings that transferred to them?

- Yes No Don't know

- If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?

- Packages are too scientific for **farmers** to absorb ( )
- Packages are very expensive to implement ( )
- Won't work ( )
- Not popular ( )
- Associated with many problems ( )
- **Farmers** rejected them for other reason (s) ( )
- Other ( )
- If other please specify: ____________________

Q14. To what extent did transferred packages resulted in productivity increase and/or quality improvement to (*farmers*') products?

- Don't know
- Not at all
- Increase of 0-10%
- Increase of 10-20%
- Increase of 20-30%
- Increase of 30-40%
- Increase of 40-50%
- Increase of more than 50%
- If there is no increase, please specify why: ____________________

Q15. Have all your reports and/or feedback (s) included in (*NARIs*) research strategy?

- Yes No Don't know
- If No please specify why (enter 1 for most important, 2 for next down to 5 for least important)?
- Lack of effective linkages between **extension services** and **NARIs** ( )
- **NARIs** view them as irrelevant and inappropriate ( )
- **NARIs** follow their own research strategy ( )
- **NARIs** reject them for other reason (s) ( )
- Other ( )

If other please specify: ____________________

Q16. Have any of your reports and/or feedback (s) included in (*universities/colleges*') curricular teaching/demonstration manuals?

- Yes No Don't know
- If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?

- Lack of proper linkages between your institution and **universities** ( )
- **Universities'** staff view them as inappropriate for teaching purposes ( )
- **Universities' researchers** believe only on their own research findings ( )
- **Universities** are not efficiently updating their curricular teaching manuals ( )
- **Universities** are more theoretically oriented towards rural development ( )
- **Universities** reject them for other reason (s) ( )
- Other ( )

If other please specify: ____________________

Q17. At the national level, what is/are the reason (s) behind the productivity gap (please tick as many as you think apply)?

- **NARIs** are not efficient and effective in technology development
- **Farmers** are not effectively involved in **NARIs** research strategy
- **Extension services** are not effectively involved in **NARIs** research strategy
- **Farmers'** absorption capacity for technology is inadequate
- **Extensionists'** absorption capacity for technology is inadequate
- There is no incentives for **farmers** to increase productivity
- There is no incentives for **extensionists** to transfer the technology
- The implementation system fail to recognise the fundamental economic constraints facing traditional farming systems in Sudan
- **Extension services** are not efficient and effective in technology transfer
- Poor linkage between **extension services** and **NARIs**
- Poor linkage between **extension services** and **farmers**
- Poor linkage between **extension services** and **universities**
- The difficult economic situation of the country
- Changing of policies and objectives
- Other socio-political factors
- Other
- If other please specify: ____________________

Q18. Have you changed you extension work as a result of this productivity gap?

- Yes No
- If yes how? ____________________

Q19. How can the productivity gap be closed in the future? ____________________

APPENDIX-F

Descriptive Statistics

APPENDIX-F

RESEARCH DESCRIPTIVE STATISTICS

QUESTIONS AND CODES (SPSS)

F1 FARMERS

Q1. **Gender** *Male – Female*

G. Gender (Male 1 & Female 2)

Q2. **What age group do you belong to?**

(25-29) – (30-34) – (35-39) – (40-50) – (Over 50)

A. Age {(25-29) 1; (30-34) 2; (35-39) 3; (40-50) 4 & (Over 50) 5}

Q3. **How many years did you spend in education?**

None - Pre-school - Primary - Intermediate - High secondary - Other

E. Education (None 1; Pre-school 2; Primary 3; Intermediate 4; High secondary 5 & Other 6)

Q4. **Is farming the only job you do?** *Yes - No*

J. Job (Yes 1 & No 2)

Q5. **Do you own this farm?** *Yes - No*

F. Farm (Yes 1 & No 2)

Q6. **Where is your farm located relative to the main irrigation canal?** *Near – Moderate - Away from the irrigation canal*

L. Location (Near 1; Moderate 2 & Away 3)

Q11. **From where do you finance all these farming expenses (you may tick more than one box)?** *Personal financing - Bank loan - Loan from other sources (merchant - friend - relative) - Other*

P. Personal financing (1 or 0) **B.** Bank loan (1 or 0)

L. Loan from other sources (1 or 0) **O.** Other sources (1 or 0)

Q12. Do you have any problem with finance? *Yes - No*

F1. Finance (Yes 1 & No 2)

Q13. From where do you receive information and advice about farming practices (enter 1 for most important, 2 for next down to 3 for least important)? *Extension services - Your own personal experience - Other*

E1. Extension services (0; 1; 2 or 3) **E2.** Personal experience (0; 1; 2 or 3)

O1. Other source of information (0; 1; 2 or 3)

Q14. Have you ever visited by any person from the extension services? *Yes – No*

V. Visit (Yes 1 & No 2)

Q15. How often he/she visits you?

Daily - Few days – Weekly - 2-3 weeks – Monthly - 3 months - 6 months – Yearly – Never - Other

T. Time (Daily 1; Few days 2; Weekly 3; 2-3 weeks 4; Monthly 5; 3 months 6; 6 months 7; Yearly 8; Never 9 & Other 10)

Q16. In his/her visit to your farm, what facilities does he/she provided (enter 1 for most important, 2 for next down to 7 for least important)?

Technical advice - Purchasing of input materials - Credit/financial facilities - Make some on-farm demonstrations - Listening to your problems - Taking note of all your feedback on previous trials – Other

T1. Technical advice (0; 1; 2; 3; 4; 5; 6 or 7)

I. Input materials (0; 1; 2; 3; 4; 5; 6 or 7)

C. Credit facilities (0; 1; 2; 3; 4; 5; 6 or 7)

D. Demonstrations (0; 1; 2; 3; 4; 5; 6 or 7)

L2. Listening (0; 1; 2; 3; 4; 5; 6 or 7)

F2. Feedback (0; 1; 2; 3; 4; 5; 6 or 7)

O2. Other facilities (0; 1; 2; 3; 4; 5; 6 or 7)

Q17. Elsewhere does he/she meet you? *Yes – No*

E3. Elsewhere (Yes 1 & No 2)

If Yes where do you meet him/her (you may tick more than one box)? Extension service demonstration farm - Extension services demonstration/education sessions - Village meetings - Farmers union meeting halls - Extension services' offices - Other

D1. Demonstration farm (1 or 0) **E4.** Education sessions (1 or 0)

V1. Village meetings (1 or 0) **U.** Union meeting halls (1 or 0)

E5. Extension services' offices (1 or 0) **O3.** Other places (1 or 0)

Q18. Have you implemented all the advice he/she delivered to you? *Yes - No*

I1. Implementation (Yes 1 & No 2)

If No please specify why (you may tick more than one box)?

Irrelevant and not appropriate to your farming needs - Too scientific to understand - Very expensive to implement - Won't work - Not popular - Associated with many problems – Other

I2. Irrelevant (1 or 0) **S.** Scientific (1 or 0)

E6. Expensive (1 or 0) **W.** Won't work (1 or 0)

N. Not popular (1 or 0) **P1.** Problems (1 or 0)

O4. Other reasons (1 or 0)

Q19. To what extent did the advice he/she delivered to you resulted in productivity increase? *Not at all – Increase – Decrease - Don't know*

P2. Productivity (Not at all 1; Increase 2; Decrease 3; Don't know 4 or Not applicable 5)

Q20. Are you member of the Farmers Union? *Yes – No*

F3. Farmers Union membership (Yes 1 & No 2)

If Yes what facilities does it provide (enter 1 for most important, 2 for next down to 6 for least important)?

Technical advice - Purchasing of input materials - Credit/financial facilities - Competitive/ reasonable prices - Marketing of your crops - Other

T2. Technical advice (0; 1; 2; 3; 4; 5 or 6)

I3. Input materials (0; 1; 2; 3; 4; 5 or 6)

C1. Credit facilities (0; 1; 2; 3; 4; 5 or 6)

P3. Prices (0; 1; 2; 3; 4; 5 or 6)

M. Marketing (0; 1; 2; 3; 4; 5 or 6)

O5. Other reasons (0; 1; 2; 3; 4; 5 or 6)

Q21. Have you ever lost your produce? *Yes – No*

P4. Produce (Yes 1 & No 2)

If Yes please specify the three most important reasons (enter 1 for most important, 2 for next down and 3 for lest important)? Inferior seeds - Bad management - Theft of the crops - Shortages of inputs - Unable to perform the different operations on time – Diseases - Others

S1. Seeds (0; 1; 2; or 3)

M1. Management (0; 1; 2; or 3)

T3. Theft (0; 1; 2; or 3)

I4. Inputs shortages (0; 1; 2; or 3)

P5. Performance (0; 1; 2; or 3)

D2. Diseases (0; 1; 2; or 3)

O6. Other reasons (0; 1; 2; or 3)

F1.1 SPSS Data

No	G	A	E	J	F	L	P	B	L1	O	F1	E1	E2	O1	V	T	T1
1	1	4	3	1	1	1	1	0	1	1	1	1	2	3	1	5	1
2	1	2	3	1	1	2	1	0	0	0	2	2	1	3	2	9	0
3	1	2	5	2	1	1	1	0	1	0	1	2	1	3	2	9	0
4	1	3	5	2	1	1	0	0	0	1	1	0	1	2	1	5	0
5	1	5	3	2	1	3	1	0	0	1	1	0	1	0	1	10	0
6	1	3	5	1	1	2	1	0	0	0	2	2	1	3	1	3	1
7	1	3	5	1	1	3	1	0	0	0	1	1	0	2	1	10	0
8	1	3	6	2	1	3	1	0	0	0	1	1	2	0	1	10	1
9	1	5	3	1	1	1	0	1	1	0	1	1	2	0	1	8	1
10	1	4	3	2	1	2	1	0	1	0	1	0	1	0	2	9	0
11	1	3	5	1	1	1	1	0	0	1	1	1	2	0	1	5	1
12	1	2	5	2	1	2	1	0	0	0	2	2	1	0	2	9	0
13	1	4	5	2	1	2	1	0	0	0	1	0	1	2	1	10	1
14	1	2	6	1	1	2	1	0	0	1	1	0	1	2	2	9	0
15	1	4	3	2	1	1	1	0	1	0	1	0	1	0	1	3	1
16	1	5	3	1	1	1	1	0	0	0	2	0	1	0	2	9	0
17	1	3	5	2	1	2	1	0	0	0	2	0	2	1	1	3	3
18	1	2	6	2	1	2	1	0	0	0	1	2	1	0	1	5	1
19	1	5	3	1	1	2	1	0	0	0	1	1	2	0	1	10	1
20	1	2	6	1	1	1	1	0	0	1	1	2	1	0	1	6	1
21	1	5	5	1	1	1	1	0	0	0	1	2	1	0	1	10	0
22	1	4	6	2	1	1	1	0	0	0	1	0	1	1	1	8	1
23	1	3	3	2	1	3	1	0	0	0	1	0	1	0	1	5	1
24	1	2	5	1	1	3	1	0	0	0	1	0	1	0	1	5	1
25	1	4	5	1	1	1	1	0	0	0	2	0	1	2	1	10	1
26	1	3	5	1	1	2	1	0	0	0	2	2	1	0	1	10	0
27	1	2	5	1	1	2	1	0	0	0	2	1	0	0	1	3	1
28	1	4	3	2	2	3	1	0	0	0	1	0	1	2	1	3	1
29	1	5	1	1	1	2	1	0	1	0	1	0	1	0	1	5	1
30	1	5	1	1	1	3	1	0	0	0	1	0	1	0	2	9	0
31	1	5	1	1	1	3	1	0	0	1	1	0	1	0	1	3	1
32	1	5	6	2	1	1	1	0	1	1	1	2	1	3	2	9	0
33	1	5	1	2	1	2	1	0	0	0	1	0	1	0	2	9	0
34	1	5	5	2	1	2	1	0	0	1	2	1	2	0	1	5	1
35	1	2	3	1	1	2	1	0	0	1	1	2	1	0	2	9	0
36	1	1	1	1	1	3	1	0	0	1	1	0	1	0	1	8	1
37	1	5	3	1	1	2	1	0	0	1	1	0	1	0	1	10	2
38	1	5	1	2	1	1	1	0	0	1	1	0	1	0	1	3	1
39	1	1	1	1	1	3	1	0	0	1	1	0	1	0	1	10	1
40	1	3	6	2	1	2	1	0	1	1	1	1	2	0	1	8	1

No	G	A	E	J	F	L	P	B	L1	O	F1	E1	E2	O1	V	T	T1
41	1	5	5	2	1	1	1	0	0	1	1	2	1	0	1	3	1
42	1	3	5	2	2	2	1	0	0	1	2	0	2	1	1	10	1
43	1	5	1	1	1	2	1	0	0	1	1	0	1	0	1	8	1
44	1	5	1	1	1	2	1	0	0	1	1	0	1	0	2	9	0
45	1	2	5	2	2	3	1	0	0	1	2	0	1	0	1	10	1
46	1	4	5	1	1	3	1	0	0	0	1	2	1	3	1	10	0
47	1	5	1	1	1	3	0	0	1	0	1	0	1	0	1	5	0
48	1	1	5	2	1	1	0	0	1	0	1	1	0	0	1	8	0
49	1	2	1	2	1	1	0	0	1	0	1	0	1	2	1	6	1
50	1	5	1	1	1	1	0	0	1	0	1	0	1	0	1	3	1
51	1	5	1	1	1	3	0	0	1	0	1	0	1	2	2	9	0
52	1	4	3	1	1	2	1	1	0	0	1	0	1	0	2	9	0
53	1	4	5	1	1	3	1	1	0	0	1	0	1	0	2	9	0
54	1	4	5	1	1	2	1	1	0	0	1	0	1	0	2	9	0
55	1	5	3	1	1	1	1	1	0	0	1	0	1	2	2	9	0
56	1	5	3	1	1	1	1	1	0	0	1	0	1	0	2	9	0
57	1	3	5	1	2	1	1	1	0	0	1	0	1	0	2	9	0
58	1	3	5	2	1	2	1	1	0	0	1	0	1	0	2	9	0
59	1	3	3	1	1	1	1	1	0	0	1	0	1	0	2	9	0
60	1	3	5	2	2	1	1	1	0	0	1	0	1	0	2	9	0
61	1	5	3	1	1	1	0	0	0	1	1	0	1	0	1	6	1
62	1	4	1	1	1	1	0	0	1	0	1	0	1	0	1	6	1
63	1	4	1	1	1	1	1	0	0	0	1	0	1	0	1	6	2
64	1	1	6	2	1	1	0	0	0	1	2	0	0	1	1	5	1
65	2	5	1	1	1	3	0	0	0	1	1	0	1	2	2	9	0
66	1	5	5	2	1	2	0	0	1	0	1	0	1	0	1	5	0
67	1	5	1	2	1	2	0	0	1	0	1	2	1	0	1	8	0
68	2	5	1	1	1	2	0	0	0	1	1	1	0	0	2	9	0
69	2	5	1	1	1	1	0	0	0	1	1	0	0	1	1	7	0
70	1	3	3	2	1	1	1	0	0	1	1	0	1	0	1	3	2
71	1	4	1	1	1	1	0	0	1	1	1	0	1	2	1	10	1
72	2	5	1	1	1	3	0	0	1	1	1	0	1	0	1	6	1
73	1	4	1	1	1	1	0	0	0	1	1	1	2	0	1	3	1
74	1	3	3	1	1	1	1	0	0	0	1	0	0	1	1	3	1
75	1	4	5	2	2	2	1	0	0	0	2	0	1	0	1	6	1
76	1	5	3	2	1	3	1	0	0	0	1	0	1	0	1	10	1
77	1	5	1	2	1	2	1	0	1	0	1	0	1	0	1	5	1
78	1	4	3	2	2	1	1	0	1	0	1	2	1	0	1	3	1
79	1	4	3	1	1	2	0	0	1	0	1	0	1	0	1	7	1
80	1	2	5	1	1	1	1	0	0	1	1	1	0	0	1	3	1

No	G	A	E	J	F	L	P	B	L1	O	F1	E1	E2	O1	V	T	T1
81	1	4	1	1	1	2	0	0	0	1	1	0	1	0	1	6	1
82	1	5	1	1	1	1	0	0	0	1	1	0	1	0	1	10	1
83	1	5	1	1	1	3	0	0	0	1	1	0	1	0	1	6	1
84	1	5	1	1	1	3	0	0	0	1	1	0	1	0	1	10	1
85	1	5	1	1	1	1	0	0	1	0	1	0	1	0	1	6	1
86	1	5	1	1	1	3	0	0	0	1	1	0	1	0	1	6	1
87	1	4	1	1	1	2	0	0	1	0	1	0	1	0	1	6	0
88	1	4	5	2	1	1	1	0	0	0	1	0	1	0	1	6	1
89	1	1	6	1	1	2	0	0	0	1	1	0	0	1	1	6	0
90	2	5	1	1	1	3	0	0	0	1	1	0	1	0	2	9	0
91	1	4	3	1	1	1	1	0	1	0	1	1	2	0	1	3	0
92	1	1	3	1	2	2	1	1	0	0	1	0	1	0	1	6	1
93	1	2	3	2	2	2	1	1	0	0	1	0	1	0	1	8	1
94	1	5	3	1	1	2	1	0	0	0	1	0	1	0	1	8	1
95	1	1	3	1	1	1	1	1	0	0	2	0	1	0	2	9	0
96	1	1	3	1	2	1	1	1	0	0	1	0	1	0	2	9	0
97	1	5	3	2	1	1	1	1	0	0	1	0	1	0	1	5	1
98	1	3	5	1	1	2	1	1	0	0	1	0	1	0	2	9	0
99	1	3	5	2	1	2	1	1	0	0	1	0	1	0	2	9	0
100	1	1	3	1	2	3	1	0	0	0	1	0	1	0	2	9	0
101	1	4	5	1	1	3	1	1	0	0	1	0	1	0	2	9	0
102	1	1	5	1	1	3	1	1	0	0	1	0	1	0	1	6	1
103	1	5	3	1	1	1	1	1	0	0	1	0	1	0	1	7	1
104	1	5	5	1	1	3	1	1	0	0	1	0	1	0	2	9	0
105	1	4	3	1	2	2	1	0	0	0	1	0	1	0	1	7	1
106	1	1	5	1	2	1	1	1	0	0	1	0	1	0	2	9	0
107	1	4	5	1	1	1	1	1	0	0	1	0	1	0	2	9	0
108	1	3	5	1	1	2	1	1	0	0	1	0	1	0	2	9	0
109	1	4	3	1	2	3	1	1	0	0	1	0	1	0	1	8	1
110	1	5	5	1	1	3	1	0	0	0	1	0	1	0	2	9	0
111	1	1	5	1	1	2	1	1	0	0	1	0	1	0	2	9	0
112	1	1	5	1	2	1	1	1	0	0	1	0	1	0	1	6	1
113	1	4	5	1	1	1	1	1	0	0	1	0	1	0	1	5	1
114	1	5	3	1	1	2	1	1	0	0	1	0	1	0	2	9	0
115	1	2	3	1	2	1	1	1	0	0	1	0	1	0	2	9	0
116	1	2	5	2	1	1	1	1	0	0	1	0	1	0	2	9	0
117	1	2	5	2	1	1	1	1	0	0	1	0	1	0	2	9	0
118	1	4	5	2	2	1	1	0	1	0	1	1	2	0	1	3	1
119	1	5	3	1	1	1	1	1	0	0	1	2	1	0	1	8	1
120	1	4	1	1	1	2	1	0	1	0	1	1	2	0	1	8	0

No	I	C	D	L2	F2	O2	E3	D1	E4	V1	U	E5	O3	I1	I2	S	E6	W
1	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
2	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
3	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
4	0	0	0	1	2	0	1	0	0	1	0	0	0	1	0	0	0	0
5	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
6	0	0	0	2	0	0	1	1	1	1	0	0	0	1	0	0	0	0
7	1	0	0	2	3	0	2	0	0	0	0	0	0	1	0	0	0	0
8	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0
9	2	0	0	3	0	0	1	0	0	1	0	1	0	1	0	0	0	0
10	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
11	2	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
12	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
13	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0
14	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
15	0	0	0	2	0	0	1	0	0	0	0	1	1	1	0	0	0	0
16	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
17	0	0	0	1	2	0	1	0	0	1	0	0	1	1	0	0	0	0
18	0	0	0	2	0	0	1	0	0	0	0	0	1	2	0	0	1	0
19	0	0	0	0	0	0	1	0	0	0	0	1	1	2	0	0	1	0
20	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
21	0	0	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0
22	0	0	0	2	0	0	1	0	0	1	0	0	0	1	0	0	0	0
23	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
24	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
25	0	0	0	2	0	0	1	0	0	0	0	1	0	1	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0
27	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
28	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
29	0	0	0	0	0	0	1	0	0	1	0	1	0	2	0	0	1	0
30	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
31	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	1	0
32	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
33	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
34	0	0	0	2	0	0	1	0	0	1	0	0	0	1	0	0	0	0
35	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
36	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
37	0	0	0	1	0	3	1	0	0	1	0	0	0	1	0	0	0	0
38	2	0	0	0	0	0	1	0	0	1	0	1	1	1	0	0	0	0
39	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
40	0	0	0	2	0	0	1	0	0	0	0	1	1	1	0	0	0	0

No	I	C	D	L2	F2	O2	E3	D1	E4	V1	U	E5	O3	I1	I2	S	E6	W
41	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
42	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	1	1	1
43	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
44	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
45	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
46	0	0	0	2	3	1	1	0	0	1	0	1	0	1	0	0	0	0
47	0	0	0	1	2	0	1	0	0	1	0	0	0	1	0	0	0	0
48	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	1	0
49	0	0	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0
50	0	0	0	2	0	0	1	0	0	0	0	1	1	1	0	0	0	0
51	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
52	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
53	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
54	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
55	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
56	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
57	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
58	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
59	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
60	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
61	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
62	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
63	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0
64	0	0	2	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
65	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
66	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	1	0
67	0	0	0	0	0	0	1	0	0	0	0	1	1	2	1	0	1	0
68	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
69	0	0	0	1	2	0	1	0	0	0	0	1	0	2	0	0	1	0
70	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0
71	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0
72	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
73	0	0	0	2	0	0	1	0	1	0	0	0	1	1	0	0	0	0
74	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
75	0	0	0	2	0	0	1	0	0	0	0	0	1	2	0	1	1	0
76	0	0	0	2	0	0	1	0	0	0	0	1	1	1	0	0	0	0
77	0	0	0	0	0	2	2	0	0	0	0	0	0	2	1	0	1	0
78	0	0	0	2	3	0	1	0	0	0	0	0	1	2	1	1	1	1
79	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
80	0	2	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0

No	I	C	D	L2	F2	O2	E3	D1	E4	V1	U	E5	O3	I1	I2	S	E6	W
81	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
82	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
83	0	0	0	2	0	0	1	1	1	0	0	0	1	1	0	0	0	0
84	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
85	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
86	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0
87	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0
88	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
89	0	0	0	1	0	0	2	0	0	0	0	0	0	1	0	0	0	0
90	0	0	0	0	0	0	1	0	0	0	0	0	1	3	0	0	0	0
91	0	0	1	0	0	0	2	0	0	0	0	0	0	2	0	0	1	1
92	0	0	3	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0
93	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	0	0
94	0	0	0	0	0	0	1	0	0	1	0	0	0	2	1	1	1	1
95	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
96	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
97	0	0	0	2	0	0	2	0	0	0	0	0	0	1	0	0	0	0
98	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
99	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
100	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
101	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
102	0	0	0	2	0	0	1	0	0	0	0	0	1	2	0	0	0	0
103	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	1	0
104	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
105	0	0	0	2	3	0	1	0	0	0	0	0	1	1	0	0	0	0
106	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
107	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
108	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
109	0	0	0	2	0	0	2	0	0	0	0	0	0	2	0	1	1	0
110	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
111	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
112	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0
113	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	1	0
114	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
115	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
116	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
117	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0
118	0	0	4	2	3	0	2	0	0	0	0	0	0	1	0	0	0	0
119	0	0	0	2	0	0	2	0	0	0	0	0	0	2	1	0	1	0
120	0	0	0	0	0	1	1	0	0	0	0	0	1	2	0	0	1	0

No	N	P1	O4	P2	F3	T2	I3	C1	P3	M	O5	P4	S1	M1	T3	I4	P5	D2	O6
1	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0
2	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
3	0	0	0	5	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1
4	0	0	0	1	1	0	2	0	0	1	0	1	0	1	0	0	0	2	3
5	0	0	0	3	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0
6	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0
7	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	1	2
8	0	0	0	1	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0
9	0	0	0	1	1	0	1	0	0	0	2	1	0	2	0	0	0	0	1
10	0	0	0	5	1	0	1	0	0	0	2	2	0	0	0	0	0	0	0
11	0	0	0	2	1	0	0	0	0	0	1	1	2	0	0	0	0	3	1
12	0	0	0	5	1	0	0	0	0	0	0	1	0	1	0	0	0	0	2
13	0	0	0	2	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0
14	0	0	0	5	1	0	0	0	0	0	0	1	0	1	0	0	0	2	0
15	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	1	2
16	0	0	0	5	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0
17	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1
18	1	0	1	5	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
19	0	0	1	5	1	0	0	0	0	0	1	1	0	1	0	0	0	0	2
20	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0	0	0	0	2
21	0	0	0	2	1	0	0	0	0	0	0	1	0	2	0	0	0	0	1
22	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0	0	0	2	3
23	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
24	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
25	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1
26	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
27	0	0	0	2	1	1	0	0	0	2	0	1	0	1	0	0	0	0	0
28	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	2
29	0	0	1	5	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
30	0	0	0	5	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
31	0	0	1	5	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
32	0	0	0	5	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0
33	0	0	0	5	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
34	0	0	0	2	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1
35	0	0	0	5	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
36	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0	0	2	0	0
37	0	0	0	4	1	0	0	0	0	0	0	1	0	3	0	0	2	0	1
38	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	3	2	0
39	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0	0	0	0	2
40	0	0	0	2	1	0	0	0	0	0	1	1	0	2	0	0	0	0	1

No	N	P1	O4	P2	F3	T2	I3	C1	P3	M	O5	P4	S1	M1	T3	I4	P5	D2	O6
41	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0
42	0	1	1	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
43	0	0	0	3	1	0	0	0	0	0	0	1	0	1	0	0	2	0	0
44	0	0	0	5	1	0	0	0	0	0	0	1	0	1	0	0	2	0	0
45	0	0	0	3	1	0	0	0	0	0	0	1	0	1	0	0	0	3	2
46	0	0	0	3	1	0	0	0	0	0	0	1	0	0	0	0	1	2	0
47	0	0	0	4	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0
48	0	0	1	5	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1
49	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
50	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0
51	0	0	0	5	2	0	0	0	0	0	0	1	0	1	0	0	0	2	3
52	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	2	3	1
53	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	1	3	2
54	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	2	0	1
55	0	0	0	5	1	0	0	0	0	0	0	1	3	2	0	0	0	1	0
56	0	0	0	5	2	0	0	0	0	0	0	1	3	0	0	0	2	1	0
57	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	3	1	2
58	0	0	0	5	2	0	0	0	0	0	0	1	0	1	0	0	3	2	0
59	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	2	1	3
60	0	0	0	5	2	0	0	0	0	0	0	1	1	0	0	0	0	0	2
61	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0
62	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0
63	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0
64	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0
65	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
66	0	0	1	5	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0
67	0	0	1	5	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0
68	0	0	0	5	2	0	0	1	0	0	0	1	0	1	0	0	0	2	0
69	1	1	1	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
70	0	0	0	4	2	0	1	0	2	0	0	1	0	0	0	0	0	0	1
71	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0
72	0	0	0	2	2	0	0	0	0	0	0	1	0	3	0	0	0	1	2
73	0	0	0	2	2	0	0	0	0	0	0	1	0	2	0	3	4	1	0
74	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	2
75	0	1	1	5	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0
76	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0
77	1	0	1	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
78	0	0	1	5	2	0	0	0	0	0	0	1	0	0	2	3	1	0	0
79	0	0	0	4	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
80	0	0	0	2	2	0	0	1	0	0	0	1	0	3	0	0	0	2	1

No	N	P1	O4	P2	F3	T2	I3	C1	P3	M	O5	P4	S1	M1	T3	I4	P5	D2	O6
81	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
82	0	0	0	2	2	0	0	0	0	0	0	1	0	2	0	0	0	1	0
83	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
84	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	2	0	1
85	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	2	1
86	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	1	2
87	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	1	2
88	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
89	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0
90	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
91	1	0	1	5	2	0	0	0	0	0	0	1	2	0	0	0	0	3	1
92	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	2	1
93	0	0	0	4	2	0	0	0	0	0	0	1	0	0	0	0	2	3	1
94	0	0	1	1	2	0	0	0	0	0	0	1	3	0	0	0	0	1	2
95	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	0	1	2
96	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	3	1	2
97	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	2	1
98	0	0	0	5	2	0	0	0	0	0	0	1	1	0	0	0	0	0	2
99	0	0	0	5	2	0	0	0	0	0	0	1	2	0	0	0	0	0	1
100	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
101	0	0	0	5	2	0	0	0	0	0	0	1	0	3	0	0	0	2	1
102	0	0	1	4	2	0	0	0	0	0	0	1	2	0	0	0	0	0	1
103	0	0	1	4	2	0	0	0	0	0	0	1	0	0	0	0	3	2	1
104	0	0	0	5	2	0	0	0	0	0	0	1	0	1	0	0	0	2	1
105	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1
106	0	0	0	5	2	0	0	0	0	0	0	1	0	2	0	0	1	0	3
107	0	0	0	5	2	0	0	0	0	0	0	1	0	3	0	0	0	1	2
108	0	0	0	5	2	0	0	0	0	0	0	1	0	3	0	1	0	2	0
109	0	0	1	4	2	0	0	0	0	0	0	1	0	0	0	0	0	2	1
110	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	2	1	0	3
111	0	0	0	5	2	0	0	0	0	0	0	1	0	3	0	0	0	1	2
112	0	0	0	2	2	0	0	0	0	0	0	1	2	3	0	0	0	0	1
113	0	1	1	3	2	0	0	0	0	0	0	1	1	0	0	0	0	0	2
114	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	2	1	0
115	0	0	0	5	2	0	0	0	0	0	0	1	0	1	0	0	0	3	2
116	0	0	0	5	2	0	0	0	0	0	0	1	0	0	0	0	2	1	3
117	0	0	0	5	2	0	0	0	0	0	0	1	1	0	0	0	0	3	2
118	0	0	0	2	2	0	0	0	0	0	0	1	3	0	0	0	2	1	0
119	0	0	1	5	2	0	0	0	0	0	0	1	1	0	0	0	0	2	0
120	0	0	1	5	2	0	0	0	0	0	0	1	0	2	0	0	0	0	1

F2 RESEARCHERS

Q1. **Gender** *Male – Female*

G. Gender (Male 1 & Female 2)

Q2. **What age group do you belong to?**

(25-29) – (30-34) – (35-39) – (40 – 50) – (Over 50)

A. Age {(25-29) 1; (30-34) 2; (35-39) 3; (40-50) 4 & (Over 50) 5}

Q3. **Higher degree obtained (Year – Country)**

BSc – Higher Diploma – MSc – PhD - Other

E. Education (BSc 1; Higher Diploma 2; MSc 3; PhD 4 & Other 5)

C. Country (Sudan 1; UK 2; USA 3 & Other 4)

Q4. **Speciality** *Economics – Forestry - Plant Breeding - Entomology - Pathology - Horticulture – Wildlife – Fish Science – Food Science – Agronomy – Animal Science – Soil Science - Agricultural Engineering – Weeds – Other*

S. Speciality (Economics 1; Forestry 2; Plant Breeding 3; Entomology 4; Pathology 5; Horticulture 6; Wildlife 7; Fish Science 8; Food Science 9; Agronomy 10; Animal Science 11; Soil Science 12; Agricultural Engineering 13; Weeds 14 & Other 15)

Q6. **Do you have any linkage (s) with the extension services?** *Yes – No*

L. Linkage(s) (Yes 1 & No 2)

Q7. **Do you have any linkage (s) with universities/colleges researchers?**

Yes – No

L1. Linkage(s) (Yes 1 & No 2)

Q8. **How often, if ever, do you meet the farmers at their fields?**

Daily - Few days – Weekly - 2-3 weeks – Monthly - 3 months - 6 months – Yearly – Never - Other

V. Visit (Daily 1; Few days 2; Weekly 3; 2-3 weeks 4; Monthly 5; 3 months 6; 6 months 7; Yearly 8; Never 9 & Other 10)

Q9. Where else do you meet the farmers (you may tick more than one box)? *Your demonstration farm - Demonstration/education sessions - Farmers union meeting halls – Your office - Other*

D. Demonstration farm (1 or 0) **E1.** Education sessions (1 or 0)

U. Union meeting halls (1 or 0) **O.** Your offices (1 or 0)

O1. Other places (1 or 0)

Q10. In your visit to the farmers, what do you provide (enter 1 for most important, 2 for next down to 7 for least important)? *Technical advice - Purchasing of input materials - Credit/financial facilities - Make some on-farm demonstrations - Listening to farmers problems - Taking note of all farmer's feedback on previous trials – Other*

T. Technical advice (0; 1; 2; 3; 4; 5; 6 or 7)

I. Input materials (0; 1; 2; 3; 4; 5; 6 or 7)

C1. Credit facilities (0; 1; 2; 3; 4; 5; 6 or 7)

D1. Demonstrations (0; 1; 2; 3; 4; 5; 6 or 7)

L2. Listening (0; 1; 2; 3; 4; 5; 6 or 7)

F. Feedback (0; 1; 2; 3; 4; 5; 6 or 7)

O2. Other facilities (0; 1; 2; 3; 4; 5; 6 or 7)

Q11. Have all your research/experiment/study findings transferred to the farmers? *Yes – No - Don't know*

R. Research findings transferred to farmers (Yes 1; No 2; Don't Know 3 & Inapplicable 4)

If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?

Lack of effective linkages between NARIs and the extension services - Recommended packages are too scientific for extensionist to absorb - Extensionists view them as irrelevant and inappropriate to farmers needs - Extension services are not efficient and effective in technology transfer - Poor *linkages between extension services and the farmers - Extension services reject them for other reasons - Other*

L3. Lack of effective linkages between NARIs and the extension services (0; 1; 2; 3; 4; 5; 6 or 7)

A1. Recommended packages are too scientific for extensionist to absorb (0; 1; 2; 3; 4; 5; 6 or 7)

I1. Extension services view them as irrelevant and inappropriate to farmers needs (0; 1; 2; 3; 4; 5; 6 or 7)

E2. Extension services are not efficient & effective in technology transfer (0; 1; 2; 3; 4; 5; 6 or 7)

P. Poor linkages between extension services and the farmers (0; 1; 2; 3; 4; 5; 6 or 7)

R1. Extension services reject them for other reasons (0; 1; 2; 3; 4; 5; 6 or 7)

O3. Others (0; 1; 2; 3; 4; 5; 6 or 7)

Q12. Have the farmers implemented all your research findings that transferred to them? *Yes – No - Don't know*

I2. Implementation (Yes 1; No 2; Don't Know 3 & Inapplicable 4)

If No please specify why (enter 1 for most important, 2 for next down to 6 for least important)?

Recommended packages have not been transferred exactly to farmers as they originally formulated by you - Extension services transferred only the packages which they think more relevant and appropriate to farmers needs - Packages are too scientific for farmers to absorb - Lack of effective linkages between your institution and farmers - Farmers rejected them for other reasons - Other

R2. Recommended packages have not been transferred exactly to farmers as they originally formulated by you (0; 1; 2; 3; 4; 5 or 6)

R3. Extension services transferred only the packages which they think more relevant and appropriate to farmers needs (0; 1; 2; 3; 4; 5 or 6)

A2. Packages are too scientific for farmers to absorb (0; 1; 2; 3; 4; 5 or 6)

E3. Lack of effective linkages between your institution and farmers (0; 1; 2; 3; 4; 5 or 6)

R4. Farmers rejected them for other reason (0; 1; 2; 3; 4; 5 or 6)

O4. Other (0; 1; 2; 3; 4; 5 or 6)

Q13. To what extent did your recommended research findings resulted in productivity increase and/or quality improvement to farmers' products?

Don't know - Not at all - Increase of (0-10%) - Increase of (10-20%) - Increase of (20-30%) - Increase of (30-40%) - Increase of (40-50%) - Increase of more than (50%)

P1. Productivity (Don't know 1; Not at all 2; Increase of (0-10%) 3; Increase of (10-20%) 4; Increase of (20-30%) 5; Increase of (30-40)% 6; Increase of (40-50%) 7; Increase of more than (50%) 8 & Inapplicable 9)

Q14. What is the difference between the level of productivity increase and/or quality improvement you achieved by your research and that achieved by farmers?

Don't know - Not difference at all – Difference of (0-10%) – Difference of (10-20%) – Difference of (20-30%) – Difference of (30-40%) – Difference of (40-50%) – Difference of more than (50%)

G. Gap between researchers and farmers (Don't know 1; Not difference at all 2; Difference of (0-10%) 3; Difference of (10-20%) 4; Difference of (20-30%) 5; Difference of (30-40%) 6; Difference of (40-50%) 7; Difference of more than (50%) 8 & Inapplicable 9)

Q15. At the national level, what is/are the reason (s) behind the productivity gap (please tick as many as you think apply)?

There is a divergence between NARIs goals and orientation - NARIs are not efficient and effective in technology development - Farmers are not effectively involved in NARIs research strategy - Extension services are not effectively involved in NARIs research strategy - Farmers' absorption capacity for technology is inadequate - Extensionists' absorption capacity for technology is inadequate - There is no incentives for farmers to increase productivity - There is no incentives for extensionists to transfer the technology - The implementation system fail to recognise the fundamental economic constraints facing traditional farming systems in Sudan - Extension services are not efficient and effective in technology transfer - Poor linkage between NARIs *and universities - Poor linkage between NARIs and extension services - Poor linkage between NARIs and farmers - The difficult economic situation of the country - Changing of policies and objectives - Other socio-political factors – Other*

D2. There is a divergence between NARIs goals and orientation (1 or 0)

E4. NARIs are not efficient and effective in technology development (1 or 0)

S1. Farmers are not effectively involved in NARIs research strategy (1 or 0)

S2. Extensionists are not effectively involved in NARIs research strategy (1 or 0)

I3. Farmers' absorption capacity for technology is inadequate (1 or 0)

I4. Extensionists' absorption capacity for technology is inadequate (1 or 0)

I5. There is no incentives for farmers to increase productivity (1 or 0)

I6. There is no incentives for extensionists to transfer the technology (1 or 0)

S3. The implementation system fail to recognise the fundamental economic constraints facing traditional farming systems in Sudan (1 or 0)

E5. Extension services are not efficient and effective in technology transfer (1 or 0)

L4. Poor linkage between NARIs and universities (1 or 0)

L5. Poor linkage between NARIs and extension services (1 or 0)

L6. Poor linkage between NARIs and farmers (1 or 0)

D3. The difficult economic situation of the country (1 or 0)

P2. Changing of policies and objectives (1 or 0)

S4. Socio-political factors (1 or 0)

O5. Other (1 or 0)

Q16. Have you changed you research strategy as a result of this productivity gap? *Yes – No*

S5. Strategy (Yes 1 & No 2)

Q17. What are the five most important issues upon which you prioritise and choose your research objectives (enter 1 for most important, 2 for next down to 5 for least important)?

Farmers feedback - Extension services feedback - Your institution research strategy - National agricultural research strategy - Regional and international research strategy - Local funds available - Donors funds available - Media *report (s) - Agricultural policy and decision makers directions - Book (s) you have read - Reports on research studies - Socio-economic factors - Agricultural corporations or any other client (s) - National higher agricultural and veterinary education strategy - Other*

F1. Farmers feedback (0; 1; 2; 3; 4 or 5)

F2. Extension services feedback (0; 1; 2; 3; 4 or 5)

S6. Your institution research strategy (0; 1; 2; 3; 4 or 5)

S7. National agricultural research strategy (0; 1; 2; 3; 4 or 5)

S8. Regional and international research strategy (0; 1; 2; 3; 4 or 5)

F3. Local funds available (0; 1; 2; 3; 4 or 5)

F4. Donors funds available (0; 1; 2; 3; 4 or 5)

M. Media report (s) (0; 1; 2; 3; 4 or 5)

P3. Agricultural policy and decision makers directions (0; 1; 2; 3; 4 or 5)

B. Book (s) you have read (0; 1; 2; 3; 4 or 5)

R5. Reports on research studies (0; 1; 2; 3; 4 or 5)

S9. Socio-economic factors (0; 1; 2; 3; 4 or 5)

C2. Agricultural corporations or any other client (s) (0; 1; 2; 3; 4 or 5)

S10. National higher agricultural & veterinary education strategy (0; 1; 2; 3; 4 or 5)

O6. Other (0; 1; 2; 3; 4 or 5)

Q18. Have any of your research/experiment/study findings included in universities/colleges' curricular teaching/demonstration manuals?

Yes – No - Don't know

M1. Manuals (Yes 1; No 2; Don't Know 3 & Inapplicable 4)

If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?

Lack of effective linkages between your institution and universities - Universities' staff view them as inappropriate for teaching purposes - Universities' researchers believe only on their own research findings - Universities are not efficiently updating their curricular teaching manuals - Universities are more theoretically oriented towards rural development – universities reject them for other reason (s) - Other

L7. Lack of effective linkages between your institution and universities (0; 1; 2; 3; 4; 5; 6 or 7)

L8. Universities' staff view them as inappropriate for teaching purposes (0; 1; 2; 3; 4; 5; 6 or 7)

B1. Universities' researchers believe only on their own research findings (0; 1; 2; 3; 4; 5; 6 or 7)

U1. Universities are not efficiently updating their curricular teaching manuals (0; 1; 2; 3; 4; 5; 6 or 7)

O7. Universities are more theoretically oriented towards rural development (0; 1; 2; 3; 4; 5; 6 or 7)

R6. Universities reject them for other reasons (0; 1; 2; 3; 4; 5; 6 or 7)

O8. Other (0; 1; 2; 3; 4; 5; 6 or 7)

F2.1 SPSS Data

No	G	A	E	C	S	L	L1	V	D	E1	U	O	O1	T	I	C1	D1	L2	F	O2
1	1	4	4	4	13	1	1	3	1	1	1	1	1	1	6	7	4	3	5	2
2	1	5	4	4	12	1	1	6	0	1	1	1	0	1	0	0	4	2	3	0
3	1	3	1	1	13	2	1	10	0	0	0	0	1	2	0	4	1	3	0	0
4	1	4	3	4	4	1	2	7	0	1	0	1	0	1	0	0	0	2	0	0
5	1	4	3	4	12	2	1	8	0	0	0	1	0	0	0	0	0	0	1	0
6	1	3	4	1	12	1	1	10	0	0	0	1	0	1	0	2	5	3	4	0
7	2	3	3	1	10	1	1	10	1	0	0	1	0	1	0	0	2	3	4	0
8	1	5	4	4	12	1	1	5	0	1	0	1	0	1	0	0	0	2	3	0
9	1	4	3	1	15	2	1	7	0	1	0	0	0	1	0	0	0	2	3	0
10	1	4	3	4	15	1	1	7	0	0	0	0	0	1	0	0	0	0	0	0
11	2	2	1	1	4	2	2	5	1	0	0	0	0	4	6	5	2	3	1	7
12	1	4	4	4	6	1	1	10	0	1	0	0	0	1	0	0	0	0	2	0
13	1	4	4	4	4	2	1	10	0	1	0	1	0	1	0	0	0	2	3	0
14	1	5	4	4	10	1	1	5	0	1	0	0	0	2	0	0	0	1	3	0
15	1	5	4	4	12	2	1	6	0	0	0	1	0	2	0	0	4	1	3	0
16	1	4	3	4	6	2	1	10	0	0	0	0	0	0	0	0	0	0	0	1
17	1	4	4	4	10	1	1	5	1	1	0	0	0	4	5	6	2	1	3	7
18	1	4	4	4	12	1	1	10	1	0	0	0	0	1	5	6	4	2	3	0
19	1	2	3	1	12	1	2	8	1	0	0	1	0	1	5	6	4	2	3	0
20	1	3	3	1	14	1	2	10	1	0	0	0	0	1	0	0	2	0	0	0
21	2	1	1	1	5	2	2	9	0	0	0	1	0	6	5	4	3	1	2	7
22	1	3	4	4	3	2	1	10	0	0	0	1	0	1	0	0	3	4	2	0
23	1	3	2	1	4	1	1	3	0	0	0	0	1	1	6	5	4	2	3	0
24	1	2	1	1	3	2	1	10	1	0	0	1	0	1	0	0	4	2	3	0
25	2	1	1	1	6	2	2	9	0	0	0	0	0	0	0	0	0	0	0	0
26	1	2	1	1	3	2	2	8	1	0	0	1	0	2	5	6	1	3	4	7
27	1	2	1	1	4	2	1	3	0	0	1	0	0	3	2	6	4	1	5	0
28	2	2	3	1	12	2	2	9	0	0	1	0	0	0	0	0	0	0	0	0
29	1	3	1	1	3	2	1	9	1	0	0	0	0	1	0	0	0	0	0	0
30	2	2	3	1	12	2	1	9	0	0	0	0	0	0	0	0	0	0	0	0
31	1	1	1	1	13	2	1	8	1	1	1	1	0	1	6	5	4	3	2	0
32	2	3	3	1	4	1	2	8	0	1	0	1	0	1	0	0	0	2	3	0
33	1	2	1	1	4	2	1	3	0	0	1	1	0	4	3	7	6	1	2	5
34	1	1	1	1	4	2	1	3	0	1	0	0	0	2	0	0	0	1	3	0
35	1	5	4	1	12	2	1	10	0	0	0	0	1	1	0	0	2	3	4	5
36	1	1	1	1	13	1	1	3	1	0	1	1	0	1	0	0	3	2	4	0
37	2	3	4	1	12	2	2	9	0	0	0	0	0	0	0	0	0	0	0	0
38	1	3	1	1	10	2	2	8	1	0	0	0	0	3	0	0	1	2	0	0
39	1	5	4	4	3	1	1	5	0	0	0	0	1	1	0	0	0	2	3	0
40	1	4	4	4	1	2	1	7	0	0	1	0	0	0	0	0	0	1	2	0
41	1	3	3	4	1	2	1	8	1	0	0	0	0	3	0	0	0	2	1	0
42	2	2	1	1	5	1	1	3	0	1	0	1	0	1	0	0	3	2	4	0

No	G	A	E	C	S	L	L1	V	D	E1	U	O	O1	T	I	C1	D1	L2	F	O2
43	1	3	3	1	6	2	1	9	0	0	0	0	0	0	0	0	0	0	0	0
44	1	1	3	1	10	2	2	7	1	0	0	0	0	4	5	6	1	2	3	0
45	2	2	1	1	5	2	1	5	0	0	0	1	0	1	0	0	0	2	3	0
46	2	3	3	1	5	1	1	5	1	1	0	1	0	1	0	0	0	2	3	0
47	1	3	3	1	4	1	1	3	1	1	0	1	0	1	0	0	2	3	4	0
48	1	4	3	1	12	2	2	10	0	0	0	0	0	0	0	0	0	0	0	0
49	1	3	3	4	3	1	2	6	0	0	0	1	0	3	5	6	4	1	2	7
50	2	1	3	1	14	2	2	8	0	1	0	0	0	0	0	0	0	0	1	0
51	1	2	3	4	3	1	1	5	1	1	0	1	0	1	6	5	4	2	3	0
52	1	1	1	1	14	2	2	5	0	0	0	1	0	1	4	5	6	2	3	7
53	1	4	4	4	5	2	1	9	0	0	0	1	0	1	0	0	0	2	0	0
54	1	4	4	4	4	1	1	5	1	1	0	1	0	1	0	0	3	2	4	0
55	1	5	4	4	3	1	1	9	0	0	0	1	0	1	0	0	0	2	0	0
56	1	5	4	4	5	2	1	10	1	0	0	1	0	1	7	2	3	4	5	6
57	1	4	4	4	4	2	1	6	0	0	0	1	0	1	0	0	0	2	0	0
58	1	3	3	1	3	1	1	9	1	0	0	0	0	1	0	0	3	2	4	5
59	2	1	1	1	3	2	2	9	0	0	0	0	0	0	0	0	0	0	0	0
60	2	1	2	1	12	2	1	9	0	0	0	1	0	0	0	0	1	0	0	0
61	2	2	3	1	5	2	2	9	0	0	0	0	0	0	0	0	0	0	0	0
62	1	2	1	1	5	2	2	9	0	0	0	0	0	0	0	0	0	0	0	0
63	2	1	3	1	5	2	2	10	1	0	0	0	1	6	5	3	4	1	2	0
64	1	5	4	4	10	1	1	6	0	1	1	0	0	1	0	0	3	2	4	0
65	2	1	3	1	3	2	2	8	1	0	0	1	0	3	4	6	5	1	2	7
66	2	3	3	1	15	1	1	10	0	0	0	1	0	1	4	2	5	3	6	0
67	2	2	1	1	4	1	1	3	1	1	0	1	1	4	0	0	1	3	2	0
68	2	4	4	4	5	1	1	3	1	1	0	1	0	1	0	0	4	2	3	0
69	1	3	3	4	3	1	1	10	1	0	0	0	1	1	0	0	3	2	4	0
70	2	4	4	1	4	1	2	8	1	1	0	1	0	1	0	0	2	0	3	0
71	1	1	3	1	2	1	1	9	0	1	0	0	0	3	0	0	0	1	2	0
72	1	4	4	4	3	1	1	3	1	0	0	1	1	2	5	6	3	1	4	0
73	1	5	3	1	12	2	1	10	0	1	0	0	0	1	0	0	0	2	0	0
74	1	4	3	1	2	1	1	9	0	0	0	0	0	0	0	0	0	0	0	0
75	1	4	3	1	4	1	2	6	0	1	0	1	0	7	1	2	3	6	5	0
76	2	2	3	1	2	1	2	9	0	0	0	0	0	0	0	0	0	0	0	0
77	1	5	3	1	12	2	1	7	1	0	0	1	0	0	0	0	1	0	2	0
78	1	3	3	4	12	2	2	9	0	1	0	0	0	2	0	0	0	1	0	0
79	1	1	1	1	5	2	1	9	0	0	0	0	0	1	4	5	0	2	3	0
80	1	3	4	4	10	2	2	8	1	0	0	1	0	1	0	0	0	2	0	0
81	1	1	3	1	3	2	2	8	1	0	0	1	0	1	0	0	0	2	0	0
82	1	4	4	4	12	2	1	8	0	0	1	1	1	1	5	6	4	2	3	0
83	1	5	4	4	10	1	1	5	1	1	1	0	0	4	5	6	1	3	2	0
84	1	5	3	1	12	2	1	10	0	0	0	1	1	1	0	0	2	3	4	0

No	R	L3	A1	I1	E2	P	R1	O3	I2	R2	R3	A2	E3	R4	O4	P1	G	D2	E4
1	2	1	0	0	0	2	0	0	2	0	0	0	0	0	1	6	8	0	0
2	2	1	0	0	3	2	0	0	2	0	0	0	1	0	0	8	6	0	0
3	2	0	0	0	0	0	1	0	2	1	0	0	0	0	2	1	1	1	0
4	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	5	0	0
5	3	0	0	0	1	0	0	0	3	0	0	0	0	1	0	4	4	0	0
6	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	1	0
7	2	1	0	0	2	0	0	0	2	2	0	0	0	1	0	1	1	0	0
8	1	0	0	0	0	0	0	0	2	4	3	6	5	1	2	8	8	0	0
9	2	1	0	0	2	3	0	0	2	3	2	0	1	4	0	1	1	0	0
10	2	1	0	0	0	0	0	0	2	0	0	0	1	0	0	1	1	0	0
11	3	1	0	0	2	3	0	0	3	0	0	0	0	0	1	1	1	0	0
12	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0
13	2	1	0	0	2	3	4	0	2	3	1	0	2	0	0	1	1	0	0
14	2	1	0	0	2	3	0	0	2	1	0	0	2	0	0	7	8	0	0
15	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0
16	2	0	0	0	0	0	0	1	3	0	0	0	0	0	0	1	1	0	0
17	2	1	0	0	0	2	0	0	3	0	0	0	0	0	0	5	1	0	0
18	2	1	4	5	3	2	6	0	2	0	0	0	0	2	1	1	6	0	0
19	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8	5	0	0
20	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	8	0	0
21	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
22	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
23	2	0	0	0	0	1	0	0	2	0	3	2	4	0	1	1	1	0	0
24	2	1	0	0	2	3	0	0	2	1	3	0	2	4	0	5	7	0	0
25	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
26	2	1	4	7	2	3	5	6	2	1	4	3	2	6	5	1	1	0	0
27	2	0	5	4	1	2	3	0	2	5	1	3	7	2	0	9	1	0	1
28	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0
29	2	0	0	0	0	1	0	0	3	0	1	0	0	0	0	4	1	0	0
30	1	0	0	0	0	0	0	0	2	0	0	0	0	1	0	1	1	0	0
31	1	0	0	0	0	0	0	0	2	0	3	0	1	2	0	5	5	0	0
32	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	7	5	0	0
33	2	0	7	5	1	3	4	0	2	4	1	2	5	3	0	9	1	0	1
34	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
35	2	0	0	0	0	0	1	0	2	0	0	0	0	1	0	2	1	0	0
36	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	8	2	0	0
37	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0
38	2	2	0	0	3	1	0	0	2	0	0	0	1	0	2	1	1	0	0
39	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	7	0	0
40	2	1	0	0	2	3	0	0	2	0	0	0	1	2	0	5	5	0	0
41	2	3	0	0	1	2	0	0	2	0	0	0	1	0	2	6	8	0	0
42	1	0	0	0	0	0	0	0	1	2	0	0	0	1	0	1	1	0	0

No	R	L3	A1	I1	E2	P	R1	O3	I2	R2	R3	A2	E3	R4	O4	P1	G	D2	E4
43	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
44	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8	7	0	0
45	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0
46	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	8	4	0	0
47	3	0	0	0	1	1	0	0	3	1	2	0	0	0	0	1	1	0	0
48	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
49	1	0	0	0	0	0	0	0	2	0	0	0	0	0	1	4	5	0	0
50	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	5	0	0
51	2	2	0	0	1	3	0	0	1	0	0	0	0	0	0	8	8	0	0
52	3	2	0	0	3	1	0	0	2	2	3	4	1	5	6	4	5	0	0
53	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0
54	1	0	0	0	0	0	0	0	2	0	0	0	1	2	0	8	3	0	0
55	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8	8	0	0
56	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	8	0	1
57	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	7	7	0	0
58	2	0	0	0	0	1	0	0	1	0	0	0	0	0	0	8	8	0	0
59	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
60	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	8	8	0	0
61	2	1	0	0	0	0	0	0	2	1	0	0	0	0	0	9	9	0	0
62	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
63	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	4	0	0
64	2	1	0	0	4	0	0	0	2	0	0	0	1	0	0	1	5	0	0
65	2	3	4	5	1	2	6	7	3	0	0	0	0	0	0	5	1	0	0
66	3	1	0	0	0	0	0	0	2	2	1	3	4	5	0	1	1	0	0
67	2	0	0	0	0	1	0	2	2	0	2	0	1	3	0	6	8	0	0
68	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8	3	0	0
69	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	8	0	0
70	3	0	0	0	0	0	0	0	2	0	1	0	2	3	0	8	5	0	0
71	2	1	4	0	3	2	0	0	2	5	3	2	1	4	0	8	7	0	1
72	2	0	0	0	0	0	0	1	2	0	0	0	0	0	1	4	4	0	1
73	2	1	0	0	0	0	0	0	3	2	1	0	0	0	0	1	1	0	0
74	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	9	9	0	0
75	2	1	0	0	2	0	0	0	3	0	0	0	0	0	0	7	6	0	0
76	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	9	9	0	0
77	2	1	3	0	2	0	0	0	2	0	0	1	2	3	0	8	7	0	0
78	2	0	0	0	0	0	0	1	2	0	0	0	0	0	1	1	1	1	1
79	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0
80	1	0	0	0	0	0	0	0	2	0	0	0	1	2	0	8	7	0	0
81	1	0	0	0	0	0	0	0	2	0	0	0	2	1	0	8	7	0	0
82	2	3	1	5	2	4	6	0	2	4	3	1	2	5	0	5	1	0	0
83	1	0	0	0	0	0	0	0	2	2	0	0	3	0	1	8	8	0	0
84	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	4	0	0

No	S1	S2	I3	I4	I5	I6	S3	E5	L4	L5	L6	D3	P2	S4	O5	S5	F1	F2	S6	S7
1	0	0	0	0	1	1	0	1	0	0	0	1	1	1	0	2	4	3	0	1
2	1	1	1	0	0	1	0	1	0	1	1	1	0	0	0	2	1	0	2	3
3	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	2	0	0	1	2
4	1	1	0	1	1	1	0	1	0	1	0	1	1	1	0	1	4	0	3	2
5	0	0	1	0	1	0	1	1	0	0	0	1	1	1	0	2	0	0	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	3
7	1	1	1	0	1	1	0	0	0	0	0	1	1	1	0	2	1	2	3	4
8	0	0	0	0	1	1	1	1	0	0	0	1	0	1	0	2	4	3	2	1
9	0	0	0	0	1	1	0	1	1	1	1	1	0	0	0	2	0	0	5	4
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	4
11	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	1	0	2	0
12	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	1	2
13	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	0	4	3
14	0	1	0	0	0	0	0	1	0	1	1	1	1	1	0	2	1	3	2	5
15	0	1	0	0	1	1	1	0	0	0	0	1	1	0	0	2	0	0	1	3
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1
17	0	1	0	1	0	0	1	0	0	1	1	1	1	0	0	2	2	5	4	2
18	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	1	2	4	0
19	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	2	1	0	2	3
20	0	1	1	0	0	1	0	0	0	1	1	0	0	0	0	2	3	2	1	0
21	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	2	2	0	3	4
22	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	3	5	2	1
23	1	1	1	0	1	1	0	1	1	1	1	1	0	1	0	1	1	2	4	0
24	0	1	1	1	1	0	1	0	0	1	1	1	1	0	0	2	1	0	2	3
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
26	1	0	0	0	1	1	0	0	1	0	0	1	1	1	0	2	2	3	0	1
27	1	0	1	0	0	0	0	0	1	0	1	1	1	1	0	2	0	0	1	3
28	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	3	4	0	5
29	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2	0	0	0	1
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
31	1	1	1	0	1	0	0	1	1	1	1	1	0	0	0	2	1	2	3	0
32	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	1	2
33	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	2	0	0	1	3
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	5
35	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	2	4	0	0	2
36	1	1	0	0	1	0	0	1	1	1	1	1	1	1	0	2	1	0	2	3
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
38	1	1	1	0	1	1	1	1	0	1	1	0	1	0	0	1	3	0	2	1
39	0	1	0	0	1	0	1	1	0	0	0	1	0	1	0	2	0	0	1	2
40	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	4	0	0	1
41	0	1	0	0	0	1	0	1	0	1	1	0	0	0	0	2	1	0	0	0
42	0	1	1	1	1	1	0	1	0	0	0	1	1	1	0	2	3	4	5	0

No	S1	S2	I3	I4	I5	I6	S3	E5	L4	L5	L6	D3	P2	S4	O5	S5	F1	F2	S6	S7
43	1	0	0	0	0	1	1	0	1	0	1	1	1	0	0	3	0	0	1	0
44	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	2
45	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	2	0	0	2	3
46	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	1	2
47	0	1	1	0	0	1	0	1	0	0	0	1	1	1	0	1	0	0	1	2
48	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0	2	0	0	3	1
49	0	0	1	1	1	1	1	0	1	1	0	1	1	1	0	2	3	4	1	0
50	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	2	1	0	0
51	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	2	0	1	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
53	1	1	1	1	0	1	0	1	0	1	0	1	0	0	0	2	0	0	1	2
54	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	5	0	2	1
55	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	2	0	0	0	1
56	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2	0	0	1
57	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2	2	0	0	1
58	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	2	0	0	2	1
59	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	3	4	0	2	5
60	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	1	2	0	3
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
63	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	2	0	0	1	0
64	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	2	0	0	1	4
65	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	2	1	2	3	4
66	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2	1	3	4
67	1	1	0	0	0	0	0	1	1	1	1	1	1	1	0	2	3	4	0	0
68	0	1	0	0	1	0	0	0	0	1	1	0	1	0	0	1	3	0	2	1
69	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	2	2	0	1	0
70	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	2	5	0	3	4
71	1	0	1	0	0	0	1	1	1	0	1	1	1	1	1	1	5	0	3	2
72	1	1	1	1	0	0	0	1	0	0	1	1	1	0	0	2	2	3	1	0
73	1	0	0	0	1	0	1	1	1	1	1	1	0	0	0	2	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
75	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	2	2	5	1	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1
77	0	1	1	1	0	0	1	0	0	1	0	1	1	1	0	1	0	0	1	0
78	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	2	3
79	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0	4	1	0
80	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	2	5	0	1
81	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	2	2	5	3	1
82	1	1	1	0	0	1	0	0	0	1	1	1	1	0	0	2	0	0	1	0
83	0	1	0	1	0	1	1	1	0	0	0	1	1	0	0	1	1	0	2	3
84	0	0	1	1	1	1	1	0	1	0	1	1	1	1	0	1	0	0	1	2

No	S8	F3	F4	M	P3	B	R5	S9	C2	S10	O6	M1	L7	L8	B1	U1	O7	R6	O8
1	5	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0
2	0	0	0	0	4	0	0	5	0	0	0	1	0	0	0	0	0	0	0
3	0	3	0	0	4	0	0	5	0	0	0	2	0	0	0	0	0	0	1
4	0	5	0	0	0	0	0	1	0	0	0	2	1	3	0	4	2	0	0
5	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
6	0	0	2	0	0	0	4	5	0	0	0	1	0	0	0	0	0	0	0
7	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8	0	0	0	0	5	0	0	0	0	0	0	3	0	0	0	0	0	0	0
9	0	2	1	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0
10	0	3	0	0	2	0	0	0	5	0	0	1	0	0	0	0	0	0	0
11	0	3	0	0	4	5	0	0	0	0	0	3	0	0	0	0	0	0	0
12	3	5	0	4	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
13	0	1	5	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
14	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
15	2	4	5	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
16	0	3	4	0	0	0	5	0	0	0	0	3	0	0	0	0	0	0	0
17	1	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0
18	0	3	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
19	0	4	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0
20	0	4	0	0	0	0	0	5	0	0	0	4	0	0	0	0	0	0	1
21	5	0	0	0	0	0	0	0	0	1	0	4	0	0	1	0	0	0	0
22	4	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1
23	0	3	0	0	0	0	0	5	0	0	0	2	0	0	0	0	1	0	0
24	0	4	0	0	0	0	0	0	5	0	0	2	0	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
26	0	0	0	0	5	0	0	0	4	0	0	2	1	5	3	4	2	7	6
27	4	2	0	0	0	0	5	0	0	0	0	2	6	3	1	2	5	4	0
28	0	1	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
30	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0
31	0	0	5	0	0	0	0	4	0	0	0	2	0	0	0	1	0	0	0
32	3	4	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
33	4	2	0	0	0	0	0	0	0	0	0	2	7	6	2	1	4	5	0
34	0	3	0	0	4	0	2	0	0	0	0	4	0	0	0	0	0	0	0
35	0	3	5	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1
36	0	4	5	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
38	5	4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0
39	0	3	5	0	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0
40	0	0	3	0	2	5	0	0	0	0	0	3	0	0	0	0	0	0	0
41	0	0	4	0	3	0	0	2	0	0	0	2	3	0	0	1	2	0	0
42	0	2	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0

No	S8	F3	F4	M	P3	B	R5	S9	C2	S10	O6	M1	L7	L8	B1	U1	O7	R6	O8
43	5	0	0	3	2	4	0	0	0	0	0	2	0	0	0	0	0	0	1
44	0	0	0	0	0	3	0	4	5	0	0	1	0	0	0	0	0	0	0
45	4	5	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0
46	3	4	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
47	3	4	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
48	2	4	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
49	0	2	0	0	0	0	5	0	0	0	0	3	0	0	0	0	0	0	0
50	0	0	0	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
51	0	3	0	0	0	0	5	0	0	0	4	1	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
53	0	3	4	0	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0
54	3	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0
55	0	2	5	0	3	0	0	4	0	0	0	3	0	0	0	0	0	0	0
56	0	4	3	0	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0
57	0	4	5	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	0
58	0	0	0	0	3	0	0	5	0	0	4	2	2	0	0	1	0	0	0
59	0	1	0	0	0	0	3	0	0	0	0	4	0	0	0	0	0	0	0
60	0	0	0	4	5	0	0	0	0	0	0	3	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
62	0	0	1	5	2	4	3	0	0	0	0	4	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	0	0	0	0
64	2	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0
65	5	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
66	0	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0
67	0	1	2	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0
68	0	0	0	0	5	0	4	0	0	0	0	1	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
70	0	1	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0
71	4	0	0	0	0	0	0	1	0	0	0	2	4	3	6	1	2	5	0
72	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	1	0	0
74	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
75	0	3	4	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
76	0	2	0	0	0	0	5	4	3	0	0	2	0	0	0	0	0	0	0
77	0	2	3	0	4	0	0	5	0	0	0	1	0	0	0	0	0	0	0
78	4	5	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0
79	3	0	0	0	2	0	0	0	0	5	0	3	0	0	0	0	0	0	0
80	3	4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1
81	0	4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
82	2	3	0	0	0	4	0	0	5	0	0	1	0	0	0	0	0	0	0
83	0	0	0	0	4	0	0	0	5	0	0	1	0	0	0	0	0	0	0
84	0	0	5	0	3	0	0	4	0	0	0	1	0	0	0	0	0	0	0

F3 ACADEMIC STAFF

Q1. **Gender** *Male – Female*

G. Gender (Male 1 & Female 2)

Q2. **What age group do you belong to?**

(25-29) – (30-34) – (35-39) – (40 – 50) – (Over 50)

A. Age {(25-29) 1; (30-34) 2; (35-39) 3; (40-50) 4 & (Over 50) 5}

Q3. **Higher degree obtained (Year – Country)**

BSc – Higher Diploma – MSc – PhD - Other

E. Education (BSc 1; Higher Diploma 2; MSc 3; PhD 4 & Other 5)

D. Country (Sudan 1; UK 2; USA 3 & Other 4)

Q4. **Speciality** *Economics – Forestry - Plant Breeding - Entomology - Pathology - Horticulture – Wildlife – Fish Science – Food Science – Agronomy – Animal Science – Soil Science - Agricultural Engineering – Weeds – Extension – Environmental Science - Other*

S. Speciality (Economics 1; Forestry 2; Plant Breeding 3; Entomology 4; Pathology 5; Horticulture 6; Wildlife 7; Fish Science 8; Food Science 9; Agronomy 10; Animal Science 11; Soil Science 12; Agricultural Engineering 13; Weeds 14; Extension 15; Environmental Science 16 & Other 17)

Q6. **Do you do any field work?** *Yes – No*

F. Field work (Yes 1 & No 2)

Q7. **Do you have any linkage (s) with the extension services?** *Yes – No*

M. Linkage(s) (Yes 1 & No 2)

Q8. **Do you have any linkage (s) with NARIs researchers?** *Yes – No*

L1. Linkage(s) (Yes 1 & No 2)

Q9. **How often, if ever, do you meet the farmers at their fields?**

Daily - Few days – Weekly - 2-3 weeks – Monthly - 3 months - 6 months – Yearly – Never - Other

V. Visit (Daily 1; Few days 2; Weekly 3; 2-3 weeks 4; Monthly 5; 3 months 6; 6 months 7; Yearly 8; Never 9 & Other 10)

Q10. Where else do you meet the farmers (you may tick more than one box)?
Your demonstration farm - Demonstration/education sessions - Farmers union meeting halls - Your office - Other

D. Demonstration farm (1 or 0)
E1. Education sessions (1 or 0)
U. Union meeting halls (1 or 0)
O. Your offices (1 or 0)
O1. Other places (1 or 0)

Q11. In your visit to the farmers, what do you provide (enter 1 for most important, 2 for next down to 7 for least important)?
Technical advice - Purchasing of input materials - Credit/financial facilities - Make some on-farm demonstrations - Listening to farmers problems - Taking note of all farmer's feedback on previous trials – Other

T. Technical advice (0; 1; 2; 3; 4; 5; 6 or 7)
I. Input materials (0; 1; 2; 3; 4; 5; 6 or 7)
C1. Credit facilities (0; 1; 2; 3; 4; 5; 6 or 7)
D1. Demonstrations (0; 1; 2; 3; 4; 5; 6 or 7)
L2. Listening (0; 1; 2; 3; 4; 5; 6 or 7)
F1. Feedback (0; 1; 2; 3; 4; 5; 6 or 7)
O2. Other facilities (0; 1; 2; 3; 4; 5; 6 or 7)

Q12. Have all your research/experiment/study findings transferred to the farmers? *Yes – No - Don't know*

R. Research findings transferred to farmers (Yes 1; No 2; Don't Know 3 & Inapplicable 4)
If No please specify why (enter 1 for most important, 2 for next down to 7 for least important)?
Lack of effective linkages between universities and the extension services - Recommended packages are too scientific for extensionist to absorb - Extensionists view them as irrelevant and inappropriate to farmers needs - Extension services are not efficient and effective in technology transfer - Poor

linkages between extension services and the farmers - Extension services reject them for other reason (s) - Other

L3. Lack of effective linkages between universities and the extension services (0; 1; 2; 3; 4; 5; 6 or 7)

A1. Recommended packages are too scientific for extensionist to absorb (0; 1; 2; 3; 4; 5; 6 or 7)

I1. Extensionists view them as irrelevant and inappropriate to farmers needs (0; 1; 2; 3; 4; 5; 6 or 7)

E2. Extension services are not efficient & effective in technology transfer (0; 1; 2; 3; 4; 5; 6 or 7)

P. Poor linkages between extension services & the farmers (0; 1; 2; 3; 4; 5; 6 or 7)

R1. Extension services reject them for other reasons (0; 1; 2; 3; 4; 5; 6 or 7)

O3. Other reasons (0; 1; 2; 3; 4; 5; 6 or 7)

Q13. Have the farmers implemented all your research findings that transferred to them? *Yes – No - Don't know*

I2. Implementation (Yes 1; No 2; Don't Know 3 & Inapplicable 4)

If No please specify why (enter 1 for most important, 2 for next down to 6 for least important)?

Recommended packages have not been transferred exactly to farmers as they originally formulated by you - Extension services transferred only the packages which they think more relevant and appropriate to farmers needs - Packages are too scientific for farmers to absorb - Lack of effective linkages between your university and farmers - Farmers rejected them for other reason - Other

R2. Recommended packages have not been transferred exactly to farmers as they originally formulated by you (0; 1; 2; 3; 4; 5 or 6)

R3. Extension services transferred only the packages which they think more relevant and appropriate to farmers needs (0; 1; 2; 3; 4; 5 or 6)

A2. Packages are too scientific for farmers to absorb (0; 1; 2; 3; 4; 5 or 6)

E3. Lack of effective linkages between your university and farmers (0; 1; 2; 3; 4; 5 or 6)

R4. Farmers rejected them for other reason (0; 1; 2; 3; 4; 5 or 6)

O4. Other (0; 1; 2; 3; 4; 5 or 6)

Q14. To what extent did your recommended research findings resulted in productivity increase and/or quality improvement to farmers' products?

Don't know - Not at all - Increase of (0-10%) - Increase of (10-20%) - Increase of (20-30%) - Increase of (30-40%) - Increase of (40-50%) - Increase of more than (50%)

P1. Productivity (Don't know 1; Not at all 2; Increase of (0-10%) 3; Increase of (10-20%) 4; Increase of (20-30%) 5; Increase of (30-40)% 6; Increase of (40-50%) 7; Increase of more than (50%) 8 & Inapplicable 9)

Q15. What is the difference between the level of productivity increase and/or quality improvement you achieved by your research and that achieved by farmers?

Don't know - Not difference at all – Difference of (0-10%) – Difference of (10-20%) – Difference of (20-30%) – Difference of (30-40%) – Difference of (40-50%) – Difference of more than (50%)

G. Gap between researchers and farmers (Don't know 1; Not difference at all 2; Difference of (0-10%) 3; Difference of (10-20%) 4; Difference of (20-30%) 5; Difference of (30-40%) 6; Difference of (40-50%) 7; Difference of more than (50%) 8 & Inapplicable 9)

Q16. What are the five most important issues upon which you prioritise and choose your research objectives (enter 1 for most important, 2 for next down to 5 for least important)?

Farmers feedback - Extension services feedback - Your university research strategy - National agricultural research strategy - Regional and international research strategy - Local funds available - Donors funds available - Media report (s) - Agricultural policy and decision makers directions - Book (s) you have read - Reports on research studies - Socio-economic factors - Agricultural corporations or any other client (s) - National higher agricultural and veterinary education strategy - Other

F2. Farmers feedback (0; 1; 2; 3; 4 or 5)

F3. Extension services feedback (0; 1; 2; 3; 4 or 5)

S1. Your university research strategy (0; 1; 2; 3; 4 or 5)

S2. National agricultural research strategy (0; 1; 2; 3; 4 or 5)

S3. Regional and international research strategy (0; 1; 2; 3; 4 or 5)

F4. Local funds available (0; 1; 2; 3; 4 or 5)

F5. Donors funds available (0; 1; 2; 3; 4 or 5)

M. Media report (s) (0; 1; 2; 3; 4 or 5)

P2. Agricultural policy and decision makers directions (0; 1; 2; 3; 4 or 5)

B. Book (s) you have read (0; 1; 2; 3; 4 or 5)

R5. Reports on research studies (0; 1; 2; 3; 4 or 5)

S4. Socio-economic factors (0; 1; 2; 3; 4 or 5)

C2. Agricultural corporations or any other client (s) (0; 1; 2; 3; 4 or 5)

S5. National higher agric. & veterinary education strategy (0; 1; 2; 3; 4 or 5)

O5. Other

Q17. Do you use your research finding (s) in your teaching/demonstration manuals? *Yes – No*

M1. Manuals (Yes 1 & No 2)

Q18. At the national level, what is/are the reason (s) behind the productivity gap (please tick as many as you think apply)?

There is a divergence between universities goals and orientation – Universities are not efficient and effective in technology development - Farmers are not effectively involved in universities research strategy - Extension services are not effectively involved in universities research strategy - Farmers' absorption capacity for technology is inadequate - Extensionists' absorption capacity for technology is inadequate - There is no incentives for farmers to increase productivity - There is no incentives for extensionists to transfer the technology - The implementation system fail to recognise the fundamental economic constraints facing traditional farming systems in Sudan - Extension services are not efficient and effective in technology transfer - Poor linkage between universities and NARIs - Poor linkage between universities and extension services - Poor linkage between *universities and farmers - The difficult economic situation of the country - Changing of policies and objectives - Other socio-political factors – Other*

D2. There is a divergence between universities goals and orientation (1 or 0)

E4. Universities are not efficient and effective in technology development (1 or 0)

S6. Farmers are not effectively involved in universities research strategy (1 or 0)

S7. Extension services are not effectively involved in universities research strategy (1 or 0)

I3. Farmers' absorption capacity for technology is inadequate (1 or 0)

I4. Extensionists' absorption capacity for technology is inadequate (1 or 0)

I5. There is no incentives for farmers to increase productivity (1 or 0)

I6. There is no incentives for extensionists to transfer the technology (1 or 0)

S8. The implementation system fail to recognise the fundamental economic constraints facing traditional farming systems in Sudan (1 or 0)

E5. Extension services are not efficient and effective in technology transfer (1 or 0)

L4. Poor linkage between universities and NARIs (1 or 0)

L5. Poor linkage between universities and extension services (1 or 0)

L6. Poor linkage between universities and farmers (1 or 0)

D3. The difficult economic situation of the country (1 or 0)

P3. Changing of policies and objectives (1 or 0)

S9. Socio-political factors (1 or 0)

O6. Other (1 or 0)

Q19. Have you changed you research strategy as a result of this productivity gap? *Yes – No*

S10. Strategy of research (Yes 1 & No 2)

F3.1 SPSS Data

No	G	A	E	C	S	F	L	L1	V	D	E1	U	O	O1	T	I	C1	D1
1	1	3	3	1	11	1	2	1	3	0	0	0	0	1	0	7	0	0
2	1	2	1	1	15	2	1	2	6	1	1	0	0	0	4	5	6	3
3	1	4	4	4	12	1	1	1	8	1	1	1	0	0	1	0	0	3
4	1	3	3	1	15	1	2	2	3	1	1	0	1	0	1	0	0	0
5	2	1	1	1	16	1	1	2	3	1	0	0	0	0	3	0	0	0
6	1	4	4	1	16	1	2	2	10	0	0	0	0	1	0	0	0	0
7	2	4	4	1	14	1	2	1	10	0	0	0	0	1	0	0	0	1
8	1	3	3	1	1	2	2	2	9	0	0	0	0	0	0	0	0	0
9	1	5	3	4	13	2	2	1	9	1	1	0	0	0	1	0	0	0
10	2	2	3	1	11	2	2	2	9	0	0	0	0	0	0	0	0	0
11	1	3	3	1	11	2	2	2	10	0	0	0	0	0	1	4	5	3
12	1	2	3	1	2	1	2	2	9	0	0	0	0	0	0	0	0	0
13	1	4	3	1	13	1	2	2	5	0	1	0	1	0	0	0	0	0
14	1	5	4	4	12	1	2	2	9	1	1	0	0	0	0	0	0	0
15	1	4	3	1	11	1	1	2	10	0	0	1	1	0	3	0	0	0
16	1	4	3	4	12	1	2	1	9	0	1	0	1	0	0	0	0	0
17	1	5	4	0	4	1	2	2	5	1	0	0	0	0	0	0	0	0
18	1	4	3	1	4	1	1	1	9	0	1	0	0	0	1	0	7	0
19	1	5	4	4	3	1	2	2	9	1	0	0	0	0	0	0	0	0
20	1	4	4	0	6	1	2	2	5	1	0	0	1	0	1	5	4	3
21	2	4	3	1	11	2	2	2	10	0	0	1	0	1	1	5	0	2
22	1	5	4	0	4	1	1	1	3	1	1	0	1	0	1	0	0	0
23	1	4	4	0	10	1	2	2	6	1	0	0	0	0	1	0	0	2
24	1	4	4	4	4	1	2	2	9	0	0	0	0	1	0	0	0	0
25	1	5	4	0	1	2	2	1	10	0	0	0	0	1	0	0	0	0
26	1	3	3	1	3	2	2	2	9	1	1	0	0	0	0	0	0	0
27	1	5	4	0	12	1	2	1	7	0	1	0	0	1	3	0	0	2
28	1	3	4	0	10	1	2	1	8	0	1	0	0	0	1	0	0	0
29	1	5	4	0	1	1	1	1	6	1	1	0	1	0	2	0	0	3
30	1	4	3	4	11	1	2	2	9	1	1	1	0	0	0	0	0	0
31	1	4	3	1	5	1	2	2	5	1	1	0	1	0	3	0	0	1
32	1	4	4	0	3	1	1	1	6	1	1	1	1	0	1	0	0	3
33	1	4	4	0	11	1	1	2	3	1	1	0	1	0	1	0	0	2

No	L2	F1	O2	R	L3	A1	I1	E2	P	R1	O3	I2	R2	R3	A2	E3	R4	O4
1	1	2	0	2	2	0	0	0	1	7	0	2	0	0	0	1	6	0
2	2	1	0	2	4	3	2	1	5	0	0	3	0	0	0	0	0	0
3	2	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0
4	0	0	0	2	1	0	0	0	0	0	0	2	0	0	0	1	0	0
5	2	1	0	2	2	0	0	0	1	0	0	3	0	0	0	0	0	0
6	1	2	3	2	1	0	0	0	0	0	2	3	1	2	0	0	0	3
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No	P1	G	F2	F3	S1	S2	S3	F4	F5	M	P2	B	R5	S4	C2	S5	O5	M1
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No	D2	E4	S6	S7	I3	I4	I5	I6	S8	E5	L4	L5	L6	D3	P3	S9	O6	S10
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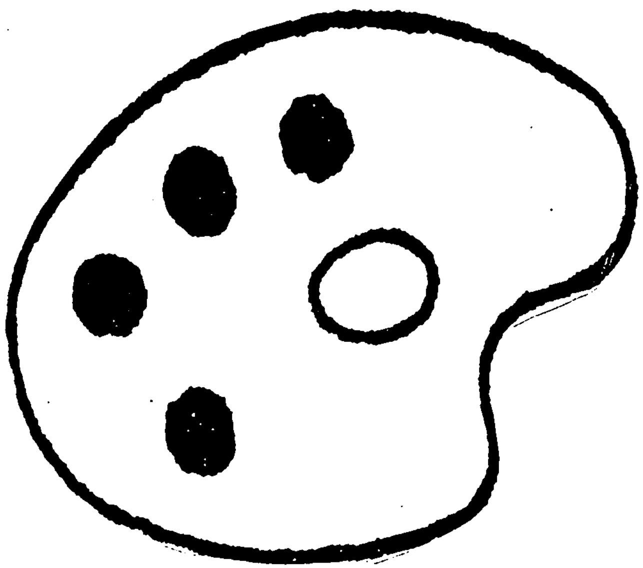
33	0	1	1	1	0	0	0	1	1	1	1	1	0	1	1	1	0	1

APPENDIX-G

Pictures

NUMEROUS ORIGINALS
IN COLOUR

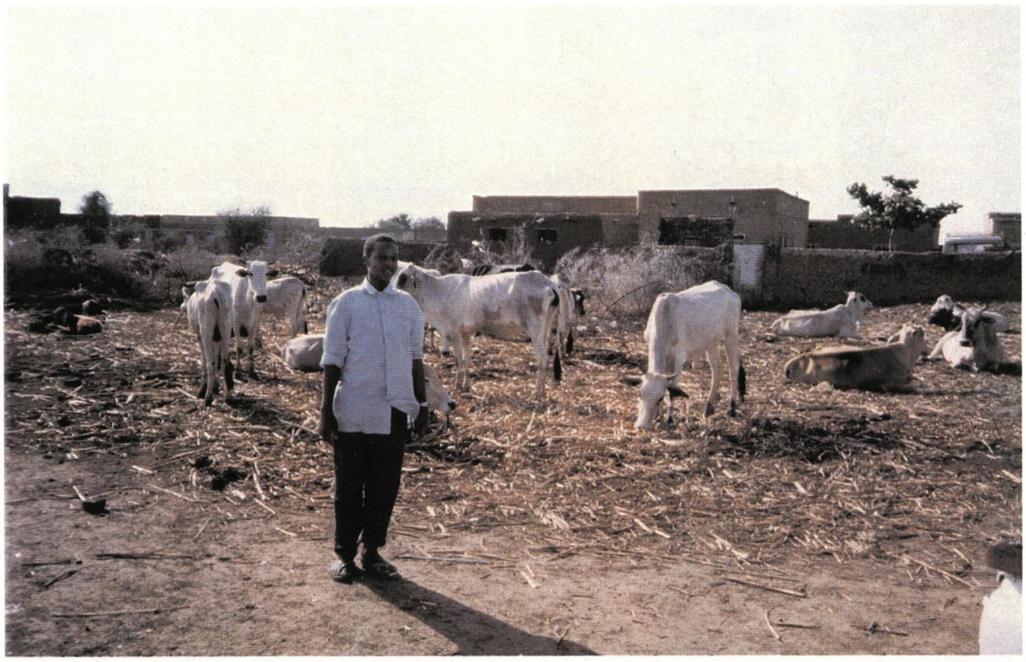


APPENDIX-G

SELECTED PICTURES DURING THE STUDY SURVEY

G1 FARMERS

G1.1 Unhealthy living conditions in villages



G1.2 Very poor farmers

G1.3 Very basic farmer's house

G1.4 Difficult living conditions during the raining season

G1.5 Water shortage

G1.6 Irrigation problems

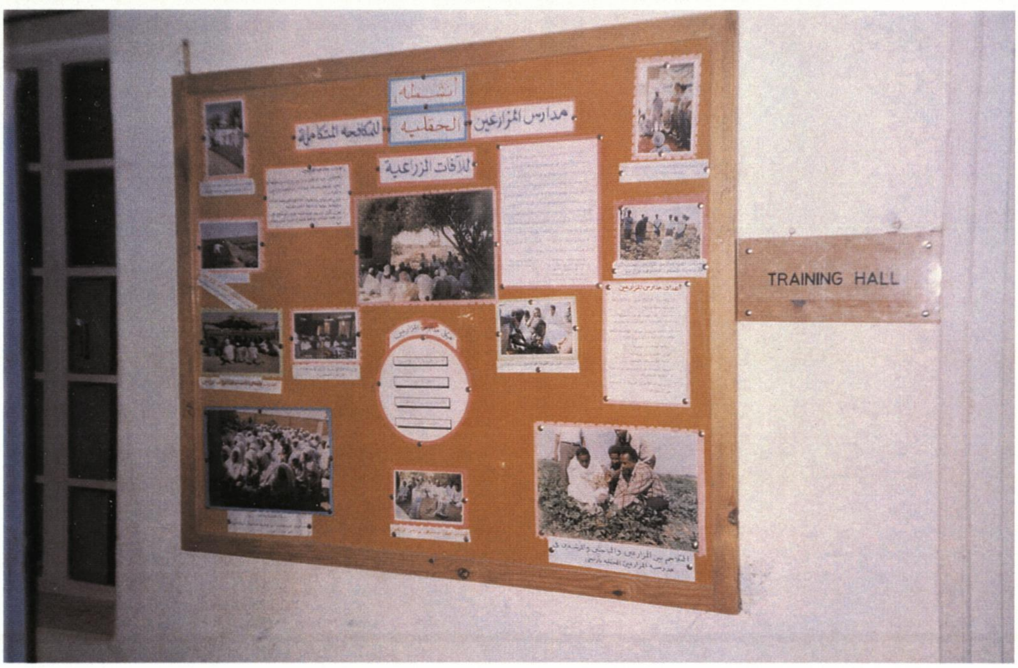
G1.7 Poor roads linking villages to the near by towns

G1.8 Extension services unable to get to the farmers

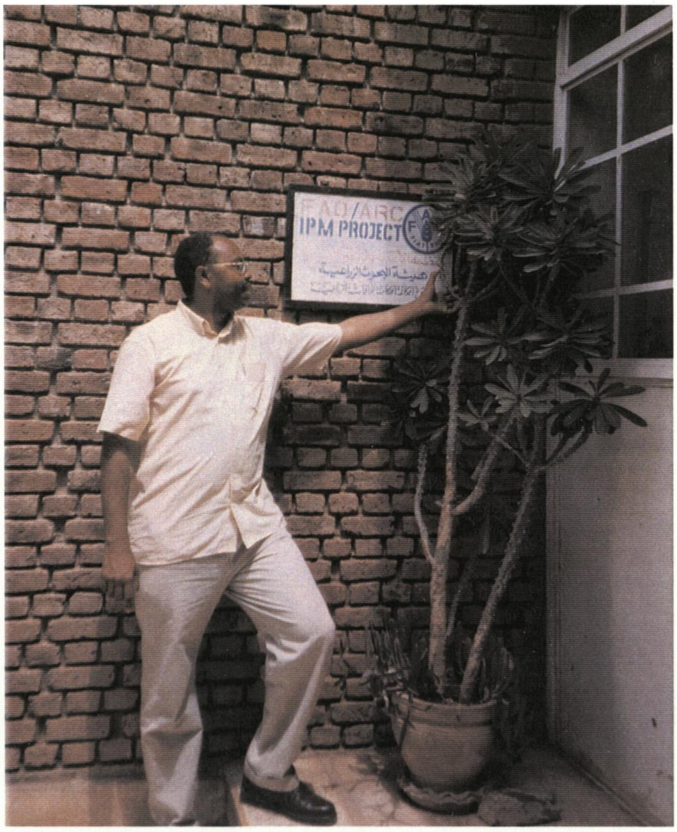
G2 AGRICULTURAL RESEARCH CORPORTAION

G2.1 Meeting with ARC Staff

G2.2 FFSs Training Programs



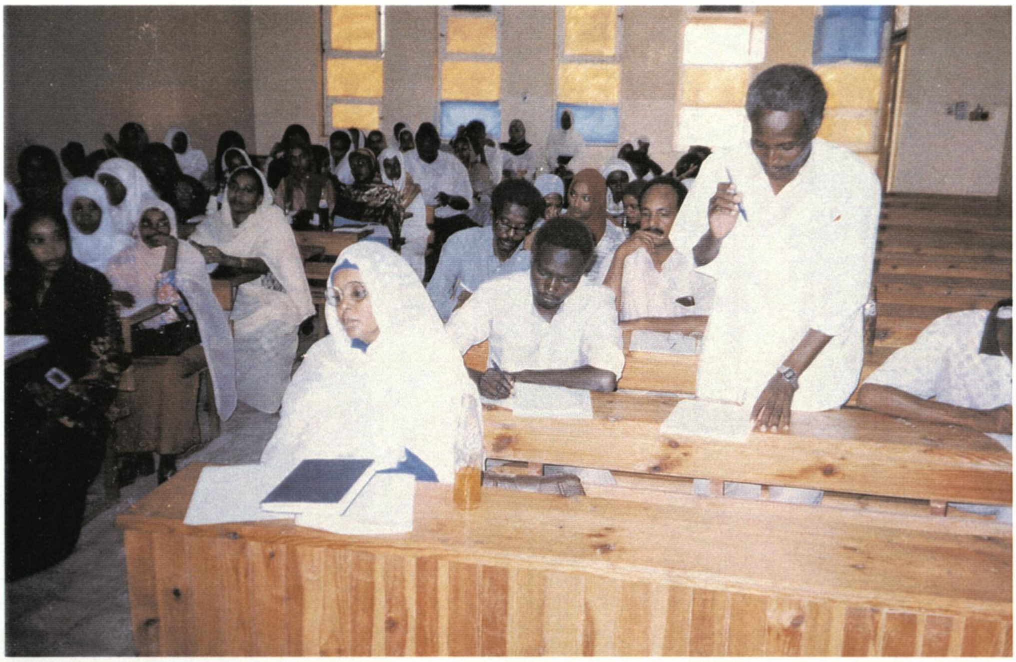
G2.3 FAO/ARC Extension Project



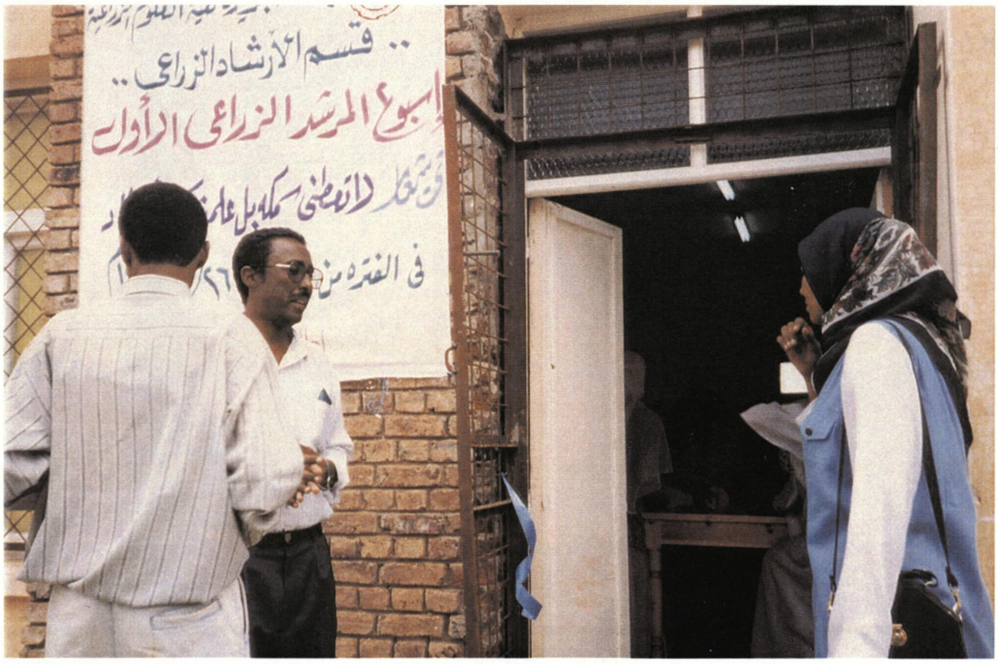
G2.4 IPM Training Centre

G3 UNIVERSITY OF GEZIRA

G3.1 Agricultural Economics Research Conference



G3.2 The 1st Agricultural Extension Week



G3.3 On-Farm research investigation

G3.4 Poor facilities, overcrowded and sever staff shortage

G4 EXTENSION SERVICES

G4.1 Preparation of an extension TV message

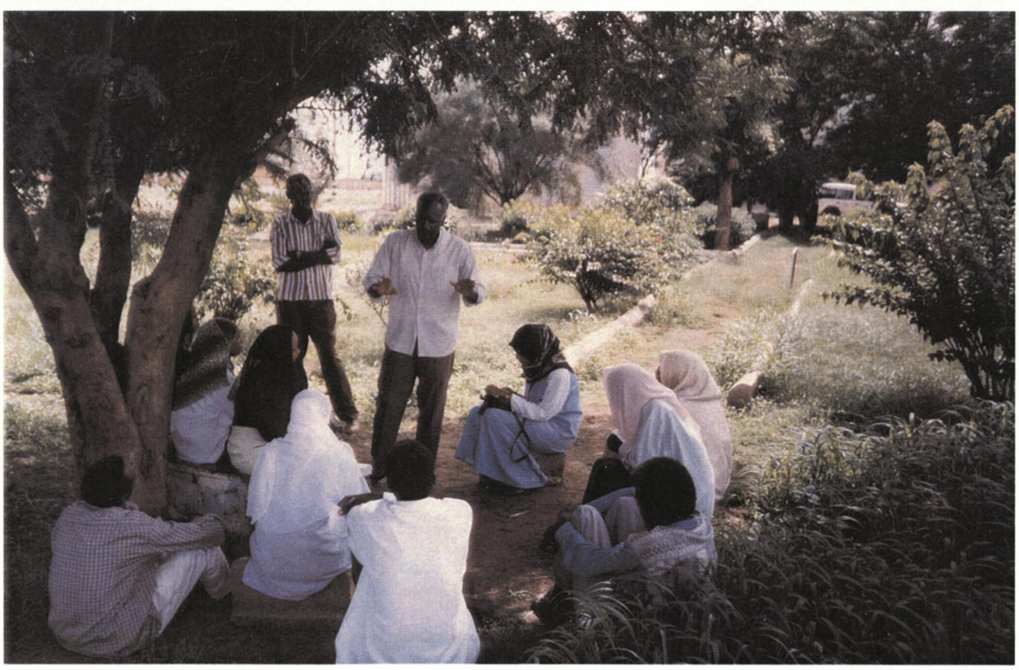
G4.2 On-field discussion of the message purpose and content

G4.3 Recording of the message

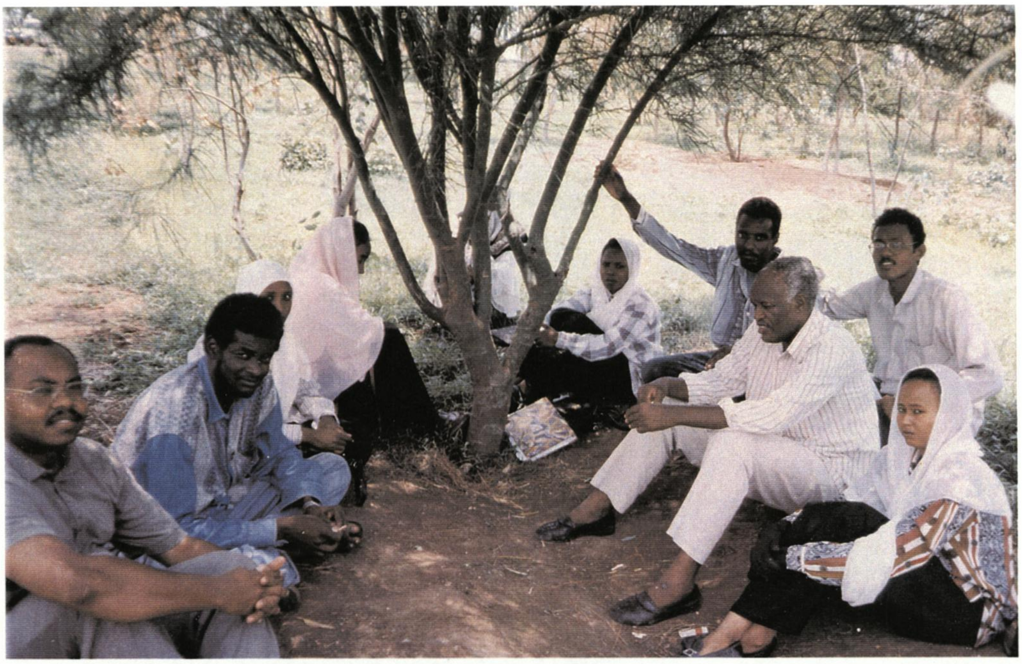
G4.4 Broadcasting of the message form the local Gezira TV station

G4.5 Training on FFSs

G4.6 Discussion on the purpose and content of the lesson



G4.7 Getting immediate farmers' feedback



G4.8 On-field preparation and selection of location

DAWN

Scientists call for technology transfer

By Our Staff Reporter

KARACHI April 26: Twelve papers were presented on Wednesday at the international science conference which opened earlier this week at a local hotel. The experts presenting papers discussed in detail new technologies, transfer of technologies and the role of the international organizations in technology transfer.

The conference is being organized jointly by Karachi University and Science Technology and Development Forum – a UK-based charity. The experts taking part in the third day's proceedings, quoted various studies and the experience of various developing countries and said that the available resources should be developed to derive maximum benefits for the people.

They said the developing countries could make use of the scientific and technological advancement of the developed countries but for this a basic infrastructure had to be developed and adequate resources allocated.

There was a consensus that though developing countries could gain a lot from the advanced technologies, however, poor countries should strive to develop indigenous and lowcast technologies relevant to their needs and resources.

Dr Husam Morad of Syria said that if a government's objectives were to increase research activities and bring about tech nological progress, it could do so either by increasing tax rates or through bargaining with the industrialized countries on the royalty rate on imported foreign technology. He said a decrease in royalty on the imported foreign technology would certainly increase research activities and technological production which in turn would increase the national income. Prof Dr Masud Qureshi of the University of Karachi in his paper stressed on the efforts to control the rate of population increase which, he said was directly-related to the overall state of development and prosperity. He said some of the densely-populated countries had successfully brought down their rates of population increase and its positive effects on their economy were now visible.

Some of the papers concentrated on the projects for rural uplift and proposed devising appropriate indigenous technologies for sustainable rural community development and integrated multi-sectoral approach with community-based organizations.

Another paper invited attention of the participants on the fact that solar energy, which was abundantly available in most of the developing countries, had still not been tapped due to the fact that technology to harness solar energy was too costly, said a press release of Karachi University.

G5 Conference Paper

An abstract of the paper entitled *'New approach to technology transfer in Sudan'* presented at the Fifth International Conference of the UK Based Third World Science Technology and Development Forum' on: Technology & Development in the New Millennium, 26 April 2000, University of Karachi, Pakistan. (Ahmed & Adams, 2000). Pakistani Daily Newspaper, DAWN Thursday, April 27, 2000.

REFERENCES

REFERENCES

Ahmed, A. E. O. (2000). Analysing the Productivity Gap in Sudan. Paper presented at Napier University Faculty of Arts and Social Science Postgraduate Conference, 01 June 2000, Napier University, Edinburgh - UK.

Ahmed, A. E. O. and Adams, J. (2000). New approach to technology transfer in Sudan. Paper presented at the Fifth International Conference of the UK Based 'Third World Science Technology and Development Forum' on: Technology & Development in the New Millennium, 26 April 2000, University of Karachi, Karachi - Pakistan.

Ahmed, A. E. O. (1999a). Politics of Aid. Paper presented at the British Council International Links in the Classroom Seminar, 20 May 1999, Westerhailes Education Centre, Edinburgh - UK.

Ahmed, A. E. O. (1999b). Analysing agricultural research effectiveness: The case of the Sudan agricultural research institutions. Paper presented at the Development Studies Association - Scotland Study Group Conference, 24 April 1999, Edinburgh University, Edinburgh - UK.

Ahmed, A. E. O. (1999c). The case of technology transfer, agricultural transformation and policy reform in Sudan. Paper presented at the Scottish Economic Society Annual Conference, April 8-9, Napier University, Edinburgh - UK.

Ahmed, A. E. O. (1998). The impact of in-country research upon agricultural and related economic development in the Third World - Sudan case study. MSc Thesis, School of Business, The Royal Agricultural College, Cirencester - UK.

Ahmed, A. E. O. (1996). History shows that every civilised society has destroyed itself; how can agriculture help to prevent this happening to ours?. Paper submitted for the Royal Agricultural College Scholarship Award, The Royal Agricultural College, Cirencester - UK.

Ahmed, A. E. O. (1993). Marketing of Dura (Sorghum) in Sudan. Agricultural International Magazine (AIM), edition no. 6, June, 1993, IAAS - International, Leuven, Belgium.

Abadi Ghadim, A.K. and Pannell, D. J. (1999). A conceptual framework of adoption of an agricultural innovation. Agricultural Economics 21 (1999) 145-154.

Abalu, G. O. I. (1980). Farm level surveys of west African Agriculture: A Critique of conventional methodology. In Purdue.

Abdel Gadir, K. (1989). Valuation of irrigation water: Some aspects of the economics and management of irrigation in the Gezira scheme. PhD Thesis, Faculty of Agricultural Sciences, University of Gezira, Sudan.

Adesina, A., Baidu-Forson, J. (1995). Farmers perceptions of new agricultural technology- evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics 13, 1-9.

Adesina, A., Zinnah, M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: a tobit model application in Sierra Leone. Agricultural Economics 9, 297-311.

The African Development Bank (ADB) (1997). African development report 1997: Fostering private sector development in Africa, economic & social statistics on Africa.

Ageeb, O. A. A. (1999). Notes on: Agricultural Research Systems. Unpublished Paper presented at the ARC/FAO Training Workshop, August, 1999. ARC, Wad-Medani, Sudan.

Ageeb, O. A. A. and Hamdoun, A. M. (1997). A project for: In-depth analysis of NARIs in 26 West Asian and North African Countries (WANA): Sudan case study, An unpublished report, ARC - Sudan.

Ageeb, O. A. A.; Salih, S. H.; Saxena, M. C. and Solh, M. B. (1995). Production and improvement of cool-season food Legumes in the Sudan. Proceedings of the National Research Review Workshop, 27-30 August 1995, Agricultural Research Corporation, Wad Medani, Sudan.

Ageeb, O. A. A.; Elahmadi, A. B.; Saxena, M. C. and Solh, M. B. (1995). Wheat production and improvement in the Sudan. Proceedings of the National Research Review Workshop, 27-30 August 1995, Agricultural Research Corporation, Wad Medani, Sudan.

Agricultural Research Corporation (ARC) (1998). List of Research Scientists. ARC, Wad-Medani, Sudan.

Agricultural Research Corporation (ARC) (1997). ARC/FAO -IPM Project in Sudan. ARC, Wad Medani, Sudan

Agricultural Research Corporation (ARC) (1994). Research strategy for the nineties and beyond. ARC, Wad-Medani, Sudan.

Agricultural Research Corporation (ARC) (1993). Research Annual Report. ARC, Wad-Medani, Sudan.

Agricultural Research Corporation (ARC) (1992). Research Annual Report. ARC, Wad-Medani, Sudan.

Agricultural Research & Extension Network (AgREN) (2000). Agricultural Research-Extension Linkage Systems: An International Perspective. Network Paper No. 106, ODI, July 2000.

Aklilu, B. (1980). The diffusion of fertilisers in Ethiopia: Patterns, determinants, and implications. Journal of Development Areas. 14:387-399.

Alston, J.M., Norton, G.W., Pardey, P.G. (1995). Science Under Scarcity. Principles and Practice For Agricultural Research Evaluation and Priority Setting. Cornell University Press, Ithaca.

Amann, V. F., ed. (1973). Agricultural policy issues in east Africa. Proceeding of the East African Agricultural Economics Society Conference, Nairobi, June 1971. Kampala, Uganda, Makerere University Printery.

Amin, S., C. Atta-Mills, A. Bujra, G. Hamid, and T. Mkandawire. (1978). Social science and the development crisis in Africa, problems and prospects. Africa Development 3(4):23-45.

Anthony, G., Anderson, J. R. (1991). Modelling technology replacement over time for ex-ante analysis of agricultural research projects. Agricultural Systems 37, 183-192.

Anthony, K. R. M.; B. F. Johnston; W. O. Jones & V. C. Uchendu. (1979). Agricultural change in tropical Africa. Ithaca, Cornell University Press.

Ashby, J. A. (1995). Institutionalising farmer participation in adaptive technology testing with the 'CIAL", Network Paper 57, July 1995, Overseas Development Institute, Agricultural Research and Extension Network, UK.

Axinn, G. H. (1988). Guide on alternative extension approaches. FAO, Rome.

Axinn, G. H. (1987). The different systems of agricultural extension education, with special attention to Asia and Africa. In Rivera, W. H. and Schram, S. G., Agricultural Extension World-wide, pp. (103-14). London, New York, Sidney, Croom Helm.

Axinn, G. H. & Thorat, S. (1972). Modernising world agriculture: A comparative study of agricultural extension education systems. New York, Praeger Publishers, New Delhi, Oxford & IBH.

Bailey, J. C. (1945). Seaman A. Knapp, Schoolmaster of American agriculture. New York, Columbia University Press.

Baranson, J. (1963). Economic and social considerations in adapting technologies for developing countries. Technology and Culture, 4(1), 22-29.

Barnett, T. (1981). "Evaluating the Gezira scheme: Black box or pandora's box" in Heyer, Roberts and Williams, pp. 306-324.

Barnett, T. (1979). "Why are bureaucrats slow adopters? The case of water management in the Gezira scheme." Sociologia Ruralis 19(1):60-70.

Barnett, T. (1977). The Gezira scheme: An illusion of development. Frank Cass & Co. Ltd, London..

Bates, R. H. & M. F. Lofchie, eds. (1980). Agricultural development in Africa: Issues and public policy. New York, Praeger.

Batz, F.-J., Peters, K.J. and Janssen, W. (1999). The influence of technology characteristics on the rate and speed of adoption. Agricultural Economics 21 (1999) 121-130.

Bauer, P. (1967). Afrika Spectrum, September 1967.

Beeden, P.; Norman, D. W.; Kroeker, W. J.; Pryor, D. H.; Hays, H. M.; and Huizinga, B. (1976). The Feasibility of improved sole crop cotton production technology for the small-scale farmer in the Northern Guinea Savanna Zone of Nigeria. Zaria, Nigeria, Ahmadu Bello University, IAR, Samaru Miscellaneous Paper 60.

Beets, W. C. (1994). Excerpted and adapted from a conference paper presented at the First International Tyndall School Symposium, Carlow, 7 September. Agronomy Department, University of California at Davis,1994.

Belshaw, D. G. R., and M. Hall. (1972). The analysis and use of agricultural experimental data in tropical Africa. Eastern Africa Journal of Rural Development. 5:39-72.

Benneh, G. (1972). "Systems of agriculture in tropical Africa." Economic Geography 48(3):244-257.

Benor, D. et. al. (1984). Agricultural extension: the training and visit system. Washington, World Bank.

Benor, D. & Baxter, M. (1984). Training and visit system. Washington, World Bank.

Benor, D. & Harrison, J. Q. (1977). Agricultural extension: The training and visit system. Washington, World Bank.

Biggs, S.D. (1990). A multiple source of innovation model of agricultural research and technology promotion. World Development 18, 1481-1499.

Binswanger, H. (1978). The economics of tractors in south Asia. An analytical review. New York and Hyderabad, ADC and ICRISAT.

Borlaug, N. E. (1997). Feeding the world in the 21st century: The challenges before us. Keynote address, presented at the world congress of the International Food and Agribusiness Management Association (IAMA), Jakarta, Indonesia.

Boyce, J. K. & R. E. Evenson (1975). National and international research and extension programs. New York, ADC.

Brandt, W. (1980). North - South: A Programme for survival. The report of the Independent Commission on International Development Issues. Pan Books.

Braun, J. von & Kennedy, E. (1986). Commercialisation of subsistence agriculture: income and nutritional effects in developing countries. Washington, International Food Policy Research Institute.

Braverman, A.; Guasch, J. L.; Huppi, M. & Lorenz. (1991). Agricultural Biotechnology: The next "green Revolution"? World Bank: Washington, D.C.

Brunner, E. de S. & Yang, E. H. P. (1949). Rural America and the extension service. New York; Columbia University Press.

Bryant, C. and White, L. G. (1982). Managing development in the Third World. Westview Press, Colorado.

Bryman, A. and Cramer, D. (1997). Quantitative data analysis with SPSS for windows.

Budhoo, D. L. (1990), 'Enough is Enough'. Open Letter of Resignation to the Managing Director of the International Monetary Fund, New Horizons Press, New York.

Bunting, A. H., ed. (1970). Change in agriculture. New York, Praeger.

Byerlee, D., de Polanco, E.H. (1982). The rate and sequence of adoption of improved cereal technologies: The case of rainfed barley in the Mexican Altiplano. Working Paper 82/4. Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico.

Byerlee, D. (1980). Rural labour markets in west Africa with emphasis on the semi-Arid tropics. In ICRISAT, 1980, pp. 348-356.

Byerlee, D. and Collinson. M. P. (1980). Planning technologies appropriate to farmers: concepts and procedures. Mexico, CIMMYT.

Byerlee, D., and Eicher. C. K. (1974). Rural employment, migration, and economic development: theoretical and empirical evidence from Africa. In agricultural policy in developing countries, N. Islam, ed. New York, Macmillan, pp. 273-313.

Campbell, M. J. (1990). New Technology and Rural Development. The social impact. Routledge, London.

CGIAR, Technical Advisory Committee. (1978). Farming systems research at the International Agricultural Research Centres. Rome, TAC Secretariat.

Chambers, R. (1997). Whose reality counts?', Putting the first last, Intermediate technology publications, London, UK.

Chambers, R. (1993). Challenging the professions. Frontiers for rural development. Intermediate Technology Publications, London, UK.

Chambers, R., Arnold Pacey & Lori Ann Thrupp (eds) (1989). Farmer first: Farmer innovation and agricultural research. Intermediate technology publications, London.

Chambers, R. (1985). Agricultural research for resource-poor farmers: the farmer-first-and-last model. Agricultural Administration, 2:1-30.

Chambers, R., ed. (1974). Managing rural development: Ideas and experience from East Africa. Uppsala, Sweden, Scandinavian Institute of African Studies.

Clayton, E. S. (1963). Economic planning in peasant agriculture. A study of the optimal use of agricultural resources by peasant farmers in Kenya. Ashford, Kent, Wye College, Department of Economics.

Clayton, E. S. (1961). Technical and Economic Optima in Peasant Agriculture. Journal of Agricultural Economics. 14:337-377.

Cleave, J. H. (1974). African farmers: Labour use in the development of smallholder agriculture. New York, Praeger.

Collinson, M. P. (1981). Micro-Level Accomplishment and challenges for the Less Developed World. In Rural change: The challenges for agricultural economists. Proceedings, Seventeenth International Conference of Agricultural Economists, 3-12 September, Banff, Canada, G. L. Johnson and A. Maunder, eds. Westmead, England, pp. 43-53.

Collinson, M. P. (1972). Farm management in peasant agriculture: A handbook for rural development planning in Africa. New York, Praeger.

Collinson, M. P. (1962-4). Farm management survey report. No. 1, 2, 3, 4. Ukiriguru Research Station, Tanganyika, Ministry of Agriculture.

Crawford, E. W. (1982). A Simulation study of constraints on traditional farming systems in northern Nigeria. East Lansing, Michigan State University, department of Agricultural Economics, MSU International Development Paper No. 2.

Dabrowski, Z. T. (1997). Integrated Pest Management in Vegetables, Wheat and Cotton in the Sudan: A Participatory Approach.

Denis Goulet. (1971). The cruel choice: A new concept in the theory of development. New York: Atheneum, 1971, p. 23, pp. 87-94, pp. 89-90.

De Vries, J. (1978). Agricultural extension and development – Ujamaa village and the problems of institutional change. Community Development Journal 13:11-19.

De Vries, J. (1976). On the effectiveness of agricultural extension: A case study of Maize growing practices in Iringa, Tanzania. Eastern African Journal of Rural Development 9(1-2):37-56.

De Wilde, J. C.; P. F. M. Mcloughlin; A. Guinard; T. Scudder & R. Maubouche. (1967). Experiences with agricultural development in tropical Africa. Vol. 1. The synthesis. Vol. 2. The case studies. Baltimore, Johns Hopkins Univ. Press.

Dewey, K. G. (1985). Nutrition, social impact, and development: a Mexican case. In Derman, W. and Whiteford, S., eds. Social impact analysis and development planning in the Third World. pp. 160-77. Boulder, Westview Press.

Dickinson, H. D. (1969). Von-Thunen's Economics. Economic Journal, vol. 79, December, 1969, pp. 894-902.

Drost, D., Long, G. and Hales, K. (1998). Targeting extension efforts for the adoption of sustainable farming practices. Journal of Extension, Vol. 36, No. 5.

Dudley Seers (1969). The meaning of development. Paper presented at the Eleventh World Conference of the Society for International Development, New Delhi, p.3.

Eicher, C. K. (1989). Sustainable Institutions for African Agricultural Development. Working Paper No. 19 prepared for the International Service for National Agricultural Research (ISNAR).

Eicher, C. K. (1988). Food security battles in sub-Saharan Africa. Plenary address, VII World Congress for Rural Sociology, Bolonga, Italy, June 26 - July 2.

Eicher, C. K. & D. C. Baker. (1982). Research on agricultural development in Sub-Saharan Africa: A critical survey. MSU International development papers. Paper no. 1. Michigan State University.

El Ghonemy, M. R., ed. (1984). How development strategies benefit the rural poor. WCARRD Follow-up Programme. FAO, Rome.

El Siddig, K. (1997). Notes on: Decline of Acala Cotton in the Gezira Scheme. Unpublished Paper prepared for the Cotton Research Program. ARC, Wad-Medani, Sudan.

Encyclopaedia Britannica (1998). 1998 Book of the Year. Events of 1998.

Eponou, T. (1996). Linkages between research and technology users in Africa: The situation and how to improve it. Briefing Paper 31, ISNAR, The Netherlands.

The Europa World (1998). The Europa World Year Book 1998. 39th Edition. Europa Publications.

Falusi, A. O. (1974/75). Application of multivariate probit to fertiliser use decisions: Sample survey of farmers in three states in Nigeria. Journal of Rural Economic Development. 9(1):49-66.

Farrington, J. (1976). A note on planned versus actual farmer performance under uncertainty in underdeveloped agriculture. Journal of Agricultural economics. 27:257-260.

Feder, G., Just, R. E., Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: a survey. Economic Development and Cultural Change 33, 255-298.

Feder, G., Umali, D.L. (1993). The adoption of agricultural innovations, A Review. Technological Forecasting and Social Change 43, 215-239.

Food and Agriculture Organisation of the United Nations (FAO) (2000). Food Crops and Shortages No.3, June 2000. FAO, Via delle Terme di Caracalla, 00100 Rome, Italy. http://www.fao.org/WAICENT/faoinfo/economic/giews/english/liens/sude.htm.

Food and Agriculture Organisation of the United Nations (FAO) (1997). Universities and national agricultural research in North Africa and the Near East. SD Dimensions/ Research & technology development. Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food and Agriculture Organisation of the United Nations (FAO) (1994a). A project for: promoting the role of universities in the national agricultural research systems of selected near east countries. Sudan case study. Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food and Agriculture Organisation of the United Nations (FAO) (1994b). Integrating environmental and sustainable development themes into agricultural education and extension programmes. Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food and Agriculture Organisation of the United Nations (FAO) (1994c), 'Strategic extension campaign', Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food and Agriculture Organisation of the United Nations (FAO) (1990a). Participation in practice. Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food and Agriculture Organisation of the United Nations (FAO) (1990b). The people participation programme. Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food and Agriculture Organisation of the United Nations (FAO) (1988). Guide on Alternative Extension. Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food and Agriculture Organisation of the United Nations (FAO). (1978). Regional food plan for Africa. Report of the Tenth FAO regional conference for Africa, 18-29 September, 1978, Tanzania. Publications Division, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Food Matters Worldwide (1991), Issue Twelve.

Fliegel, F.C., Kivlin, J.E. (1966). Farmer's perceptions of farm practice attributes. Rural Sociology 31, 197-206.

Freire, P. (1973). Education for critical consciousness. New York, Continuum.

Gaitskell, A. (1959). Gezira: A story of development in the Sudan. London, Faber and Faber.

Gemmill, G. & C. K. Eicher (1973). A framework for research on the economics of farm mechanisation in developing countries. East Lansing, Michigan State University, Department of Agricultural Economics, African Rural Employment Paper no. 6.

Gerhart, J. (1975). The Diffusion of Hybrid Maize in Western Kenya (abridged by CIMMYT). Mexico City, CIMMYT.

Ghoshal, S. and Tsai, W. (1998). Social capital and value creation: The role of intrafirm networks. Academy of Management Journal, 1998. Vol. 41, No. 4, 464-476.

Gilbert, E. H.; Norman, D. W.; and Winch, F. E. (1980). Farming systems research: A Critical Appraisal. East Lansing, Michigan State University, Department of Agricultural Economics, MSU Rural Employment Paper No. 6.

Giles, G. W. (1975). "The reorientation of agricultural mechanisation for developing countries. Part 1: Policies and attitudes for action programs." AMA: Agricultural mechanisation in Asia 6(2):15-25.

Gittinger, J. P. (1982). Economic Analysis of Agricultural projects. 2nd ed. pp. 329-342. Baltimore: Johns Hopkins University Press.

Glaeser, B. (1987). The green revolution revisited: Critique and alternatives. Allen & Unwin: London.

Gould, B.W., Saupe, W.E., Klemme, R.M. (1989). Conservation tillage: the role of farm and operator characteristics and the perception of erosion. Land Economics 65, 167-182.

Grawert, E. (1998). Making a living in rural Sudan. Macmillan Press Ltd, UK.

Grigg, D. B. (1982). The Dynamics of Agricultural Change. pp. 135-150. New York: St. Martin's Press.

Griliches, Z. (1957). Hybrid corn: An exploration in the economics of technological change. Econometrica 25, 501-523.

Hall, M. (1970). A Review of farm management research in East Africa. Agricultural Economics Bulletin for Africa. 12:11-24.

Hardaker, J. B. (1979). A Review of some farm management research methods for small farm development in the LDCs. Journal of Agricultural Economics. 30(3):315-331.

Hayami, Y., Ruttan, V.W. (1971). Agricultural Development: An International Perspective. Baltimore: Johns Hopkins University Press, pp. 366.

Hayami, Y., Ruttan, V.W. (1985). Agricultural Development: An International Perspective. Revised Edition. Baltimore and London: Johns Hopkins University Press, pp. 41, 52, 62 and 506.

Hayter, T. (1981). The creation of world poverty: An alternative view to the Brandt report. Pluto Press Limited, London.

Hayter, T. (1971). Aid as imperialism. Penguin.

Heyer, J.; P. Roberst & G. Williams, eds. (1981). Rural development in tropical Africa. New York, St. Martin's Press.

Heyer, J. (1981). Agricultural development policy in Kenya from the colonial period to 1975. In Heyer, Roberst, and Williams, 1981, pp. 90-120.

Heyer, J. (1972). An analysis of peasant farm production under conditions of uncertainty. Journal of Agricultural Economics. 23:135-146.

Heyer, J. (1971). A Linear programming analysis of constraints on peasants farms in Kenya. Food Research Institute Studies. 10:55-67.

Heyer, J. (1966). Agricultural development and peasant farming in Kenya. Ph.D. Dissertation, University of London.

Hill, P. (1968). The myth of amorphous peasantry: A Northern Nigerian Case Study. Nigerian Journal of Economic Sociological Studies. 10:239-261.

Hopkins, E. (1974). "Operation Groundnuts: Lessons from an agricultural extension scheme." IDS Bulletin 5(4):59-66.

Horn of Africa Bulletin (HAB), vol. 7 no. 1, January – February 1995.

Howell, J. (1988). Training and visit extension in practice. Overseas Development Institute (ODI): London.

Idachaba, F. S. (1980). Agricultural research policy in Nigeria. Washington, IFPRI.

ILO. (1976). Growth, employment and equity: A comprehensive strategy for the Sudan. Geneva.

International Monetary Fund (IMF) (1999). Sudan: Recent Economic Developments. IMF Staff Country Report No. 99/53. IMF, Washington, D. C.

International Service For National Agricultural Research (ISNAR) (1999). Planning Linkages Between Research, Technology, Technology Transfer, and Farmers' Organisations. Results of an Action-Oriented Project in Mali, Senegal, Tanzania, and Zimbabwe.

Integrated Pest Management (IPM) (1998). Workshop on: Review of farmers field schools and rural women schools curricula for master trainers. 25-28 May 1998, Agricultural Research Corporation, Wad Medani, Sudan.

International Service For National Agricultural Research (ISNAR) (1998). Financing agricultural research: A source book.

International Service For National Agricultural Research (ISNAR) (1995). Statistical brief on the national agricultural system of Sudan, no. 22. ISNAR indicator series project: phase II.

International Service For National Agricultural Research (ISNAR) (1994). Management of national agricultural research systems in selected Arab countries. ISNAR Country Report R57: An overview.

International Service For National Agricultural Research (ISNAR) (1989). Sustainable institutions for African agricultural development. ISNAR Working Paper no. 19.

Interpaks Interchange (1989). University of Illinois at Urbana-Champaign, March, Vol. 6, No. 1.

Interpaks Interchange (1984). University of Illinois at Urbana-Champaign, March, Vol.1, No.2.

Jock, R. A.; Robert, W. H. & Grant, M. S. (1991). Science and Food: The CGIAR and its partners. World Bank: Washington, D.C.

Johnson, S., Gatz, E. F. and Hicks, D. (1999), Expanding the content base of technology education: technology transfer as a topic of study. University of Illinois.

Jones, G. E. (1982). The Clarendon letter. In Jones, G. E. & M. Rolls eds. Progress in rural extension & community development. Vol. 1. Extension & relative advantage in rural development, pp. 11-9. Chichester, John Wiley.

Judd, M. A., Boyce, J, K. and Evenson, R. E. (1987). Investment in agricultural research and extension. In policy for agricultural research. Edited by V. W. Ruttan and C. Pray. Boulder, Colorado: Westview.

Jurion, F. & J. Henry. (1969). Can primitive farming be modernised? Translated from the French by AGRA Europe. Brussels, SERDAT.

Kasliwal, P. (1995). Development Economics.

Killick, T. (1981). Policy economics: A textbook of applied economics on developing countries. Heineman.

Killick, T. (1978). Development economics in action.

King, R. P., and D. Byerlee. (1978). Factor intensities and locational linkages of rural consumption patterns in Sierra Leone. American Journal of Agricultural Economics. 60:197-206.

King, R. and Rollins, T., (1999). An evaluation of an agricultural innovation: Justification for participatory assistance', Journal of Extension, Vol. 37, No. 4, August 1999.

Kline, C. K.; D. A. G. Green; R. L. Donahue & B. A. Stout. (1969). Agricultural mechanisation in equatorial Africa. East Lansing, Michigan State University, Institute of International Agriculture, Research Report no. 9.

Korten and Klauss (1984). People centred development. Kumarean Press, Connecticut.

Krishan, R. (1965). Agricultural demonstration and extension communication. New Delhi, Asia Publishing House.

Laflin, M. (1982). Is the information community serving farmers' needs?'. Reading rural development communications Bulletin, Development Communication Report, March, 1982.

Leakey, C. L. A. & J. B. Wills, eds. (1977). Food crops of the lowland tropics. Oxford, Oxford University Pres.

Leathers, H. D., Smale, M. (1992). A Bayesian approach to explaining sequential adoption of components of a technological package. American Journal of Agricultural Economics 68, 519-527.

Lele, U. (1975). The design of rural development: Lessons from Africa. Baltimore, John Hopkins University Press.

Leonard, D. K. (1977). Reaching the peasant farmers: Organisation theory and practice in Kenya. Chicago, University of Chicago Press.

Lewis, W. A. (1979). The dual economy revisited. Manchester School, 47, 211-29.

Lewis, W. A. (1963). Is economic growth desirable?. In the theory of economic growth. London: Allen & Unwin, p. 420.

Liedholm, C., and E. Chuta. (1976). The economics of rural and urban small-scale industries in Sierra Leone. East Lansing, Michigan State University, Department of Agricultural Economics, African Rural Economy Paper No. 14.

Lindner, R.K. (1987). Adoption and diffusion of technology: an overview, In: Champ, B. R., Highly, E., Remenyi, J.V. (Eds.), Technological Change in Post harvest Handling and Transportation of Grains in the Humid Tropics. ACIAR Proceedings No. 19, Australian Centre for International Agricultural Research, Canberra, pp. 144-151.

Lindner, R.K., Pardey, P. G., Jarrett, F.G. (1982). Distance to information source and the time lag to early adoption of trace element fertilisers. Australian Journal of Agricultural Economics 26, 98-113.

Low, A. R. C. (1978). Linear programming and the study of peasant farming situations – A Reply. Journal of Agricultural Economics. 29:189-190.

Low, A. R. C. (1974). Decision taking under uncertainty. A linear programming model of peasant farmer behaviour. Journal of Agricultural Economics. 25:311-321.

MacArthur, J. D. (1968). Experience with farm management analysis techniques in Kenya. East African Journal of Rural Development. 1(2):22-32.

Markert, L. R. (1993). Contemporary technology: Innovations, issues, and perspectives. South Holland, Illinois: Goodheart-Willcox.

Marsh, S. P., Pannell, D. J., Lindner, R.K. (1995). The adoption of lupins in Western Australia: Did extension make a difference?, Paper presented at 39th Annual Conference of the Australian Agricultural Economics Society, Perth, Western Australia, February 14-16 1995.

Massell, B. F., and Johnson, R. W. M. (1968). Economics of smallholder farming in Rhodesia: A Cross-section analysis of two areas. Food Research Institute Studies. 8: Supplement.

Mattes, H. (1993). Sudan, in Nohlen, Dieter and Nuscheler, Franz (Hrsg.), Handbuch der Dritten Welt Band 5: Ostafrika und Sudafrika (Bonn: Verag J.H.W. Dietz Nachf).

Mattocks, D. M. & Steel, R. E. (1992). Bridging the research-farmer gap: Examining the role of non-governmental organisations in agricultural extension. Conference Proceedings, 1992 Symposium for research in agricultural and extension education, May 1992, Columbus, Ohio, USA, Winrock International Institute for Agricultural Development, Morrilton, Arkansas, USA 72110.

Maunder, A. H. (1973). Agricultural Extension: a reference manual (abridged edition)', Rome, FAO.

McKelvey, J. J. (1965). Agricultural research in the African world: A survey of social research, R. A. Lystad, ed. New York, Praeger, pp. 317-351.

McLoughlin, P. F. M. ed. (1970). African food production systems: Cases and theory. Baltimore, Johns Hopkins University Press.

Mellor, J. W. (1966). Economics of Agricultural development. P. 134. Ithaca, N. Y.: Cornell University Press.

Mokyr, J. (1990). The lever of riches: Technological creativity and economic progress. Oxford University Press: New York.

Morgan, W. B. (1978). Agriculture in the Third World: A spatial analysis. Boulder, Colorado, Westview Press.

Moris, J. R. (1973). "Managerial structures and plan implementation in colonial and modern agricultural extension: A comparison of cotton and tea programs in central Kenya" in Leonard, pp. 97-131.

Mountjoy, A. B. (1983). The Third World: Problems and perspectives. The Macmillan Press Ltd, London.

National Research Council, Committee on African agricultural capabilities (1978). Post-harvest food losses in developing countries. Washington, National Academy of Sciences.

National Research Council, Committee on African agricultural capabilities (1974). African agricultural research capabilities. Washington, National Academy of Sciences.

National Research Council. (1968). Conference on agricultural research priorities for economic development in Africa. 3 vols. Washington, National Academy of Sciences.

Negatu, W. and Parikh, A. (1999). The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia. Agricultural Economics 21 (1999) 205-216.

Niang, A. (1980). Linear programming modelling of African farms, the Sahel model: case studies: Mali and Senegal. In Purdue University, 1980.

Norman, D. W. (1980). The Farming system's approach: Relevancy for the small farmer. East Lansing, Michigan State University, Department of Agricultural Economics, MSU Rural Development Paper No. 5. (Also in French and Spanish).

Norman, D. W. (1972). An Economic study of three villages in Zaria Province. 2. An Input-Output study. Vol. 1, Text. Zaria, Nigeria, Ahmadu Bello University, IAR, Samaru Miscellaneous Paper No. 37.

Norton. G. W., Pardey, P. G. and Alston, J. (1993). Science under scarcity: Theory and practice for agricultural research evaluation and priority setting. Chap. 3. Ithaca, N. Y.: Cornell University Press.

Norton, G. W. and Alwang, J. (1993). Introduction to Economics of Agricultural Development. McGraw-Hill International Editions, Agriculture Series.

O'Brian, Jay (1981). Sudan : an Arab breadbasket?. Merip reports no. 99, 22-26.

Odero-Ogwel, L., and Clayton, E. (1973). A Regional programming approach to agricultural sector analysis: An Application to Kenya agriculture. Ashfort, Kent, Wye College, Agrarian Development Studies Report No. 5.

Ofori, I. M., ed. (1973). Factors of agricultural growth in west Africa. Proceeding of an international conference held at Legon, University of Ghana, ISSER.

Ogunfowora, O., Norman, D. W. (1974). An optimisation model for evaluating the stability of sole cropping and mixed cropping systems under changing resource and technology levels. Zaria, Nigeria, Ahmed Bello University. IAR Research Bulletin No. 217.

Ojo, O. O. (1996), 'Africa and Europe: The Changing Economic Relationship', Zed Books and The African Development Bank.

Organisation for African Unity (OAU) in Arusha in 1978 and in Monrovia in 1979.

Organisation for African Unity OAU. (1980). The Lagos plan of action for the implementation of the Monrovia strategy for the economic development of Africa. Lagos, Nigeria, OAU.

Owens, E. (1987). The future of freedom in the Developing World: Economic development as political reform, p. xv. New York: Pergamon Press.

Oxfam (1997). Annual Report. UK.

Pacey, A. (1986). The culture of technology. Cambridge, MA: MIT Press.

Palmer-Jones, R. W. (1979). Linear programming and the study of peasant farming: A Rejoinder. Journal of Agricultural Economics. 30(2):199-204.

Palmer-Jones, R. W. (1977). A Comment on planned versus actual farmer performance under uncertainty in underdeveloped agriculture. Journal of Agricultural Economics. 28(2):177-179.

Pearson, S. R.; J. D. Stryker & C. P. Humphreys; et al. (1981). Rice in West Africa: Policy and economics. Stanford, Calif., Stanford University Press.

Pickering, D. C. (1987). An overview of agricultural extension; its linkages with farm research and the farmer - the World Bank experience. Journal of Extension Systems, 3(1): 4-12.

Pohelmeier (1991). Promoting rural co-operatives in Developing Countries: The case of sub-Saharan Africa. World Bank: Washington, D.C.,

Pomfret, R. (1997). Development economics. Prentice Hall Europe.

Powelsen, J. P. (1977). Operating in a complex society. Westview Press, Colorado.

Power, J. (1971). Development economics. Longman Group Limited, London.

Pudsey, D. (1967). An Economic survey of farming in a Wet, Long Grass Area of Toro. Entebbe, Uganda, Department of Agriculture.

Raffer, K. and Singer, H. W. (1996), 'The Foreign Aid Business: Economic Assistance and Development Co-operation', Edward Elgar.

Read, H. (1972). Communication: methods for all media. Urbana, University of Illinois Press.

Rogers, A. (1996). Participatory training: Using critical reflection on experience in agricultural extension training. FAO: Training for agriculture and rural development, Economic and Social Development Series (54).

Rogers, E. M. (1995). Diffusion of innovations. (4th ed.). New York: Free Press.

Rogers, E. (1983). Diffusion of innovations. 3rd ed. New York, Free Press.

Rogers, E. M. (1976a). Communication and development: The passing of the dominant paradigm. Communication Research 3(2):213-240.

Rogers, E. M. (1976b). Where we are in understanding the diffusion of innovations?. In Communication and change in the developing countries: Ten years after, W. Schramm and D. Lerner, eds. Honolulu, University of Hawaii, East-West Centre Press, pp. 204-222.

Rogers, E.M. (1962). Diffusion of Innovations. New York: Sage.

Roling, N. (1982). Alternative approaches in extension. In Jones, G. E. & Rolls, M. eds. Progress in rural extension and community development, 1:87-115. Chichester, John Wiles.

Roling, N. G. (1970). Adaptations in development: A conceptual guide to the study of non-innovative response of peasant farmers. Economic Development and Cultural Change 19(1):71-85.

Ruthenberg, H. (1980). Farming systems in the tropics. 3rd edition. London, Oxford University Press.

Ruthenberg, H. (1968). Smallholder farming and smallholder development in Tanzania: Ten case studies. Munich, West Germany, Weltforum Verlag.

Saha, A., Love, H.A., Schwart, R. (1994). Adoption of emerging technologies under output uncertainty. American Journal of Agricultural Economics 76, 836-846.

Savile, A. H. (1966). Extension in rural communities. London, Oxford University Press.

Schulten, G. G. M. (1989). The role of FAO in IPM in Africa. Insect Sci. Applic. 10(6): 795-807.

Schultz, T. W. (1964). Transforming traditional agriculture. New Haven CT: Yale University Press.

Schultz, T. W. (1953). The Economic Organisation of Agriculture. New York: McGraw-Hill.

Schwartz, L. A. & Kampen, J. (1992). Agricultural extension in East Africa. World Bank Technical Paper No. 164, Washington, USA.

Scobie, G. M. (1979). Investment in International Agricultural Research: Some Economic Dimensions. World Bank Staff Working Paper No. 361, Washington, D. C., October 1979.

Scoones, I., Thomson, J. (1994). Knowledge, power and agriculture- towards a theoretical understanding: In Scoones, I. and Thomson, J. (Eds.), Beyond Farmer First. Rural Peoples' Knowledge and Extension Practice. London: Intermediate Technology Publications, pp. 16-32.

Scotland on Sunday (1996), December 15.

Shapiro, K. H. (1973). Efficiency and modernisation in African agriculture: A case study in Geita District, Tanzania. PhD Dissertation, Stanford University.

Sidell, S. R. (1988), 'The IMF and Third-World Political Instability: Is there a Connection?', Macmillan Press.

Spencer, D. S. C. (1972). Micro-Level farm management and production economics research among traditional African farmers: Lessons from Sierra Leone. East Lansing, Michigan State University, Department of Agricultural Economics, African Rural Development Paper No. 3.

Stavis, B. (1979). Agricultural extension for small farmers. East Lansing, Michigan State University, Department of Agricultural Economics, MSU Rural Development Working Paper no. 3.

Swanson, Burton E. ed. (1991). Report of the Global Consultation on Agricultural Extension', FAO, Rome.

Swanson, Burton E. ed. (1984). Agricultural extension: a reference manual. 2nd edition. FAO, Rome.

Swanson, B. E. & Jaffar Rassi (1981). International directory of national extension systems. Urbana-Champaign, Bureau of Education Research, (University of Illinois).

Third World Development (1984). Grosvenor Press – London.

Todaro, M. P. (1997). Economic Development. 6th edition, Longman Limited.

Todaro, M. P. (1969). A Model of labour migration and urban unemployment in less developed countries. American Economic Review. 59:138-148.

Tordoff, W. (1997), 'Government and Politics in Africa', Third edition, Macmillan Press.

True, A. C. (1929). A history of agriculture extension work in the United States 1785-1925. U.S Department of Agriculture Miscellaneous Publication no. 36. Washington, D. C., Government Printing Office.

Tsur, Y., Sternberg, M., Hochman, E. (1990). Dynamic modelling of innovation process adoption with risk aversion and learning. Oxford Economic Papers 42, 336-355.

Qamar, M. K. (1997). Status and constraints of training of extension staff in Africa: An international view. Paper presented at the International Workshop on Training of Extension Personnel in Africa, and Third Informal Consultation of Donors supporting agricultural extension systems in Africa, held at Cape Coast, Ghana, from 19 to 24 October 1997. Also published by the Extension, Education and Communication Service (SDRE), FAO Research, Extension and Training Division, Rome, Italy, 1998.

United Nations Development Program (UNDP) (1995). Human Development Report. New York.

United Nations Development Program (UNDP) (1994). Human Development Report. New York: Oxford University Press, pp. 13, 15.

United Nations Development Program (UNDP) (1992). Human Development Report. New York: Oxford University Press, pp. 26-33.

Upton, M. (1979). The Unproductive production function. Journal of Agricultural Economics. 30(2):179-194.

Upton, M. (1973). Farm management in Africa: The principles of production and planning. London, Oxford University Press.

USDA, ERS. (1981). Food problems and prospects in Sub-Saharan Africa: The decade of the 1980's. Washington, USDA, Foreign Agricultural Research Report no. 166.

Vail, D. J. (1973). Induced farm innovation and derived scientific research strategy. East African Journal of Rural development. 6(1).

Westlake, M. (1976). World poverty: The growing conflict. Young Fabian Pamphlet 44, the Fabian Society, London.

Wohlmuth, K. (1994). Alternative economic strategies for the Sudan, in Harir, Sharif and Tvedt, Terje (eds), Short-Cut to Deacay: The Case of the Sudan (Uppsala: Nordiska Afrikainstitutet).

The World Bank Group. (1996). Agricultural extension and research: Achievements and problems in National Systems. Report No. 15828, 26/06/1996. World Bank: Washington, D. C.

The World Bank Group. (1991). World Development Report. New York: Oxford University Press, p.4.

The World Bank Group. (1990). The theory and practice of agricultural policy. World Bank: Washington, D. C.

The World Bank Group. (1985). Agricultural research and extension: An evaluation of the World Bank's experience. World Bank: Washington, D. C.

The World Bank Group. (1982). World Development Report. World Bank: Washington, D. C.

The World Bank Group. (1981). Accelerated development in Sub-Saharan Africa: An agenda for action. World Bank: Washington, D. C.

Young, C. (1982). Ideology and development in Africa. (New Haven, Conn.: Yale University Press), Ch. 6.

Yousif, G. M. (1997). The Gezira Scheme: The greatest on earth. First print.

Yudelman, M. (1975). Imperialism and the transfer of agricultural techniques. In Duignan and Gann, pp. 329-359.

Zijp, W. (1992). Presentation at the 12th World Bank Agricultural Symposium. Extension Specialist, The World Bank, Washington D. C.

http://www.ifmsa.org/projects/Sudan/