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WETLAND FARMING AND SMALL-SCALE INFORMAL IRRIGATION IN MALAWI: THE CASE OF SHIRE VALLEY

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WETLAND FARMING AND SMALL-SCALE INFORMAL IRRIGATION IN MALAWI: THE CASE OF SHIRE VALLEY

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This thesis is submitted in fulfillment of the requirements for the award of the degree of Doctor of Philosophy

Plate 1 (top): Scatters of small farms in the bushy Shire Valley wetlands

Plate 2 (below): Swamps created by flooding in the Shire Valley wetlands

WETLAND FARMING AND SMALL-SCALE INFORMAL IRRIGATION IN MALAWI:

THE CASE OF SHIRE VALLEY

ABSTRACT

Historically, Malawi has depended on rain-fed agricultural systems. It is reported that the frequent droughts and unreliable rainfall since early 1990s have caused many small-scale farmers to turn to the wetlands as alternative sites for crop production. There they use low-cost farming methods and various forms of 'informal' irrigation. This study, to better understand the water management practices and the socioeconomic characteristics of the wetland farmers, was carried out in the Shire Valley, at the southern tip of Malawi. This covers about 600,000ha and supports around 250,000 farming families. More than half is wetland, characterized by a network of small streams, rivers, and swamps, and a mosaic of many very small farms separated by bush.

Phase I mainly documented the agriculture technologies and socioeconomic characteristics of wetland farming and small-scale informal irrigation systems. 200 farmers and other key informants were interviewed. Phase II aimed to define and measure the benefits of the current systems. The major farming systems groups were identified using cluster analysis and focus group discussions were carried out with 7 to 10 members of each. The results were assessed using gross margin analysis.

The results show that flood recession agriculture, river diversion and treadle pumps were the commonest water management technologies among the farmers interviewed. Most preferred flood recession and river diversion to treadle pump, citing capital requirements and running costs as major obstacles. However, the government and NGOs were promoting treadle pump technology (mostly) and river diversion, but not recession agriculture. Motorized pumps, introduced under various schemes, were no longer in use due to farmers' inability to meet fuel costs and repairs.

Farmer access to land was largely under the control of individual farmers who pass on ownership to their children under traditional custom. This finding is contrary to the documented land policy which describes chiefs as custodians of the land.

Many farmers viewed group farming as a surrender of their land ownership rights. However, team work was seen to be common in river diversion technologies where a committee was usually chosen to manage a main canal traversing several farms. Even under these circumstances, farmers still preferred to manage their plots individually.

The economic analysis showed low farmer-benefits, except where flood recession agriculture was used to grow sweet potatoes, although this receives no attention from government or NGOs. Among the problems were the farmers' inability to afford inputs, promotion of unsuitable technologies, and government controlled market prices.

The study found that the increased wetland use was partly a livelihood diversification strategy linked to droughts and the worsening of the economic situations caused by structural adjustments in the early 1990s.

This study encourages government or NGOs to promote the technologies that are acceptable to the farmers and seen to benefit them under the local socioeconomic conditions. Locally, these include flood recession agriculture and small river diversions. Reducing production costs and increasing yields through more efficient water use and improved extension services should be encouraged, and subsidizing input costs and freeing market prices would also help.

ACKNOWLEDGEMENT

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TABLE OF CONTENTS

Content		Page

CHAPTER FIVE:
RESULTS I: AGRICULTURE TECHNOLOGIES AND SOCIOECONOMIC CHARACTERISTICS OF FARMING SYSTEMS IN THE SHIRE VALLEY WETLANDS 79

LIST OF TABLES

LIST OF BOXES

LIST OF FIGURES

ACRONYMS

ADD	Agricultural Development Division
BASIS	Broadening Access and Strengthening Input Market Systems
CRSP	Collaborative Research Support Programs
DFID	Department for International Development
DoI	Department of Irrigation
EPA	Extension Planning Area
FAO	Food and Agriculture organization
FEWS	Famine and Early Warning Systems
GDP	Gross Domestic product
GoM	Government of Malawi
GWA	Gender and Water Alliance
IASTED	International Association of Science and Technology for Development
IDS	Institute of Development Studies
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPTRID	International Program for Technology and Research in Irrigation and Drainage
IRIN	Integrated Regional Information Networks
IWMI	International Water Management Institute
JICA	Japanese International Co-operation Agency
NAC	National AIDS Commission
NORAD	Norwegian Agency for Development Cooperation
NSF	National Science Foundation

NSO	National Statistical Office
RDP	Rural Development Programme
SADC	Southern African Development Community
SPFS	Special Program for Food Security
TA	Traditional Authority
TIP	Targeted Input Program
UK	United Kingdom
UN	The United Nations
UNESCO	The United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commissioner for Refugees
WARFSA	Water research fund for Southern Africa
WaterNet	Water Network
WFP	World Food Programme

CHAPTER ONE

GENERAL INTRODUCTION OF MALAWI

1.1 Chapter overview

This chapter gives a brief description of Malawi, outlining the main agricultural systems and the main problems faced in the agricultural sector. The description of the problems forms a background to the study whose objectives are stated at the end of the chapter.

1.2 General introduction of Malawi

Located in the Sub-Sahara region of Africa, along the Great East African Rift Valley, Malawi has a total surface area of about 118 480 km^2. The country lies between latitudes 9^o 45' and 17^o 5' S and longitudes 30^o to 36^o E (Fig. 1.1). With plateaus, and mountain ranges on the western side, the low-lying eastern side is mostly occupied by rivers and lakes. Main water bodies include Lake Malawi, Lake Malombe, Lake Chilwa, and Shire River. Water bodies occupy about 20% of the total surface area. The rest of the surface area is occupied by land.

Malawi population censuses are carried out every ten years by the National Statistical Office (NSO). The last complete census was carried out in 1998. In 2008 another census was underway with only a draft report released. There were about 12 million people living in Malawi in 1998 (NSO, 1998). In its draft report, NSO (2008) now estimates a population of 13.1 million people. Of 13.1 million people, 49% are said to be male and 51% are female. More than 80% of the total population lives in the rural areas and depend on subsistence farming as a source of livelihoods.

Malawi, formerly a British colony known as Nyasaland by the British, became independent in 1964. Before independence, the British divided the country into three provinces (North, Central, and South) which are known today as regions. Within the three regions, there are twenty-seven districts in total.

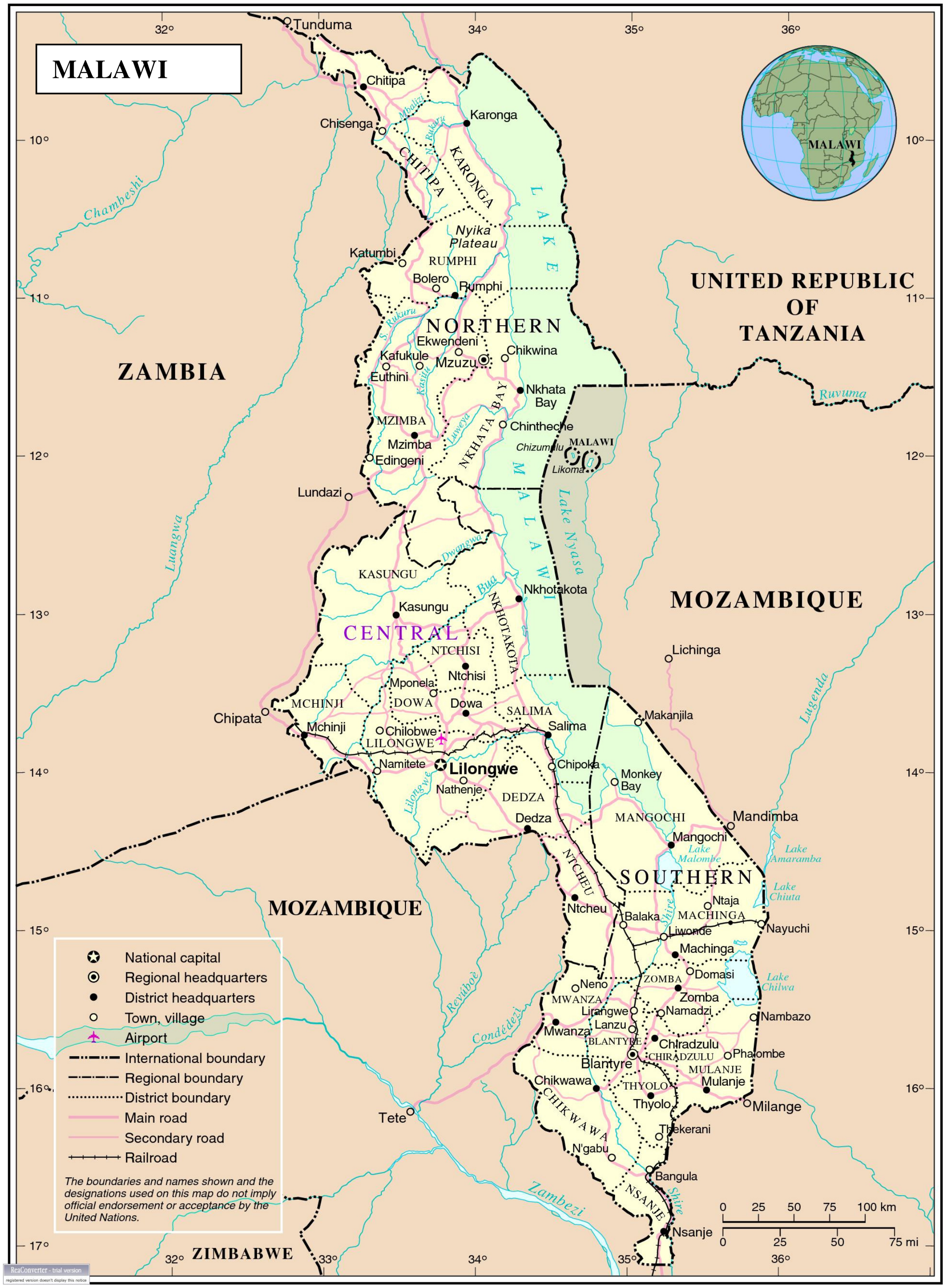


Fig. 1.1: Physical map of Malawi

1.3 Agricultural regions

Malawi is classified as a Least Developed Country by the UN, and as a Highly Indebted Country by the World Bank, depending heavily on agriculture for foreign exchange and livelihood (UNESCO, 2004). Realizing the importance of agriculture, government has established agricultural institutions throughout the country. These institutions are meant to provide extension services to farmers in all the twenty-seven districts of the country. Based on their agricultural potential, the districts are grouped into eight agricultural regions called Agricultural Development Divisions (ADDs) (Fig. 1.2). ADDs sub-divide into Rural Development Programmes (RDPs) which further split into Extension Planning Areas (EPAs). EPAs act as outreach or small manageable areas where government staff and farmers can meet and discuss issues affecting agriculture in a particular area. EPAs divide into sections which divide into blocks. Blocks are the lowest level of the agricultural regions. Each block is managed by an extension worker, whose services can be directly accessed by farmers.

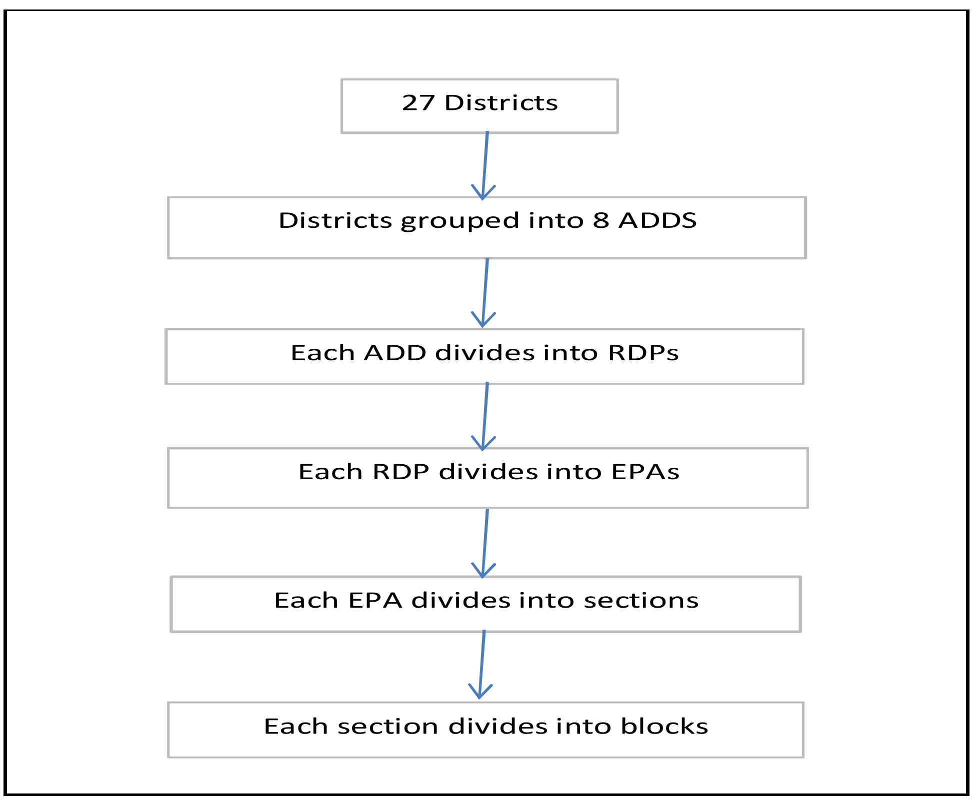


Fig. 1.2: Divisions of agricultural regions
Source: Ministry of Agriculture, (GoM, 2006a).

1.4 Agriculture and economy

As Malawi has no exploited mineral resources, agriculture plays a big role in the economy of the country. GoM (2000b) estimates that agricultural activities occupy 45,790 km^2 (about 40% of the total surface area), within which 29,400 km^2.is arable land. More than 80% of the agricultural activities are operated at smallholder or subsistence level, with maize as the main crop. Medium to large scale farmers grow maize and other cash crops such as tobacco, cotton, tea, and coffee. Buckland (1997) and GoM (2000b) showed that, together, agriculture in highlands and low-lying areas contributed more than 30% of Gross Domestic Product (GDP) and about 87% of total employment, and provided livelihood to more than 70% of the population. Imani Development (2004) estimated that agriculture contributed about 38.6% of (GDP), employed about 84.5% of labour force and accounted for 82.5% of foreign earnings.

1.5 Climatic seasons (dry and rainy seasons)

The country has two main climatic seasons, namely the rainy and dry seasons. The rainy season, sometimes known as the wet season, is the main agricultural season for the country. Although, the rainy season starts in October and ends in April (Fig. 1.3), the growing season mainly starts in November and ends in March. The mean annual rainfall varies with altitude across the country. The low-lying areas have a semi-arid climate and receive a mean annual rainfall of about 600mm, while high altitude areas with semi-arid climate to sub-humid climate receive a mean annual rainfall of slightly more than 1600mm in (Fig. 1.4).

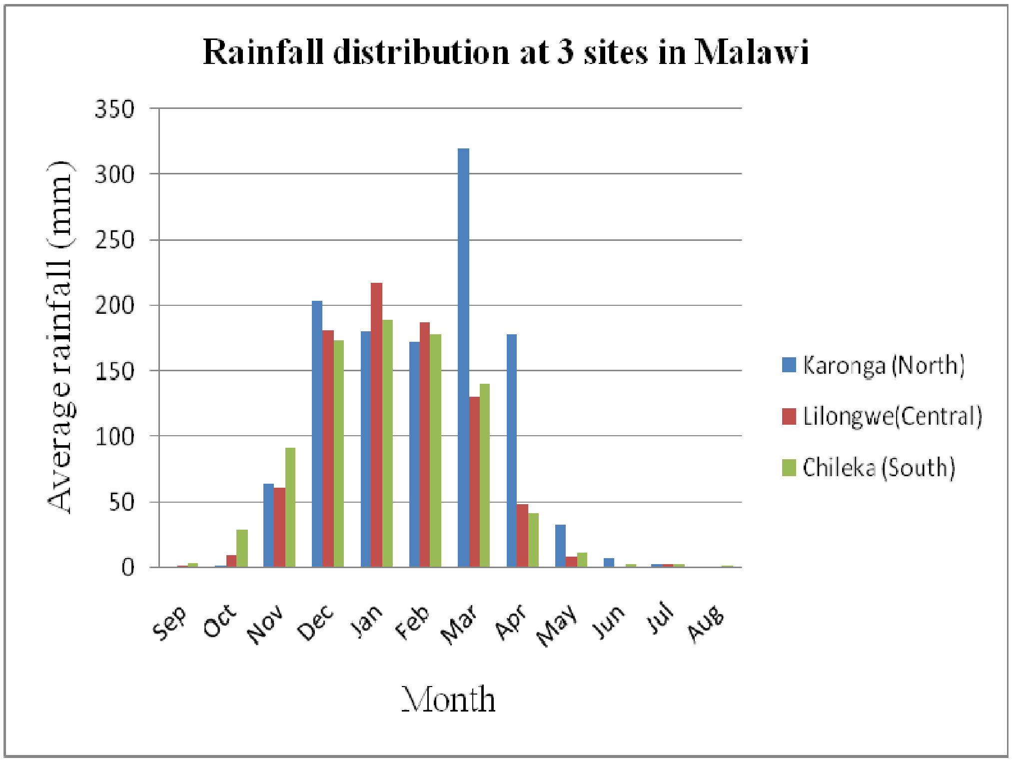


Fig. 1.3: Monthly distribution of rainfall at three sites across Malawi (1961 – 1990 data) Source: Metrological Department, (GoM, 2007c).

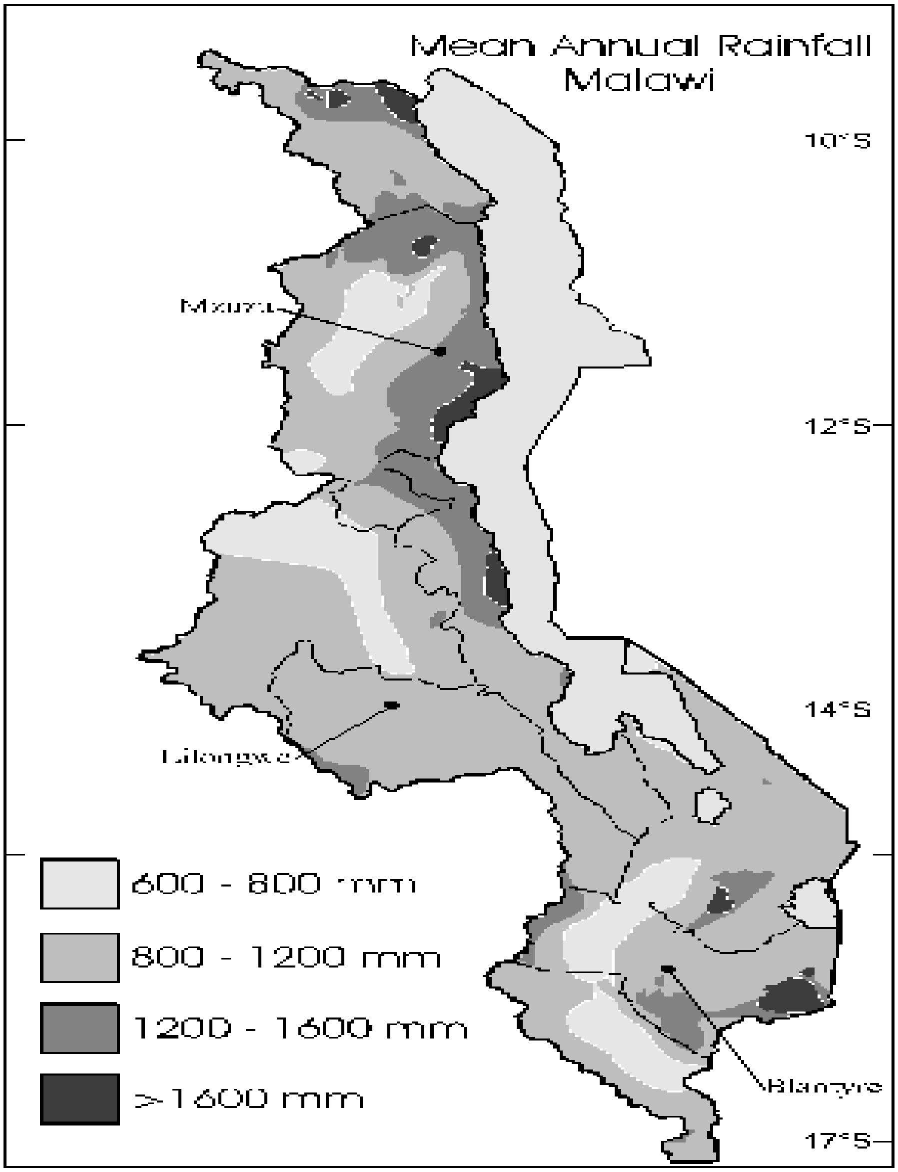


Fig. 1.4: Mean annual rainfall distribution
Source: FAO, 2000.

1.6 Agricultural systems and rainfall

The agricultural systems are defined by the climatic seasons (dry and rainy seasons). The rainy season is the main agricultural season where crops are mainly grown in upland areas, mainly relying on rainfall.

In the dry season, farming is mainly done in wetlands where small-scale irrigation systems are common. Wetlands are characterized by hydromorphic soils, swamps, small streams, and thickets of bushes (Mzembe, 1992), with scatters of small farms *(dimbas)* separated by the bush. These small farms are mostly individually owned and set up without assistance from government or NGOs. However, government or NGOs encourages sustainable management of these small farms (Noble, 1996).

1.6.1 Small-scale irrigation systems in wetlands

Small-scale irrigation systems refer to schemes that are operated and maintained by local farmers (Carter, 1989). Small-scale irrigation systems are generally low-cost technologies of which some descend from indigenous knowledge and have been modernized through modifications (Daka, 2006). In Malawi, small-scale irrigation systems are classified into two distinct categories:

Formal irrigation systems

The term formal irrigation system (Kambewa, 2005) refers to systems that serve large commercial estates or to government-owned schemes. Formal systems are normally designed and laid out by engineers according to exact specifications which have well-defined performance criteria. The first formal irrigation systems in Malawi were constructed in the early 1970s. With assistance from the Taiwanese government, these systems were constructed as settlement schemes, where landless farmers from across the country were resettled. The schemes are owned, operated and maintained by government even though the beneficiaries are farmers. Today, the Malawian government is proposing to turn responsibility for the operation and maintenance of these schemes over to the farmers. Under this proposal, farmers will have to operate and maintain the schemes by themselves. It is estimated that formal irrigation systems cover about 27,000 ha in the country (GoM, 2000b). After the early 1970s, the government was not able to establish more of the formal schemes until the year 2000, when the Japanese government under Japanese International Co-operation Agency (JICA) program, assisted in constructing Bwanje Valley Irrigation Scheme. With about 800 ha, Bwanje is not only the largest but also the latest formal irrigation scheme to be established in Malawi. After less than ten years in operation, Bwanje scheme is reported to be on the verge of collapse because, according to Veldwisch et al. (2009), “outside interveners designed an irrigation system and ‘parachuted it into’ the people.” The developers thought they would improve the indigenous system by construction of new improved structures. It later turned out that the new structures destroyed the indigenous system, and many farmers abandoned the scheme (Chidanti-Malunga, 2009). This is an example of imposed interventions which are meant to ‘improve’ existing indigenous systems but often fail to serve the needs of the farmer. Lankford (2004) observed that improving indigenous irrigation systems, which dominate irrigated areas in Africa, does not necessarily improve performance of the systems.

Informal irrigation systems

The term informal irrigation system refers to small-scale irrigation technologies developed and set up by farmers without complicated engineering design in their layout and operation (Kambewa, 2005). Usually informal systems are managed by farmers without technical assistance from government or NGOs. Kambewa (2005) estimated that in Malawi, informal irrigation systems add up to about 123,000 ha.

In Malawi, these agricultural systems are mainly built in flood plains or wetlands where water is abundant even during dry seasons. Wetlands, locally known as dambos, are flat open spaces existing along river courses or near lakes. Wetlands may be swamps or low lying areas of land which are subject to inundation, usually seasonally with hydromorphic soils, transitional morphological characteristics between terrestrial and aquatic systems, and are usually suitable for agriculture because of their available water and high soil fertility (Masija, 1991). Wetlands are prone to flooding during rainy seasons and retain residual moisture during dry seasons. This characteristic allows farmers to open up small land parcels known as *dimbas.* It is estimated that Malawi has a total wetland-area or dambo-area of about 480,000 to 600,000 ha (GoM, 2000b).

Historically, when upland rainfall was adequate, wetlands were not perceived as areas where agricultural production needed to be intensified. Wetland agriculture was seen as a productive way of passing time during the "idle" period in dry season when farmers wait for the next rainy season.

1.6.2 Rain-fed agricultural systems in uplands

Unlike small-scale irrigation systems, rain-fed agricultural systems mainly exist in the uplands, and rely on rainfall for crop production. Despite having large reserves of water in lakes, rivers, or streams, the country largely relies on rain-fed agriculture as the main form of crop production. Rain-fed agricultural systems have been in place for generations.

1.6.3 Effects of erratic rainfall and food security

Malawi experiences seasonal rainfall variations across the country. These variations are experienced more in the northern areas than the rest of the country (Fig. 1.5). During the 1990 rainy season the mean annual rainfall for the country was below 600 mm (Fig. 1.5). This marked the beginning of drought which lasted through the 1991 rainy season. By 1991, the drought had affected the entire southern Africa region, leaving more than six million people hungry (Buckland, 1997). Devereux (2002) reported that between 1000 - 3000 people were estimated to have died from hunger as a result of rainfall failure.

Sometimes drought seasons that lead to crop failures are caused by poor distribution of rainfall. For example, in 2003/04 rainy season, areas across Malawi received annual rainfall above average (Fig. 1.6), yet the country experienced one of the worst droughts leading to crop failure because of late start and early finish to the rains (FAO, 2004). This led to 14% reduction of maize yield compared to the previous season (1.26 t/ha 2002/03 growing season, and 1.09 t/ha in 2003/04), also representing 17% fall compared to the average of the previous five years (FAO, 2004). Other researchers, e.g. Dorward and Kydd (2004), linked the Malawi food crisis in 2004 to failures of development policies. Whatever the causes may be, in Malawi, low production of maize often results in serious food security problems.

The average maize yields from 1982/83 to 2005/06 growing seasons are given in Fig. 1.7.

Within the past decade, the occurrences of droughts and floods have been recurrent in Malawi. Peters (2004a) predicted that these instances are highly likely to continue in the future. The increased occurrences of droughts and floods are associated with climate change. Adger et al. (2003) documented that, ‘‘the world’s climate is changing and will continue to change into the coming century at rates projected to be unprecedented in recent human history’’. Consequently, this situation puts agriculture at risk. Magadza (2000) documented that climate change subjects dry areas (mainly uplands) of Africa, as possible future food deficit areas. In this regard, climate change adaptation, which largely depends on the characteristics of the localized systems, is important for policy development (Smith et al., 2002). As an adaptation to climate change (Dale, 1997), farmers in Malawi are diverting their attention from dry areas (uplands) to wetlands for food production (as will be discussed later sections of this chapter), although climate change may not be the only driving factor. Burkett and Kusler (2000) defined wetlands as landscapes existing in a transition zone between aquatic and terrestrial environments. In Malawi, wetlands (as discussed later) are bushy low-land areas subjected to seasonal flooding.

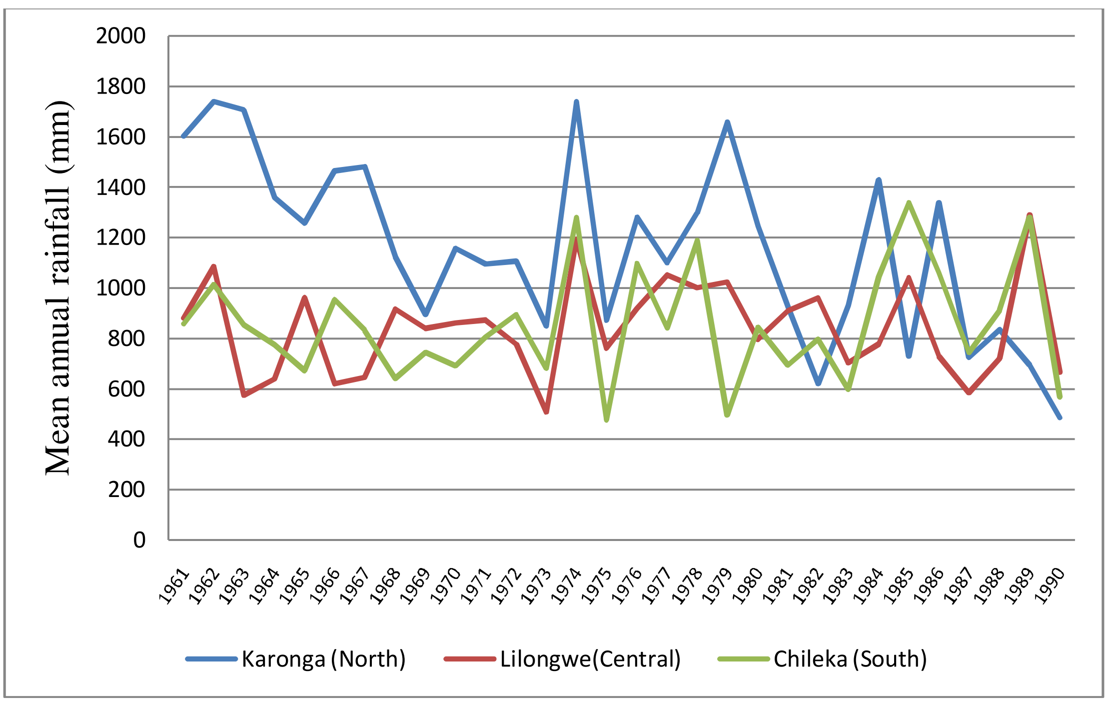


Fig. 1.5: Annual rainfall variations at three sites across Malawi (1961 – 1990 data) Source: Metrological Department, (GoM, 2007c).

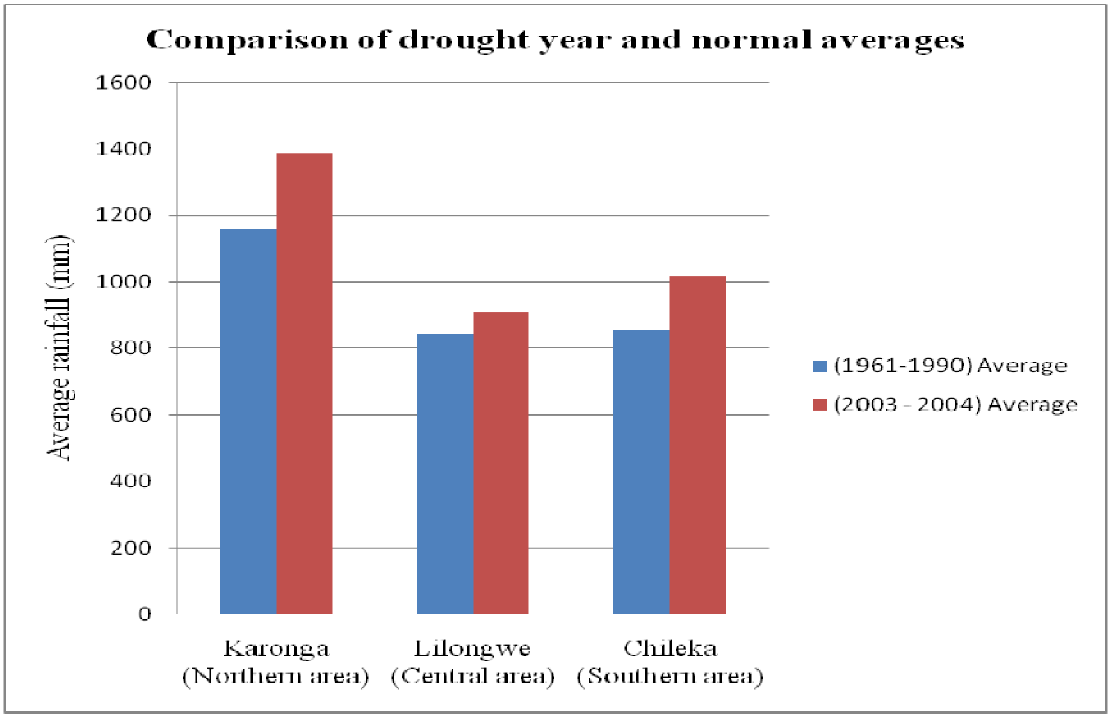


Fig. 1.6: Comparing mean rainfall for drought season (2003-04), and normal average. Data used is for three sites across Malawi. Source: NSO, 2008.

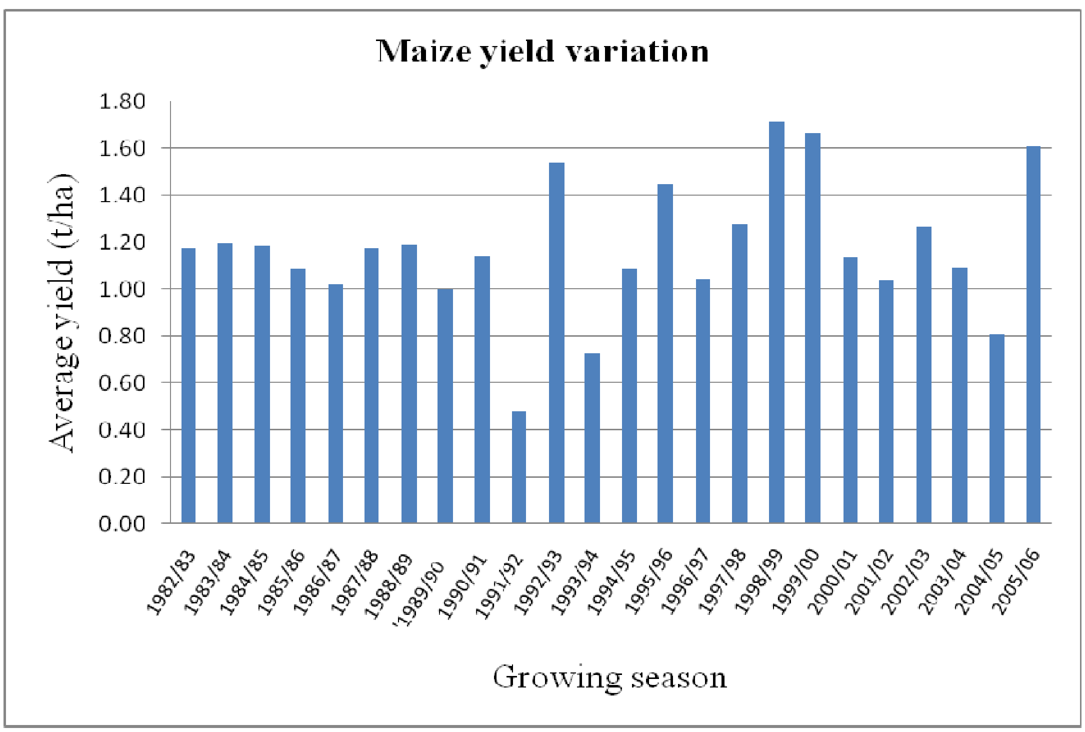


Fig. 1.7: Rain-fed upland maize yield variation (National seasonal averages from 1982/83 to 2005/06). The rain-fed growing season starts in October/November and ends in March/April. Source: FEWS, Malawi, 2007.

1.6.4 Farmers' response to erratic rainfall

When rainfall fails in the uplands, farmers look for alternative ways to produce food. With perennial rivers running through them, pools of water and residual moisture, many wetlands in Malawi are suitable for crop production during drought years. During the 2003/04 drought, many farmers across the country turned to wetlands or flood plains where, using informal irrigation systems, they managed to produce the staple food, maize (GoM, 2005d). During this drought year, maize yield under informal irrigation in wetlands was more than that under rain-fed systems in the uplands (Fig. 1.8) across the entire country. It was clear therefore that wetlands are an important source of food production when rainfall fails in Malawi (IRIN, 2002).

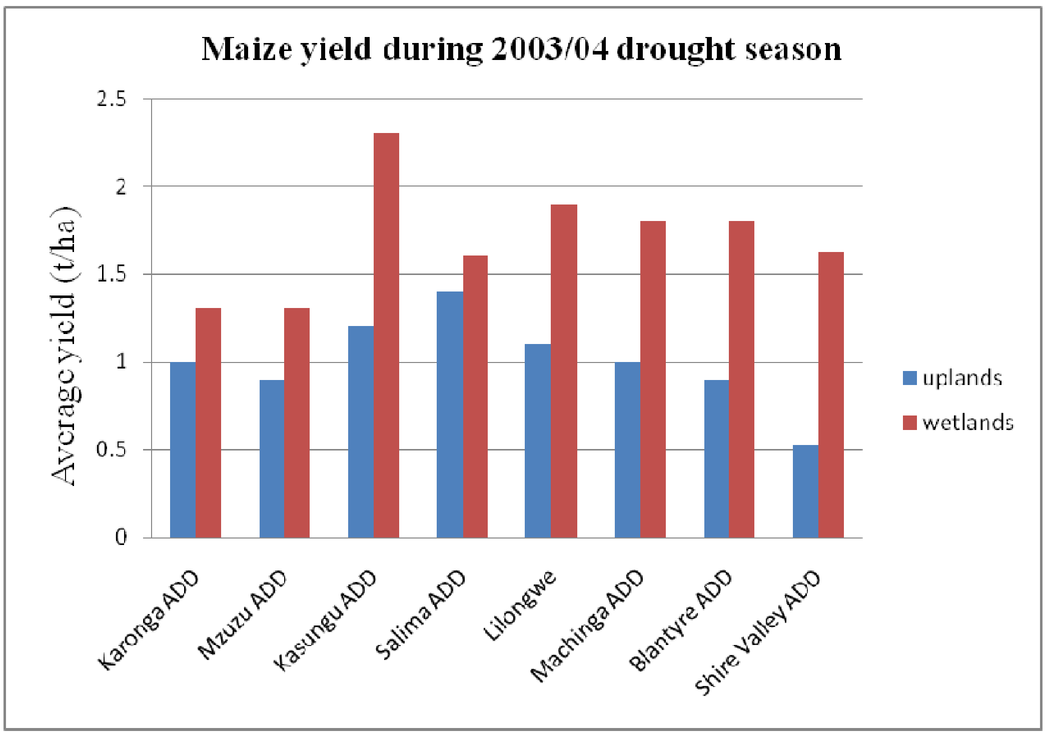


Fig. 1.8: Maize yield across Malawi during the 2003/04 drought season. These figures include maize yields from October to September.
Source: FAO/ WFP, 2004.

1.6.5 Government's response to erratic rainfall

In response to erratic rainfall, the government of Malawi has given high priority to irrigation development in its activities (Mangisoni, 2008). In 2007 irrigation development was among the six top government priorities of, "agriculture and food security; irrigation and water development; transport and communication infrastructure; energy; integrated rural development; and management and prevention of HIV and AIDS" (GoM, 2007e). There are three main areas within irrigation development priority: capacity building, policy review, and promotion of small-scale irrigation (GoM, 2000b).

Capacity building

Under capacity building, the government introduced for the first time ever, irrigation courses to be taught at agricultural colleges in the country in 2000 (GoM, 2007f). This was in response to shortages of trained personnel in irrigation science, due to earlier emphasis on rain-fed agriculture. Before 2000, agricultural colleges in Malawi (Bunda College and Natural Resources College) did not offer degree programmes in irrigation. Irrigation courses were taught as subjects embedded under agricultural engineering programmes which mainly focused on farm mechanisation. Without full knowledge in irrigation science, extension workers were nonetheless expected to assist farmers with set-up and operation of irrigation farms. It is believed that with proper training extension workers will assist farmers setting-up informal irrigation systems more effectively.

Policy review

Malawi has revised most of its environmental and agricultural policies within the last decade where new irrigation, land, and water management policies, and supporting legislation, have been approved by Parliament (Ferguson and Mulwafu, 2004). These policies include:

- The National Environmental Policy. This was developed in 1994, to promote efficient utilization and management of the country's natural resources and encourage, where appropriate, long term self-sufficiency in food, fuel wood and other energy (GoM, 1994g).

- The National Irrigation Policy and Development Strategy. This was developed in developed in 2000, and an Irrigation Act was passed through Parliament in 2001 (Mangisoni, 2008).

- Malawi Poverty Reduction Strategy Paper. Developed in 2002, it acts as a guide to reduce poverty in Malawi, outlines the need for increased irrigation development in order to reduce poverty and hunger (Mangisoni, 2008).

- The New Land Policy. This was developed in 2002. Operating without a meaningful policy on land since independence in 1964, Malawi reviewed its land policy in which all customary landholders, defined to include entire communities, families or individuals are encouraged to register their holdings as private customary estates with land tenure rights (GoM, 2002h).

Promotion of small-scale irrigation

In encouraging smallholder farmers to engage in small-scale irrigation activities, the government embarked on a small-scale irrigation technology promotion programme. In 1994, the Department of Irrigation had introduced 'Rope and Washer' pumps to farmers in the wetlands across the country. These were manual irrigation water-lifting devices which were offered to farmers at a subsidised price. The pump, ''intended for lifts of up to five meters, can sustain an output of one litre per second and can irrigate areas of about 0.25 ha'' (Lambert, 1990), and were introduced into Malawi under DFID sponsorship. Reports from the Department of Irrigation show that the programme was phased out within a few months of its inception because farmers did not show interest in buying the pumps, as many farmers could not afford to buy the pumps at the amount they were priced.

In 1999, the Department of Irrigation introduced small motorised pumps. These were 5 hp engine pumps procured by government to be distributed free to farmers across the wetlands. The exact number distributed is not known, but reports from the Department of Irrigation indicate that almost all the pumps that were distributed became non-functional by the end of 1999 because farmers could not afford the running costs of the pumps. The price for petrol or diesel was the same for all users without special subsidy being offered to irrigation farmers. Since many farmers were merely at the subsistence level, the ever-increasing costs of fuel proved to be prohibitive, and so the programme failed.

The treadle pump technology is another technology which the Department of Irrigation introduced to farmers. Although the technology had been in use earlier, the program was intensified in 2000 by the Department of Irrigation, an attempt to increase agricultural production and also to enrich the livelihoods of resource-poor farmers (Mangisoni, 2008). In 2004, the Department of Irrigation procured treadle pumps for Members of Parliament, who in turn were supposed to distribute them to farmers in their constituencies. Under this programme, Members of Parliament were supposed to act as extension staff in identifying farmers who needed the treadle pumps. The programme was politicized in a way that many decisions were made by politicians as opposed to agriculture personnel in respective areas. Many pumps were distributed across the ADDs in 2004 (Table 1.1). A study conducted by Peters (2004a) showed that this programme was more of a failure than a success. "Failure of management, especially concerning procedures for sharing the pump, is involved in some; many respondents cited the fact that they had received the pump late in the season, thus losing the ability to plant and harvest in time" (Peters, 2004). Reports from the Department of Irrigation show that some NGOs, through their own initiatives, are also distributing free treadle pumps to farmers.

Table 1.1: Free treadle pumps distributed to farmers across ADDs in 2004

ADD	Number
Karonga	600
Mzuzu	1788
Kasungu	800
Salima	3495
Lilongwe	3700
Machinga	1358
Blantyre	5264
Shire Valley	594
Total	**17599**

Source: Department of Irrigation, (GoM, 2005d).

1.7 Brief description of the study area: History, physical features, and culture of the Shire Valley

The study is location-specific, carried out in the Shire Valley (*pronounced as Shee-re-valley*), bearing in mind that irrigation systems that may seem most appropriate in one region may not be so in another (FAO, 1997), although there would be cross-cutting issues common to all areas in Malawi. This section provides brief information of the study area. The actual description of the study area is provided in chapter two.

History

The name Shire Valley is derived from the Shire River which runs through the Valley. With most of its stretch in Malawi, the Shire River was explored by the famous Scottish explorer, Dr David Livingstone, between 1858 and 1863. The explorer named the River, Shire. Livingstone also explored the Zambezi and Lake Malawi during the same period.

Physical features

The Shire River which flows out of Lake Malawi is not only the major river in Shire Valley, but also the largest in Malawi. It joins the Zambezi River in Mozambique, and empties into the Indian Ocean on the south-eastern side of Africa in Mozambique. Despite the existing channel link between the Shire Valley and the Indian Ocean, through the Shire and Zambezi Rivers, the route is not used for commercial navigation at the moment. The government of Malawi proposed in 2004, to explore the possibility of establishing commercial navigation on the route. Currently there is a rail link between Malawi and Mozambican through the Shire Valley, although this rail link is no longer in use, because it was destroyed during the civil war in Mozambique in the early 1980s. Plans are underway, by governments of Malawi and Mozambique, to revitalize the route, now that the war is over.

‘‘Between 1982 and 1986, Malawi witnessed an influx of refugees from the war in Mozambique. At the peak of this influx in 1986, it was estimated that close to one million Mozambicans had crossed into Malawi’’ (Phiri, 2000). Most of these settled in the Shire Valley. Some of the refugees are said to have intermarried with the locals because they are mostly all Sena. When the war in Mozambique was over (around 1990), many of the refugees were repatriated by UNHCR (UN, 1995) between 1994 and 1995. Some are said to have remained and are currently resident in the Valley.

The Shire River is important in the Valley, not only because of its possible commercial navigability, but also because it provides fishing grounds to the locals. The River enters the valley on the northern side. At the entrance into the Valley, the River drops from Thyolo escarpment, at a height of nearly 100 metres, at a place known as Kapichila, where waterfalls are formed. The Kapichila hydro-electric plant generates electricity and is the third largest plant after Tedzani and Nkula which are located upstream the Shire Valley. The Shire River is also used for commercial irrigation. The largest sugar estate with more than 12,000 ha is located in the Valley. The estate uses a combination of high-tech irrigation systems of computerized centre pivots and sprinklers. The estate provides employment to some residents of the Shire Valley. Many people believe that the Shire Valley is one of the areas in Malawi with huge potential for small-scale irrigation development, due to the availability of large reserves of water. With proper management of water resources, the Shire Valley could be the bread basket of Malawi. Unfortunately the numerous small-scale farmers in the Valley have always relied on rainfall. Within the Valley, the western side is drier and has been the main agricultural area under rain-fed conditions. On the eastern side however, the area is wet due to the existence of the wetland where the Shire River passes. In this study, the western side will be referred to as the uplands, while the eastern side is referred to as the wetlands.

The Shire Valley has the greatest potential for irrigation development in Malawi (Kundell, 2008). In the early 1970s there were government plans to construct an irrigation canal whose intake was proposed to be at Kapichila Falls in Chikwawa district (north of the valley). The canal would run on the western dry side through Lengwe National Park to Nsanje district. The canal would cover a distance of about 80 km. These plans failed to materialize due to lack of donor support. The plans resurfaced a number of times within the Department of Irrigation, but each time they ‘died a natural death’. In 1994 however, when Malawi changed governments from single-part to multi-party, it was widely expected that the plans would then be executed. Reports from the Department of Irrigation show that a consultant was engaged in early 2000 to carry out feasibility study of the proposed canal. However, nothing has been reported yet. The findings of the feasibility study were not publicized.

Culture

Two ethnic tribes reside in the Shire Valley. The Mang'anjas, who are believed to have been the first to settle in the Valley, are mostly found in the northern part of the Valley. It is believed that the Mang'anjas migrated from Central Malawi. They bear close resemblance in culture and tradition with the present day tribes found in central Malawi. The Senas migrated from central Mozambique. They are found in the southern areas of the Valley. The Senas are probably the larger of the two tribes. Sena is the most widely spoken language in the Valley. With bits of Portuguese words, it is directly related to the same language spoken in Mozambique which was a Portuguese colony. Because Sena is a larger tribe than Mang'anja, its culture and tradition have overshadowed that of the Mang'anja people, to the extent that many people think the Senas occupy the entire Valley.

The Sena practice patrilineal marriage rules, where a woman leaves her parents and joins a man. The man is supposed to be the bread winner and provides for his wife and children. Members of the same family live together in a cluster of houses. A cluster may compose of adult males with their families and extended families (adult females may have left to join their husbands elsewhere). A village composes of clusters of different families, with a chief as the leader. Chieftainship is usually inherited. The chief controls the activities in the village including land sharing and settling disputes. Property, including land, is usually passed on from father to son. When a man dies, his wife is set free to join her parents, leaving behind children and any other property in the hands of the immediate members of her husband's relatives. It was therefore traditionally hard for women to own land or any property under these circumstances. It must be stressed that this practice is rare these days, although it is still practiced.

1.8 The problem

As noted earlier, it can be appreciated that the government is committed to the promotion of small-scale irrigation development, although without clear policies in place to support these systems and make them socially sustainable. Irrigation programmes introduced by government have generally lacked follow-up support. These circumstances have made it difficult to achieve the aims for which small-scale irrigation development has been intended.

Even without clear policies, it is interesting to note that since early 1990s there has been an increase of informal irrigation activities in Malawi, mainly using low-cost technologies. The intensification of irrigation activities have mainly concentrated in dambos or wetlands (Peters and Kambewa, 2007). Although it is generally believed that the increased agricultural activities in wetlands is associated with climatic failures in rain-fed uplands (Dale, 1997), it is not fully understood whether climatic factors were the only driving factors for the increased wetland use in Malawi since early to mid 1990s. Further, the socioeconomic conditions within which wetland farmers operate are also not fully understood. Without thorough understanding of these issues, it is difficult for government to provide for appropriate and sustainable forms of support.

1.9 Research questions

Wetland farming systems operate under a complex interaction of factors including physical, human, and economic. Physical variables include crops, climate, topography, water availability, field size, and general system performance, while human variables include labor and economic costs, including the costs of labor, capital and energy in relation to expectable returns (FAO, 1997). This study is designed to bring to light such issues by answering the following questions:

- What farming systems or agricultural technologies exist in the wetlands? By identifying these systems, the study will document the socioeconomic characteristics that are vital in formulating strategies for improvement and promotion of small-scale informal irrigation systems.

- What are the benefits for farmers associated with each of the farming systems? Knowledge of farmer benefits will assist policy-makers to develop policies that are relevant to the current local situation. Knowledge of benefits will also assist a farmer in making correct choices when selecting an irrigation method. Depending on the benefits, farmers may prefer certain methods over others.

- Apart from droughts in the rain-fed uplands, what could be the other key factors that led to increased use of wetlands since early to mid 1990s? What lessons, if any, learned from the study, could assist in better management of wetland farming and small-scale informal irrigation methods?

1.10 Aims and objectives of the study

The main aim of the study is to increase knowledge of various forms of wetland agricultural technologies and the socioeconomic characteristics within which they exist in order to determining ways in which government could provide for appropriate and sustainable forms of support to wetland farmers. To do so, the study brings to light some of the key factors that may have caused the increased wetland use since early to mid 1990s.

The objectives of the study are:

i. To identify and describe agricultural technologies and socioeconomic characteristics of farming systems currently in use in the Shire Valley wetlands. Agricultural technologies here refer to the water management practices used by farmers to supply water or moisture to crops in wetlands.

ii. To assess the economic costs and benefits of various farming and small-scale informal irrigation systems. Costs and benefits of wetland farming systems are fundamental to the formulation of guidelines and strategies for their promotion. Gross margins, which are the difference between costs for production and total value of yields, will be used as the economic indicators.

iii. To identify issues related to increased farmer attention to wetland use since early to mid 1990s, and determine how best could the government provide for appropriate and sustainable forms of support to wetland use.

1.11 Chapter summary

Malawi, like many nations in Africa, is struggling to shift farmers away from total dependency on rainfall towards utilizing other water resources where available. A great deal of water is available seasonally in wetlands. This chapter has summarised how problems with rainfall in uplands are slowly leading into increased cultivation in wetlands. However, the increased cultivation in wetlands may not have been caused by droughts alone. This study therefore aims at understanding water management practices and socioeconomic characteristics of wetland farming systems, in order to provide basis for policy formulation.

CHAPTER TWO

DESCRIPTION OF THE STUDY AREA

2.1 Chapter overview

This chapter is intended to give the reader background information of the study area, the Shire Valley. The study was chosen to be carried out in this area because the area contains one of the largest wetlands in Malawi. Geographically, all the wetlands fall within the Great East African Rift Valley, and have similar physical features of hydromorphic soils, network of small streams, and farms bordered by bushes. It must be pointed out that the Shire Valley wetland extends from Malawi to Mozambique, although the study concentrates on the Malawian side only. Ethnically, people on both sides (Malawi and Mozambique) of the Shire Valley speak the same language, Sena.

2.2 Location of the study area (Shire Valley)

The Shire Valley, sometimes known as the Lower Shire Valley, includes uplands and wetlands. It is located at the southernmost tip of the country (Fig. 2.1). The study was carried out in the wetlands. The Shire River meanders through the wetlands and joins the Zambezi in Mozambique (Shela, 2000), with numerous clusters of scattered farms along the stretch

Fig. 2.1: Map of Malawi showing major wetland areas

Source: Department of Surveys and Physical Planning, (GoM, 2006i).

2.3 General description of the Shire Valley

The Shire Valley is made up of two districts of Chikwawa and Nsanje, which are also RDPs. Chikwawa and Nsanje RDPs, together add up to about 600,000 ha in gross area of which more than 60% is wetland and lies below 100 m above sea level (Figs. 2.2 and 2.3). It is estimated that a total of 250,000 farming families live in the Valley and depend on agriculture for livelihoods, according to reports from Agriculture Ministry in Malawi (GoM, 2001j). The Agriculture Ministry (2001j) estimates that Chikwawa RDP has a total of about 475,000 ha in gross area with a total population of about 356,000 people of which more than 80% are subsistence farmers with an estimated total of about 112,000 farming families. Arable wetlands make up 6.3% of the total area, while arable uplands constitute 4.2% of the total area. Nsanje RDP is estimated to have a population of about 204,000 people and a gross area of about 221,000 ha under which 37% is arable land, while marshes constitute 9% of the total area. Like Chikwawa RDP, agricultural activities are concentrated on the eastern side in the wetlands.

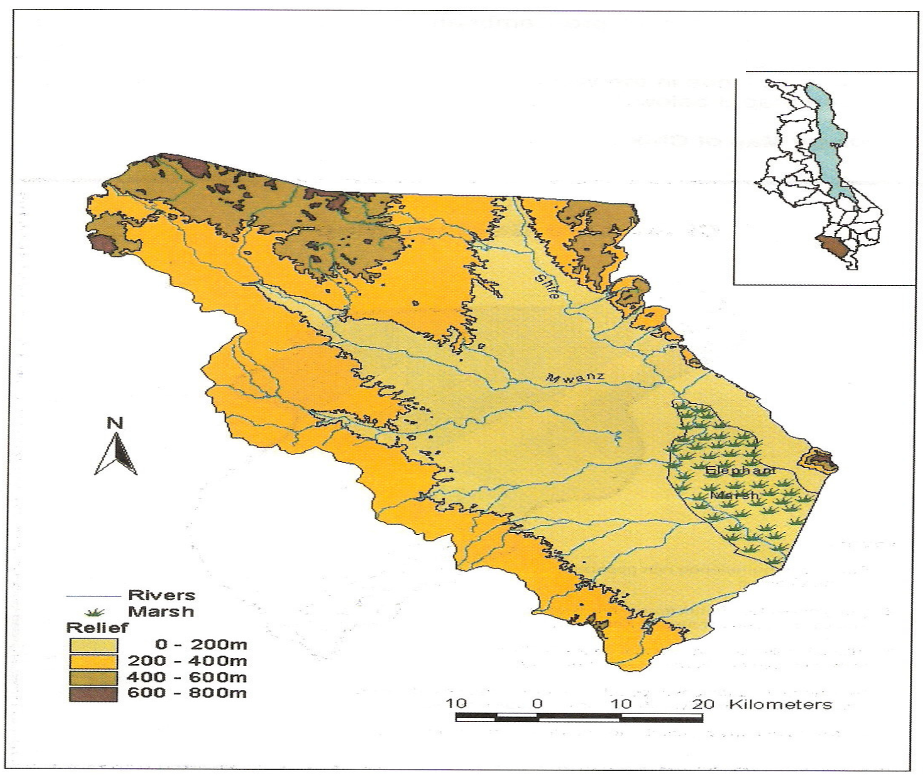


Fig. 2.2: Chikwawa RDP relief map
Source: Chikwawa District Assembly, (GoM, 2001k)

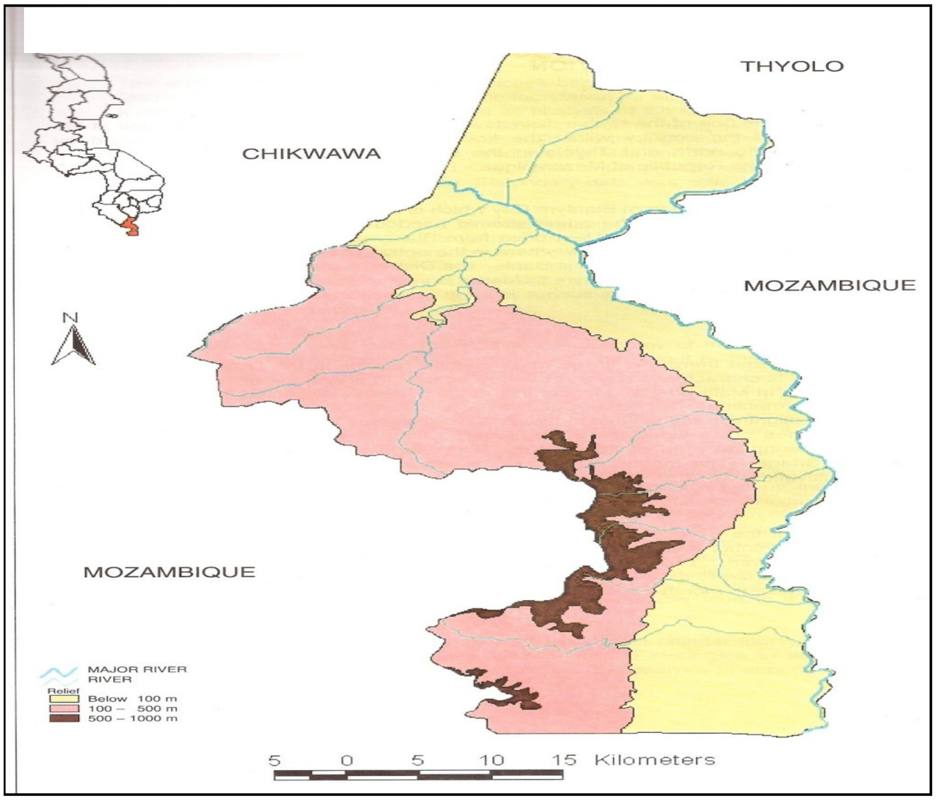


Fig. 2.3: Nsanje RDP relief map
Source: Nsanje District Assembly, (GoM, 2001*l*).

2.4 Farming systems and rainfall variations in the Shire Valley

2.4.1 Uplands and wetlands

According to Chikwawa District Assembly (GoM, 2001k) and Nsanje District Assembly (GoM, 2001*l*) profiles, two main agro-ecological zones exist in the Shire Valley: the upland and the wetlands. For generations, the upland has been the main agricultural area where millet and maize are grown for food, while cotton is grown for cash. The uplands are predominately rain-fed. Farmers in the uplands start a new farming season with the onset of the rainy season, usually in November, although in some early seasons the rainy season begins in October. In readiness to plant with the first rains, farmers in the uplands prepare their gardens two or three months before the rainy season starts. Simple agricultural tools like hoes, panga-knifes, axes, are used to prepare gardens. When the rainy season begins, all farmers concentrate on the uplands. In the uplands, March does not only mark the end of the rainy season, but the beginning of the harvest season as well.

The wetlands are generally the flood zone area during the rainy season, with scatters of irrigation activities in dry season, where maize dominates. In rainy season, when agricultural activities become impossible due to flood waters, the wetlands become fishing grounds. When floods are not intense, some wetland areas are used to plant water-tolerant crops like bananas, and sugarcane; these can then survive later floods.

Most farmers are subsistent, harvesting barely enough for survival. The three-months period of rainy season is the crucial period with most hunger cases reported during this period, since farmers have to wait another three months before the next harvest. Usually, many households use up their upland harvest by the beginning of the wetland harvest in July. As a result some households resort to other sources of income, mainly casual labour, for livelihoods.

Soils in the wetland zone of the Shire Valley are generally fertile, due to the fact that flood waters from the Shire River highland catchment area bring nutrients in the sediments which settle in this zone. Generally, crops in the Shire Valley wetland grow well without fertilizer application, although not all areas of the valley are fertile. Some areas require fertilizer application for good crop production. The majority of farmers in the Shire Valley do not apply fertilizer to their crops for two main reasons: either they feel their soils are fertile enough to sustain crop production, or the cost of fertilizer is prohibitive. Although extension messages encourage farmers to apply fertilizer to their crops, most households cannot afford the high cost.

2.4.2 Rainfall variation in the Shire valley

Rainfall data from two weather stations (Chikwawa, and Makhanga in Nsanje) (Fig. 2.4), shows the year to year variation of rainfall in the Shire Valley. From 1970 to 2001, average rainfall in the valley went below 600 mm a number of times, while in some seasons, annual rainfall reached up to 1200 mm. The figure also shows that the peaks and troughs, within successive years are very unpredictable.

Interestingly, in 1984, the average annual rainfall received was one of the lowest (below 500 mm), yet the year was not recorded as a drought year. However, during the Southern African drought of 1991, the average annual rainfall recorded was one of the lowest (less than 400 mm). Comparing the situation in 1984 and 1991, this probably means that droughts in the Shire Valley are not only a function of rainfall amount but also rainfall distribution, as observed in section 1.6.3.

Despite fluctuations of annual rainfall in the Shire Valley, the Shire River enjoys vast flows (Fig. 2.5), mainly due to contributions from Lake Malawi catchment areas. The River flows at an average of 450 m^3/s providing abundant water reserves in the wetlands. Note that secondary data were used to plot the flows. The data sources were not able to provide daily flows which could have been used to distinguish dry season from rainy season flows. The average flows used here do not explain much about low flows which are critical in irrigation.

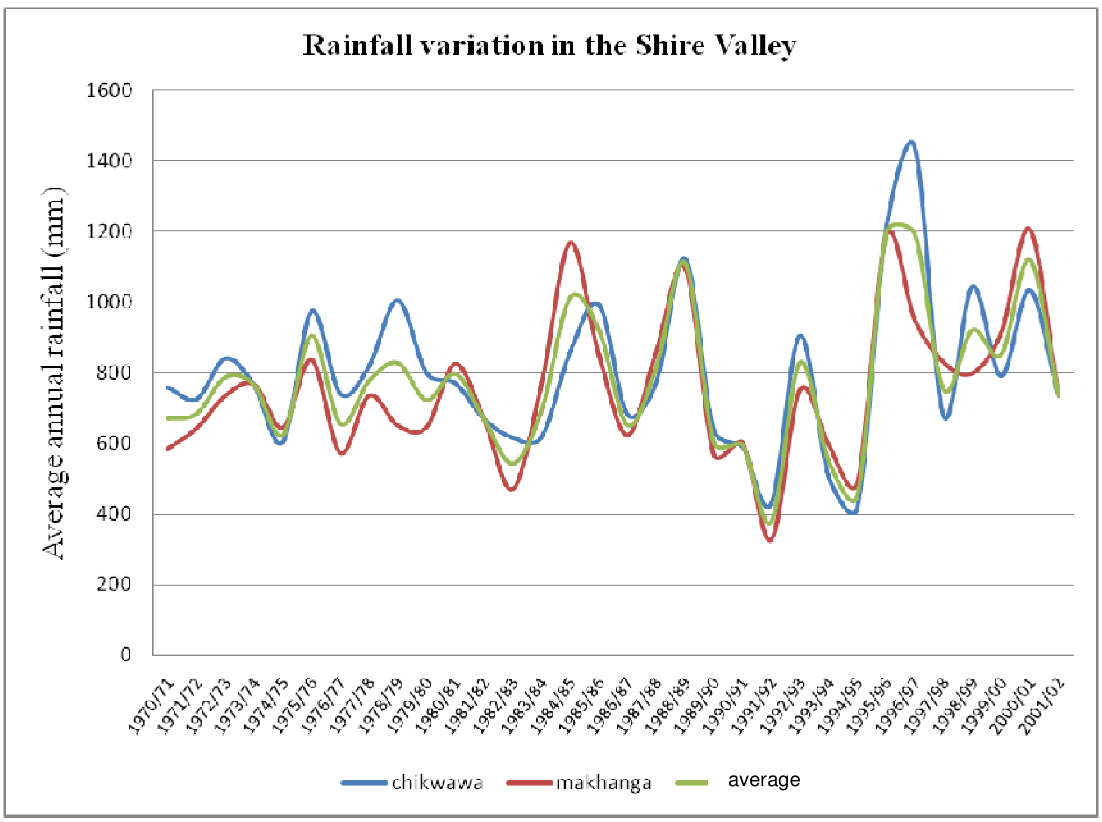


Fig. 2.4: Annual rainfall variation in the Shire Valley. The data used are annual averages (October to September) from 1970/01 to 2001/02, at two sites in the Shire Valley. Source: Metrological Department, (GoM, 2006m).

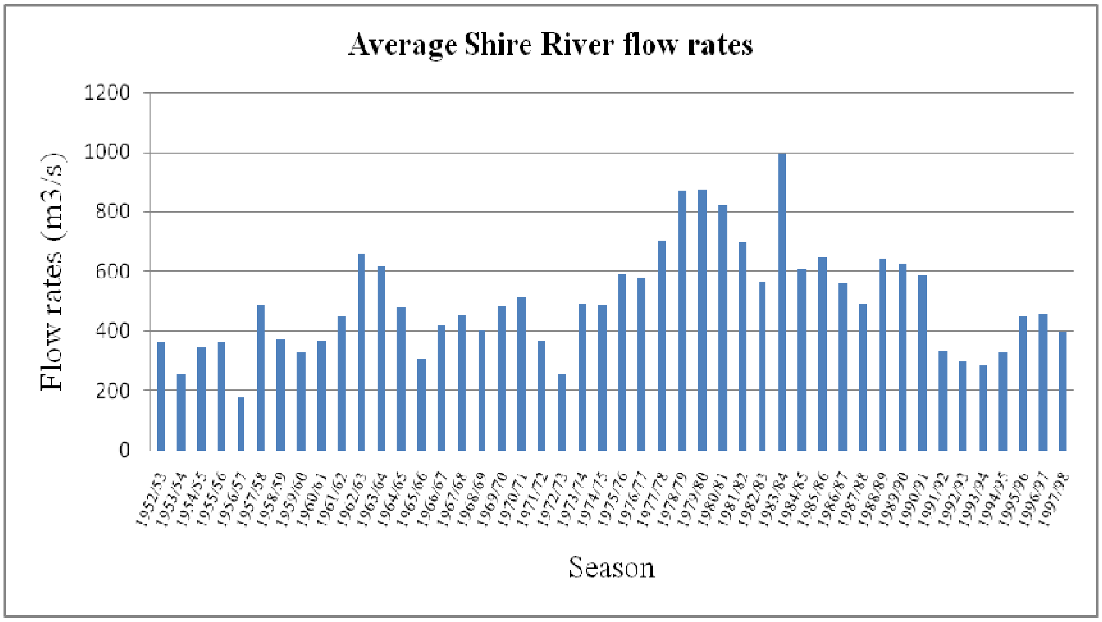


Fig. 2.5: Annual flow rates of the Shire River. The data used are annual averages (October to September) from 1952/53 to 1997/98, gauged at Chiromo in Nsanje RDP. Source: Water Department, (GoM, 2006n).

2.4.3 Recent trends of maize production in uplands and wetlands in the Shire Valley

Although rain-fed uplands remain the main agricultural area for maize, from about mid 1990s there has been a decrease in cultivated area, while irrigated area in the wetlands is seen to be slowly increasing (Fig. 2.6). The cultivated area in wetlands for 2004/05 season was noticed to be abnormally low. This may have been an error in data recording. It is important to note that data of this nature is collected through estimates from farmers in EPAs. It may be that some data was lost as it passed from EPA centres to Agriculture Ministry. Fig. 2.6 also shows missing wetland data between 1996 and 1999, probably for the same reason explained above. Thus for wetland cultivated area only figures from 1999 to 2007 were available. Even though this was the case, it was still possible to note that between 1999 and 2007, the total rain-fed area under maize in uplands was higher than that in irrigated wetlands. However, the actual yield per unit area per year was higher in the wetlands than in the uplands (Fig. 2.7). The uplands also registered poor and fluctuating yields during the same period. These trends could be summarised as; agricultural use and production are increasing in wetlands, while reducing in uplands.

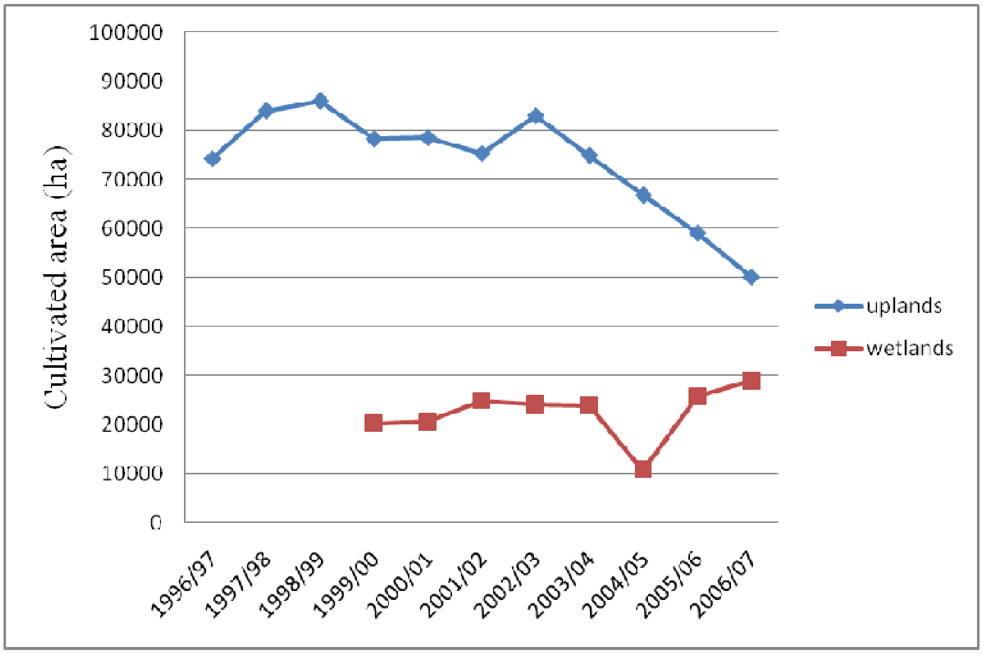


Fig. 2.6: Trends in maize cultivated area per season in rain-fed uplands and irrigated wetlands in the Shire Valley. Data were collected for seasons from 1996/97 to 2006/07 seasons (October to September). There was no data available for irrigated wetlands before 1999. Source: FEWS, Malawi 2007.

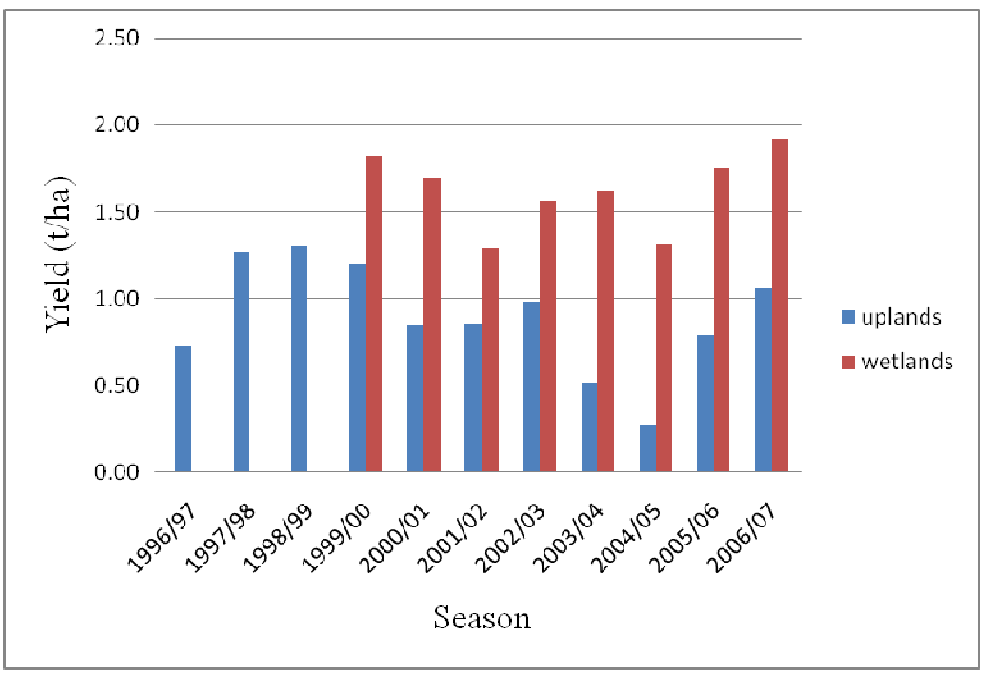


Fig. 2.7: Comparison of maize yields for rain-fed uplands and irrigated wetlands in the Shire Valley. Data were collected for seasons from 1999/00 to 2006/07 seasons (October to September). There was no data available for irrigated wetlands before 1999. Source: FEWS, Malawi 2007.

2.5 Chapter summary

In summary, the Shire River supplies large amounts of water in the wetlands, making the wetlands ideal as alternative source of crop production as rainfall continues to disappoint farmers in uplands. With limited data available, it can still be noticed that in recent times, there has been an increase in the use of wetlands, while uplands have decreased in their use.

CHAPTER THREE

REVIEW OF WETLAND FARMING AND SMALL-SCALE IRRIGATION DEVELOPMENT IN AFRICA AND RESEARCH METHODS

3.1 Chapter Overview

This chapter covers the review of wetland farming and small-scale irrigation development in Africa, and the research methods used in this study. The review includes the importance and the potential for small-scale irrigation development in Africa. Later, the chapter reviews the research methodological approaches used in capturing or collecting and analyzing data, and justifications for adopting the ones chosen. Of importance, is to answer three main questions of, how to collect data, what type of data should be collected, and how to analyze the data, in order to achieve the objectives.

3.2 Review of farming methods in wetlands of Africa

In 1996 it was predicted that the world would need to supply food to an additional 2.5 billion people (Ayres and Mc Calla, 1996). Most of these people lived in developing countries, with sub-Sahara Africa claiming the majority of the share. Ayres and Mc Calla (1996) further stated that in order to meet these challenges, developing countries would have to implement sound and stable macroeconomic and sector policies. These policies included the ‘‘need to enhance food supplies by encouraging rapid technological change, increasing the efficiency of irrigation, and improving natural resource management’’ (Ayres and Mc Calla, 1996), by using community-based approaches to manage water and natural resources. In Southern Africa, where hunger and poverty are common problems due to lacking irrigated land (Pereira et al., 2006), smallholder farmers rely on rain-fed agriculture which faces frequent dry spells and droughts (Chigerwe *et al.*, 2004). Developing irrigation land therefore becomes a priority over increasing irrigation efficiency. To move away from relying on rain-fed agriculture characterized by frequent dry spells and droughts, smallholder farmers have to find alternative sources of food production. Seasonally waterlogged, with ability to stock water, African wetlands become the likely alternative (von der Heyden, 2004). Wetlands can support various forms of irrigation and .indigenous agricultural systems of flood recession agriculture (Adams, 1993). Adams (1993) found out that wetlands can support communities who depended on the hydrological systems that manage the wetlands. The role of wetlands in enhancing agricultural production in Africa is not fully understood. Detailed studies in order to understand the socioeconomic complexity of wetlands in relation to the users to ensure continued sustainable use in Africa is essential (Thomas, 1995). Despite concerns over sustainability and management of wetland benefits in recent years, Dixon and Wood (2003) were able to show that wetlands are critical natural resources providing numerous socioeconomic benefits including food and livelihood security to local communities.

3.3 Why small-scale irrigation development in Africa

The increased attention to small-scale irrigation development in Africa within the last decade or so was orchestrated, partly, by past failures of large-scale irrigation systems (Kurukulasuriya et al., 2006). Previously, large-scale irrigation systems received most of the attention by governments and donor agencies. Improved understanding of the failings of these large schemes has been accompanied by renewed appreciation of the relative efficiency and dynamism of small farmers (Adams and Carter, 1987). Carter (1989) noted that irrigation development in Africa had not been successful in the past 30-40 years due to technical and socioeconomic constraints. Other factors leading to increased attention on small-scale irrigation development in Africa include climate change. Watson et al. (1998) documented that the wide recognition of small-scale irrigation systems in sub-Sahara were gaining ground as an adaptation to climate change, also agreed by Kurukulasuriya et al. (2006), Kundhlande et al. (2004), and Love et al. (2006). Despite ‘‘risky, recurrent droughts and dry spells’’ (Love et al., 2006), agriculture in sub-Sahara Africa still remains the main economic activity and source of livelihood for the majority of the population (Kundhlande et al., 2004).

Recognizing the key role small-scale irrigation plays a in the economy as a source of food, income and employment (Ogonjimi, 2002), FAO (1997), through its Special Program for Food Security (SPFS) of the Food and Agriculture Organization, supported the promotion of small-scale irrigation in Africa. It is important to remember that, as a 'promising vehicle for rural development' (Carter, 1992), small-scale irrigation systems can 'offer the farmer increased security of crop production, while avoiding many of the problems which have been experienced by large-scale formal projects' (Carter, 1992). Today, many African countries are promoting small-scale irrigation technologies, thereby reducing dependency on unreliable rainfall (Kulecho and Weatherhead, 2006). The need for promotion and development of small-scale irrigation projects cannot be over emphasized. To avoid past mistakes that led to failures in large-scale irrigation systems, there is need for 'new approach' (FAO, 1997). Unfortunately, there are very few studies on such systems in Africa (Adams et al., 1994). Studying and understanding the characteristics of small-scale irrigation technologies is therefore critical in their promotion and development. Generally, Africa's irrigation potential has been under utilized (Table 3.1). In Southern Africa, many countries have less than 20% of irrigation potential utilized (Table 3.1). Although the potential for irrigation is huge, care must be taken for such developments to be developed in a systematic, orderly, and sustainable manner (Adams, 1993), with effective approaches (Norman et al., 2007). In order to achieve this, studies where lessons from the past can be learnt, must be encouraged.

Table 3.1: Estimated irrigated area in relation to potential of selected Sub-Saharan countries, 1991. Source FAO, 1997.

Country	Irrigation potential (ha)	Area under irrigation (ha)	Total in % of potential
Angola	3 700 000	75 000	2.0
Botswana	14 640	1 381	9.4
Ethiopia	3 637 300	189 556	5.2
Kenya	353 060	66 610	18.9
Lesotho	12 500	2 722	21.8
Madagascar	1 500 000	1 087 000	72.5
Malawi	161 900	28 000	17.3*
Mauritius	20 000	17 500	87.5
Mozambique	3 072 000	106 710	3.5
Namibia	47 300	6 142	13.0
South Africa	1 445 000	1 270 000	87.9
Swaziland	93 220	67 400	72.3
Tanzania	990 420	150 000	15.1
Uganda	202 000	9 120	4.5
Zambia	523 000	46 400	8.9
Zimbabwe	388 400	116 577	30.0

*Note: These estimates do not include informal wetland irrigation

3.4 Irrigation potential in Malawi

Like many Sub-Saharan States, Malawi has potential for irrigated agriculture that (with only 17.3% of its irrigation utilized) has not been fully maximized, as have been discussed already (Table 3.1). In Malawi, the actual potential area for irrigation is not accurately known. Many times, the potential for irrigation is linked to the amount of wetland area available, because wetlands have water resources needed for irrigation. The Ministry of Agriculture, for example, estimates the potential area for irrigation as equal to the wetland area, in which case it is about 480,000 ha to 600,000 ha (GoM, 2005d). FAO (1997), earlier, estimated the irrigation potential in Malawi as 161, 000 ha, much lower. The difference is perhaps due to the fact that wetland areas have increased since 1997 due to more occurrences of floods over the same period, as floods have a characteristic of turning land areas into wetlands. Further, it was reported that the estimate made by FAO (1997) did not include informal wetland irrigation; hence the estimated figure was low.

The main irrigation potential lies along the Lake Malawi littoral in the central region, the flood plains of Karonga in the north, and areas around Lake Chilwa and the vast Lower Shire River valley in the south of the country. As the largest water body in Malawi, with a huge volume estimated at about 7,730 km^3, a length of about 570 km, a width of about 16 to 80 km, and an average depth of about 426m, Lake Malawi as a natural lake, can provide enormous amounts of irrigation water. Spanning almost two-thirds of the country, the lake is seen as a potential major source of irrigation water. Other sources of irrigation water include the Shire River which is the longest river in the country. The Shire River spans a distance of 1200 km from Malawi to Mozambique where it joins the Zambezi with an average flow of 450 m^3/s. Most of these water sources still flow unutilized for irrigation.

3.5 Small-scale irrigation technologies

Food security in Africa is tied to the small-scale farmers (Senay and Verdin, 2004), who operate at subsistence level, employing low-cost technologies. They are mainly farmer-managed, with insecure land rights and shares of land per household usually varying between 0.1 ha to 1 ha (Shah et al., 2002). The technologies involved are simple without complicated engineering design in their layout and operation.

One example of such technologies is the treadle pump. The treadle pump is a simple manually powered water pumping device operated by feet. It was first developed in the early 1980s in Bangladesh. The first treadle pump was designed and developed by Gunnar Barnes, a Norwegian agricultural engineer working for the Ranger-Dinajpur Rehabilitation Service in Bangladesh in 1981 (Kay, 2000).

Fig. 3.1 and Fig. 3.2 from Kay (2000), respectively, show the operating principles and components of a treadle pump. The device has two cylinders fitted with pistons. Suction lift of water is created by alternating pushing the pistons up and down in the cylinders, using the legs. A suction hose is fitted to the inlet pipe and a delivery hose is fitted to the discharge pipe. Treadle pumps are mostly suitable for shallow water sources of not more than 10m depth, and can discharge up to 2.0 l/s. They were considered well suited to the small fragments of land common in wetlands of Malawi. Kay (2000) documented that a treadle pump can irrigate an area of approximately 0.24 ha if operated by one person with an input of 50 Watts for a crop requirement of 25 mm per week assuming an irrigation time of 20 hours per week. Kay (2000) further illustrated that using watering cans (typical in Africa small-scale irrigation), for similar conditions, the irrigated area would be reduced to 0.03 ha. This shows one of the advantages of a treadle pump.

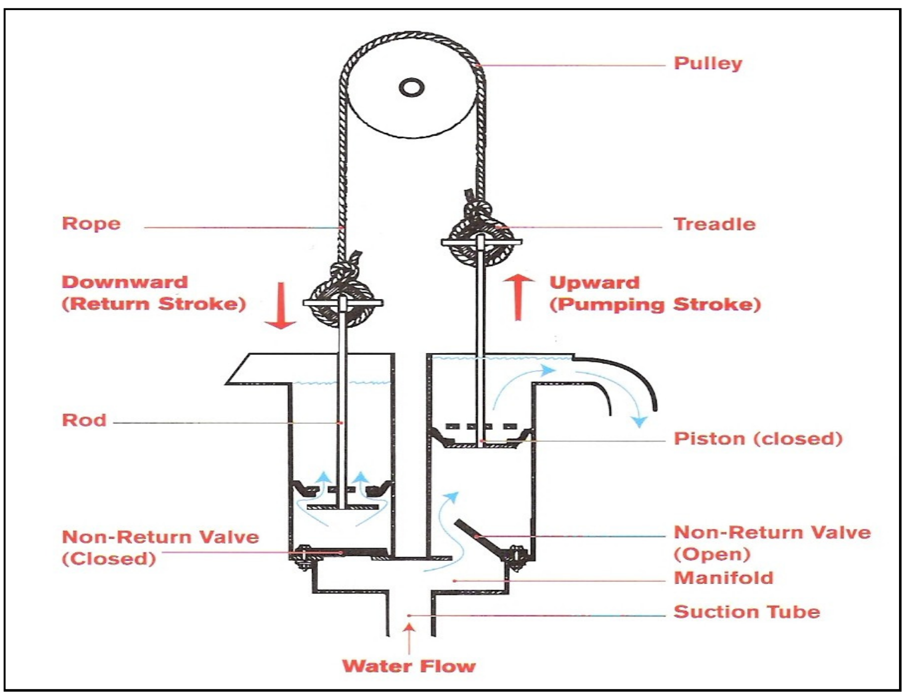


Fig. 3.1: Operating principles of a treadle pump.
Source: Kay, 2000.

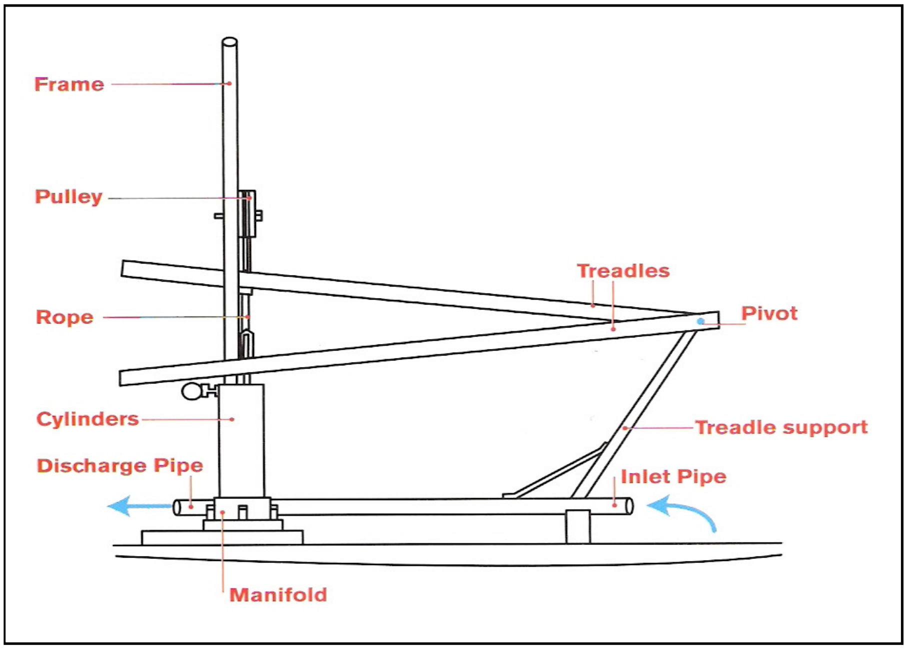


Fig. 3.2: Components of a treadle pump.
Source: Kay, 2000.

3.6 Review of treadle pump promotion in Malawi

Accessing water for irrigation of small plots is one of the major challenges facing farmers in Malawi. In wetlands where agriculture is reported to have intensified, both surface and shallow ground waters exists. The means to deliver this water from its source to the field remains a challenge to many farmers. The treadle pump has been widely perceived as one of the devices that could assist farmers to deliver irrigation water (Mangisoni, 2008).

In the mid 1990s, the Department of Irrigation initiated a programme where treadle pumps were imported from India. Initially, the treadle pumps were meant for sell to farmers across the ADDs at an approximately price of USD100. Reports from ADDs indicate that very few farmers bought the pumps. The general feeling at the Department of Irrigation was that farmers could not afford the suggested prices. Then the government decided to distribute the imported treadle pumps to farmers for free (GoM, 2005d). The criteria for selection of eligible farmers were not reported but clearly members of parliament were involved in the selection of eligible farmers. With so much political awareness about the advantages of the pumps, many NGOs assisted the government to procure more pumps for free distribution.

While some reports indicated success stories of the scheme, others indicated failures of the scheme. Reports of success included improved household food security (Mangisoni, 2008). Reports of failure were seen to be driven by politics and lack of follow-up support. The failures of the scheme were usually toned down by politicians. Undocumented reports across the country indicated that many farmers complained that the pumps were only distributed to supporters of the then ruling party, the United Democratic Front (UDF). Lack of follow-up support which included failure to provide spares frustrated my farmers. Note that the free distribution scheme did not carter for free spares. As such when spares were required, many farmers were unable to buy spares (perhaps because they thought they would receive the spares for free as well). Similar problems were noted in Kenya by Kulecho and Weatherhead (2006).

Realizing the potential market for treadle pumps, some local entrepreneurs engaged in manufacturing them within Malawi. The locally produced pumps were said to be cheaper than the imported ones. Surprisingly, with the 'efficiency' of the treadle pumps as claimed by some politicians or government officials, many farmers were still irrigating their small plots using buckets or watering cans, or indeed diverting small streams and let it flow into field furrows by gravity. Other undocumented reports indicate that female farmers discouraged their spouses to use treadle pumps as it was alleged that male farmers who owned treadle pumps became sexually inactive. As there is no documented evidence of these allegations, these reports have mainly been reported by newspapers.

Whatever the stories of treadle pumps may be, one most important question is: how helpful are treadle pumps in alleviating poverty to rural Malawians? There could be a whole lot of different answers to this question, depending on who answers the question and for what purpose. One certain feature is that treadle pumps are for very small plots often focused on subsistence crops (Polak, 2005). By largely promoting treadle pumps, the government seems to suggest that access to irrigation water is the main remedy to poverty alleviation. Polak and Yoder (2006) argued that access to affordable irrigation water should be complimented by providing access to inputs, credit, and 'new intensive agricultural methods customized for 1 ha' in order for smallholders to move out of poverty.

3.7 Review of political history on wetland use in Malawi

Malawi got independence in 1964 from British rule. From 1964 Malawi has been under one party rule headed by President Banda. Under President Banda a number of formal irrigation schemes in wetlands were established as settlement schemes. The schemes were taken out of customary land holdings. Peters and Kambewa (2007) documented that 'Members of Malawi Young Pioneers, a youth brigade of the then ruling Malawi Congress Party, were placed in the schemes, along with local residents who received plots as part of the compensation for the state takeover of customary land.'' Reports indicate that under Banda regime, people lived in fear, and used to think that, ''*zonse zimene nza Kamuzu Banda,* '' meaning that everything belonged to the president. Thus the irrigation schemes were also considered to belong to the government.

In 1992, however, the one-part regime started to fall apart. Malawi had its first multi-party election in 1994 when Muluzi was elected as President under the United Democratic Front party. Under the new political regime, people felt free and could criticize the government openly without being sent to jail; and the Malawi Young Pioneers movement was disbanded. The settlement schemes were proposed to be handed over to farmers around the same period.

Today, when new irrigation schemes are proposed, the general feeling among farmers is that government is trying, once again, to snatch customary land as it happened with settlement schemes. A good recent example is the abandonment of Bwanje Valley Irrigation scheme (Chidanti-Malunga, 2009), as discussed in section 1.6.1. It is generally believed that many farmers across the country (both in uplands and wetlands) would like to be treated as individuals, perhaps after experiencing the brutality of one-party regime.

3.8 Review of economic reforms in Malawi on agriculture from 1981 to 2000

This section reviews the major trade and economic reforms that affected the agricultural systems in Malawi from 1981 to 2000. The following is an outline of the reforms with a summary provided below in Table 3.2:

- During early 1980s many some African countries underwent structural adjustment programmes as recommended by the World Bank and the International Monetary Fund (IMF). The structural adjustment programmes which Malawi implemented since 1981 included the removal of subsidies on fertilizers and the devaluation of the Malawi Kwacha. The Malawi Kwacha was devalued by more than 300 percent over the period, 1983-93 (Chirwa, 2004). As a result of these adjustments, fertilizer prices increased more than three times between 1994/95 and 1995/96 growing seasons (FAO, 1996). Chilowa (2005) observed that the complete removal of fertilizer subsidies in 1994 created problems of timing ‘‘because most farmers had inadequate resources to purchase inputs as a result of a drought.’’

- Before Malawi changed to multi-party democracy in 1994, agricultural markets were under total control of the government by not allowing private traders to operate freely. Markets of produce were monopolized by the government marketing institution, the Agricultural Development and Marketing Corporation (ADMARC) (Chirwa, 2004). The system changed soon after Malawi changed to multi-party democracy in 1994. Agricultural markets were deregulated since 1996 leading to the abolishment of the system that required private traders to obtain licenses to conduct trade in the rural areas (Chirwa, 2004). A study by Orr and Mwale (2001) in southern Malawi showed that the liberalization of markets had a positive effect on improvement of economic status of households. Although the increase of private trading led to significant increase in maize price since 2000, it is important to note that ADMARC still controlled the market prices, particularly of maize. .

- Chirwa (2004) observed that the collapse in 1992 of the major micro financing company, Smallholder Agriculture Credit Administration (SACA), that had provided credit to farmers since independence, led to the mushrooming of other lending institutions that included: Malawi Rural Finance Company (MRFC) in 1995, the National Association of Smallholder Farmers of Malawi (NASFAM) in 1998. However, farmers still faced difficulties in accessing small loans. As a result safety net programmes were introduced by government, largely assisted by donor agencies. These included:

- The 'starter pack' program provided free inputs to resource poor farmers from 1998/99 –1999/2000. The inputs included seeds and fertilizers.

- Agricultural Productivity Improvement Programme (APIP) provided inputs on credit to resource poor farmers in 1998. This programme was funded by the European Union.

- Targeted Input Programme (TIP) provides free inputs to resource poor farmers including cereals seeds, legumes seeds and fertilizer since 2000. This programme was funded by the UK Department for International Development (DFID).

Table 3.2: Major trade and economic reforms in Malawi from 1981 to 2000
Source: Chirwa, 2004.

1981- 1986	• Annual adjustments in smallholder produce prices • Annual increases in interest rates • Periodic devaluation of the Malawi Kwacha	• All crops • All crops • All crops
1981-1992	• Periodic devaluation of the Malawi Kwacha	• All crops, except cassava the non-tradable crop
1987-1988	• Liberalisation of smallholder agricultural produce marketing • Liberalisation of interest rates	• All crops, except tobacco and cotton. • All crops
1989-1990	• Reduction in the scope of export licensing in 1989 • Preferential lending to agricultural sector abandoned in 1990	• All crops except maize and cassava • All crops
1991	• Liberalisation of marketing of agricultural inputs. • Liberalisation of burley tobacco production and introduction of two payment system for tobacco. • Removal of fertilizer subsidies.	• All crops • Tobacco • All crops
1994	• Floatation of the Malawi Kwacha and liberalisation of exchange rate market.	• All crops
1995	• Repeal of Special Crops Act and liberalisation of agricultural produce prices • Temporary export levy (10 percent) on tobacco	• All crops except prices for maize • Tobacco
1996	• Introduction of a producer price band for maize • Lifting remaining constraints on burley tobacco production • Export levy on tobacco reduced to 4 percent.	• Maize • Tobacco • Tobacco
1997	• Removal of all import and export licensing requirement. • Introduction of 'starter pack' free input distribution for food insecure households	• All crops • Maize
1998	• Devaluation of Malawi Kwacha • Elimination of the export levy	• All crops, except cassava • Tobacco
1999	• Reduction of maximum tariff rate to 25 percent	• All crops, except cassava the non-tradable
2000	• Elimination of the price band for maize • Implementation of the Agricultural Productivity Improvement Programme	• Maize • All crops, mainly food crops

3.9 Review of research methods: Quantitative and qualitative

An extremely important feature of research is the use of appropriate methods (Kumar, 2005). Quantitative and qualitative are the most commonly used research methods. Firestone (1987) elaborated that quantitative methods are usually used to prove a pre-determined hypothesis and therefore involve experimental and statistical methods. 'In quantitative research, the emphasis is on collecting data that lead to dependable answers to important questions, reported in sufficient detail that it has meaning to the reader. The proto-typical qualitative study is the ethnography which helps the reader to understand the definitions of the situation of those studies' (Firestone, 1987). With no concise definition, Preissle (2002) agreed that qualitative methods, aim at understanding realities and processes without pre-determined hypothesis, using informal interviews, case studies, and participant interviews. 'Qualitative research is a loosely defined category of research designs or models, all of which elicit verbal, visual, tactile, olfactory, and gustatory data in the form of descriptive narratives like field notes, recordings, or other transcriptions from audio and videotapes and other written records and pictures or films' (Preissle, 2002).

Although qualitative and quantitative research methods seem to complement each other there are striking differences (Tables 3.2 & 3.3). Qualitative research is subjective and often uses individual, in-depth interviews and focus groups as methods of collecting information with open ended questions, whereas quantitative methods are objective and seek in-depth descriptions (Tables 3.2 & 3.3). One advantage of qualitative methods, perfectly suited in this study, is the use of open-ended questions and probing, which gives participants the opportunity to respond in their own words, rather than forcing them to choose from fixed responses, as quantitative methods do (Mack et al., 2005). Another feature that made qualitative approach the preferred method in this study is the fact that it allows the use of semi-structured or interactive interviews to collect data. 'Qualitative approach is defined as one that typically uses purposive sampling and semi-structured or interactive interviews to collect the data, mainly, data relating to people's judgments, attitudes, preferences, priorities, and/or perceptions about a subject' (Carvalho and White, 1997). The three main methods for collecting data in qualitative research are: focus groups, in-depth interviews, and direct observations.

Table 3.3: Comparison of quantitative and qualitative research methods
Source: Mack et al., 2005.

Feature	**Quantitative**	**Qualitative**
General framework	Seek to confirm hypotheses about phenomena Instruments use more rigid style of eliciting and categorizing responses to questions Use highly structured methods such as questionnaires, surveys, and structured observation	Seek to explore phenomena Instruments use more flexible, iterative style of eliciting and categorizing responses to questions Use semi-structured methods such as in-depth interviews, focus groups, and participant observation
Analytical objectives	To quantify variation To predict causal relationships To describe characteristics of a population	To describe variation To describe and explain relationships To describe individual experiences To describe group norms
Question format	Closed-ended	Open-ended
Data format	Numerical (obtained by assigning numerical values to responses)	Textual (obtained from audiotapes, videotapes, and field notes)
Flexibility in study design	Study design is stable from beginning to end Participant responses do not influence or determine how and which questions researchers ask next Study design is subject to statistical assumptions and conditions	Some aspects of the study are flexible (for example, the addition, exclusion, or wording of particular interview questions) Participant responses affect how and which questions researchers ask next Study design is iterative, that is, data collection and research questions are adjusted according to what is learned

Table 3.4: Further comparison of quantitative and qualitative research methods
Source: Glesne and Peshkin, 1992.

Quantitative	Qualitative
Assumptions Social facts have an objective reality Primacy of method Variables can be identified and relationships measured Etic (outside's point of view)	**Assumptions** Reality is socially constructed Primacy of subject matter Variables are complex, interwoven, and difficult to measure Emic (insider's point of view)
Purpose Generalizability Prediction Causal explanations	**Purpose** Contextualization Interpretation Understanding actors' perspectives
Approach Begins with hypotheses and theories Manipulation and control Uses formal instruments Experimentation Deductive Component analysis Seeks consensus, the norm Reduces data to numerical indices Abstract language in write-up	**Approach** Ends with hypotheses and grounded theory Emergence and portrayal Researcher as instrument Naturalistic Inductive Searches for patterns Seeks pluralism, complexity Makes minor use of numerical indices Descriptive write-up
Researcher Role Detachment and impartiality Objective portrayal	**Researcher Role** Personal involvement and partiality Empathic understanding

3.10 Case study data collection approach

Case study is an example of data collection approach, often interdisciplinary and location specific, designed to look at specific agro-ecological conditions, ensuring that development of technology suitable for such farmers receive attention (Tripp et al., 1990). It is important to realize that, farmers are likely to possess location-specific knowledge, useful for design of appropriate productivity enhancing technologies (Kundhlande et al., 2004). The case study methodological approach involves gathering baseline information through interaction with farmers and other stakeholders, and usually government officials in a specific location. Questionnaires, group discussions, and interviews may be the tools used to collect such information. If need be, follow-up visits may be arranged depending on the objectives and the outcome of the baseline information. The interviewees are usually randomly selected by the government officials working in the area. In South Africa, Sturdy et al. (2008) illustrated the case study approach, reproduced in Box 3.1. Although not all case studies may be the same, the procedure is pretty similar. One thing in common is that case studies involve personal interaction between the researcher and the farmer, in so doing it becomes a learning process for both parties. Thomas (1995) recommended detailed studies of African agricultural systems, since then, a number of case study methodological approaches have been used. There are numerous examples of case study approaches, only a few can be highlighted in this section. Makombe and Sampath (2003) used the approach to evaluate the influence of socioeconomic variables (use of credit, participation in labor groups, farmer training, literacy, and gender) on the financial performance of smallholder irrigation systems in Zimbabwe. Mangisoni (2008) used the approach to study the impact of treadle pump irrigation technology on smallholder poverty and food security in Malawi. Cook et al. (2008) used a case study approach to show why digital soil mapping has not been mainstreamed further and harnessed to the problems soil information can help address. Slegers (2008) used the approach when he investigated farmers' perceptions of rainfall and drought in semi-arid central Tanzania.

Box 3.1: Case study process used by Sturdy et al. (2008).

Identification of farmers
- Attend Farmer Learning Group gardening workshops (initiated prior to project research)
- Meet with leader farmer to discuss which farmers may be interested in participatory experimentation & variation in farmers' economic & social standing
- Introduce idea of participatory experimentation to Farmer Learning Groups
- Meet with 6 farmers of various social & economic standing (identified with help of leader farmer) to invite them to participate in experimentation process. Offer to help with gardening issues & techniques learned in workshops.

Experiment initiation & garden bed preparation
- Preliminary garden visits / sketches
- Discuss possible experiments with farmers
- From the primary 6 gardens, identify 4 gardens suitable for technical experiments by assessing farmers' interest & available time
- For the 4 identified farmers, suggest various technical experiments using innovations learned in garden workshops. Farmers chose to compare innovations they were most interested in to traditional way of planting
- Facilitate the comparison of learned innovations to traditional planting through observation & note-keeping (non-technical) with all 6 farmers
-Create and distribute field notebooks (calendars, data forms, example experiment outlines, garden photos) to the 6 farmers
- Assist farmers in constructing 60 cm trench bed in 2 gardens
- Install drip kit at 1 of the 60 cm trench beds (with help from farmer)
- Farmer constructed 25 cm trench bed in 1 garden
- Construct ditch system for collecting and distributing run-on at 1 garden (with help from farmer)

Installation of technical equipment (with minor assistance from farmers)
- Install manual rain gauges at all 6 gardens
- Set up 2 pairs of Wetting Front Detectors in each of the 4 identified gardens
- Install 2 nests of Watermark® sensors in 3 of the 4 gardens
- Install 2 Capacitance Probe tubes in 3 of the 4 gardens

Interviews
- Meet with the 6 identified farmers individually to discuss garden issues/progress bimonthly (at least)
- Structured interviews with 55 farmers
- Personal diaries & process notes
- Informal communication & semi-structured interviews
- Matrix scoring activity (value ranking development projects)
- Attend community & stakeholder sponsored meetings
- In response to individual and group interest, assist an existing co-op with application for donated hydroponic green house & organizing entrepreneur training / mentoring
- Group discussions & learning process evaluations

Instrumentation monitoring & data collection
- Bi-monthly data downloads at 3 gardens with full technical instrumentation
- Quality checks & photograph farmer data records at 4 gardens doing technical experiments bi-monthly
- Discuss garden notes and records with all 6 farmers monthly
- Soil sampling & characterization tests (minor assistance from farmers)

Information sharing
- Farmer to farmer presentations (about their garden experiments)
- Researcher to farmer presentation (about experimentation process & findings)

3.10.1 Case study approach: Focus group discussions

'A focus group is a special type of group in terms of purpose, size, composition, and procedures. The purpose of a focus group is to listen and gather information'(Krueger and Casey, 2000). Focus groups data collection techniques have wide applications in social sciences. For example, in learning more about middle school students' perceptions of agriculture and the food processing industry in Iowa, Holz-Clause and Jost (1995) used focus group techniques to collect data. Focus group approach has proven to be effective for uncovering and understanding attitudes and opinions of individuals (Holz-Clause and Jost, 1995). In identifying farming styles among Australian broad acre croppers, Howden and Vanclay (2000) not only used but also recommended the use of focus group methods. 'Researchers should be aware that focus groups potentially allow the expression of mythology and should reflect on the validity of data collected by this method,' (Howden and Vanclay, 2000). When used by Trenkner and Achterberg (1991), it was shown that focus groups, like any other data collection technique, have advantages and disadvantages. 'Although there are limitations to using focus groups as a data collection technique (data are not quantitative, making data analysis difficult; responses are influenced by group dynamics; and some suggestions made by the group are not appropriate), the richness and innovativeness of the data collected make focus groups a worthwhile' (Trenkner and Achterberg, 1991).

3.10.2 Case study approach: In-depth interviews

In-depth interviews may also be used to collect data in case study approaches. Respondents are interviewed individually. During in-depth interviews, the interviewer obtains detailed information, although sometimes may lose out on the depth which could have been obtained in focus group debates. In order to maximize on the advantages, some researchers use both methods. Hyder et al. (2005) used both in-depth interviews and focus group discussions with rural women farmers in Kwale District, Kenya and Bagamoyo District, Tanzania, when studying the critical interaction among food security, gender inequity, women's health within the context of sub-Saharan Africa, where the nature of this triad from the perspective of women farmers in Africa was described and a framework for linking available interventions proposed. In-depth interviews have been widely used in social sciences. Seeking to find the relationship between farmers and those who eat their food, Cone and Myhre (2000) used in-depth interviews to collect their data. Determining the pattern of nonagricultural activities over time in Tanzania, Jambiya (1998) used in-depth interviews in their survey.

3.10.3 Case study approach: Direct observations

Direct observations are another way of data collection. Observations can be made during field surveys where a member of the study team can be the observer. Observations do not involve interviews, but may involve capturing data using video tapes, or measurements. In this study, the study team took observations and measurements during field surveys. The method has also been used by other researchers before. Whay et al. (2003) used direct observation method in assessing the welfare of daily cattle where fifty-three dairy farms in England were visited and assessed during the study. In planning technical interventions in agroforestry projects, Müller and Scherr (1990) used observations during monitoring and evaluating 165 projects worldwide. Grudens-Schuck (2001) used observation method in gathering information during a qualitative study of the influence of farm leaders' ideas on a sustainable agriculture education program.

3.11 Selecting data type

The type of data useful for the study is a combination of physical, human, and economic characteristics. One challenge of the study is to select such data. This section provides procedures followed in choosing data type for this study. The procedure begins by examining lessons learned elsewhere, and then transforms those lessons into the local conditions. Combined with the study objectives, the procedure facilitates the process for selecting useful physical, human, and economic data type for the study. Literature shows that, there are three particularly important lessons that organizations working in water have learned (DFID, 2001). The study adopts these lessons as a basis for selecting the physical, human, and economic data types for the study.

The three lessons learnt are:

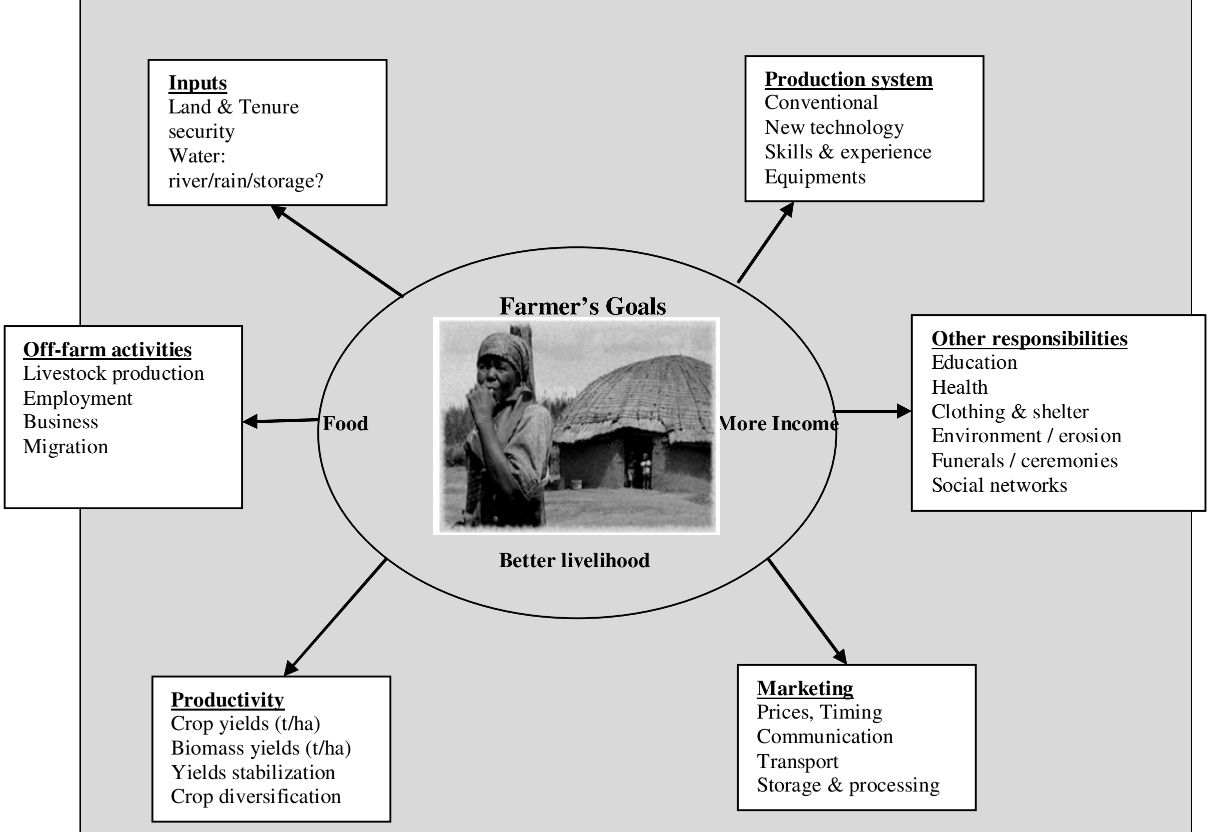
- To put people at the centre, where people's livelihoods are the main focus.
- To respond to demand, rather than be driven by supply, where costs and services are designed for local conditions accepted by the community.
- To recognize water as an economic good with an inherent value, and with costs attached to its provision. This lesson focuses on water resource as an economic good, and not a free resource, therefore it must be used efficiently.

Putting people at the centre

By considering this lesson, the study allows social and cultural issues as human characteristics to be included in the data collection tools. FAO (2002) recognized and supported the idea where issues of human equity are not ignored in irrigation development projects. Although the majority of farmers in Africa may be illiterate and lack basic knowledge of water requirements and irrigation scheduling (Ogunjimi and Adekalu, 2002), they are able to establish functional organizational structures necessary for the management of a shared irrigation water distribution system (Norman, 1997). Putting people at the centre by involving farmers in irrigation management and decision making delivers direct benefits at farm household level, and indirect benefits at system level (Hussain and Hanjra, 2004). This strategy avoids many technical problems associated with irrigation development projects. Kimmage (1991) showed that technical sustainability problems may result if issues of human equity are ignored. Kay (2000) also warned of the implications of introducing projects where social and cultural issues were ignored. In this regard, irrigation technologies should never be imposed upon traditional systems. On the contrary, literature shows that engineers are more concerned with infrastructure development than issues of human equity. Rosegrant et al. (2002), for example, showed that many engineers just think of improvement of existing water use though modernizing or upgrading irrigation and water delivery systems, without considering the issue of human equity. The engineers' concept was also elaborated by Kay (2000). Most irrigation development projects still adhere to a fairly simple formula: estimate the demand for water and then built new supply projects to meet it (Kay, 2000).

In view of the above analysis, the study incorporates ideas where social and cultural implications are not ignored. The critical task is how to identify these social and cultural factors. Social and cultural factors can be viewed as those that influence farmers' decision-making processes (Sturdy et al., 2008). An example of such factors were illustrated by Ngigi et al. (2005), reproduced in Box 3.2.

Box 3.2: Socioeconomic factors influencing farmer's decision-making process in Southern Africa (after Ngigi et al., 2005).



Responding to demand

Why is it that irrigated farming in some areas, fails to achieve its potential benefits? (FAO, 1997). The problem is not inherent in the principle of irrigation as such, but in the frequently inappropriate practice of it (FAO, 1997). Inappropriate practice of irrigation systems are a result of unwanted systems imposed on the farmers. Responding to demand means that 'households should be provided with services they want' (Whittington et al., 1998). This involves serious dialogue between policy makers and the beneficiaries. Policy makers should therefore, respond to the kind of unexpected findings that are likely to emerge from serious dialogue with project beneficiaries (Whittington et al., 1998). To overcome inappropriate practice in future irrigation developments, the study needs to know the current preferred irrigation methods in the study area.

Water as an economic good

In many parts of Africa farmers often think that water is for free because, 'water is considered an essential public good' (Hambira and Gandidzanwa, 2006). Hambira and Gandidzanwa (2006) explained that this assumption belief leads to unsustainable use, which may result in over expansion of water supply facilities to meet increases in demand emanating from population growth, climate change and other socio-economic factors. Unsustainable use of water includes over-irrigation which has negative consequences not only on yield but environment as well. Excessive irrigation contributes to its own demise by the twin scourges of water-logging and soil salinization (FAO, 1997). Viewing water as an economic good, the study includes farmers' perception on water rights and use as a social characteristic and therefore relevant to the study.

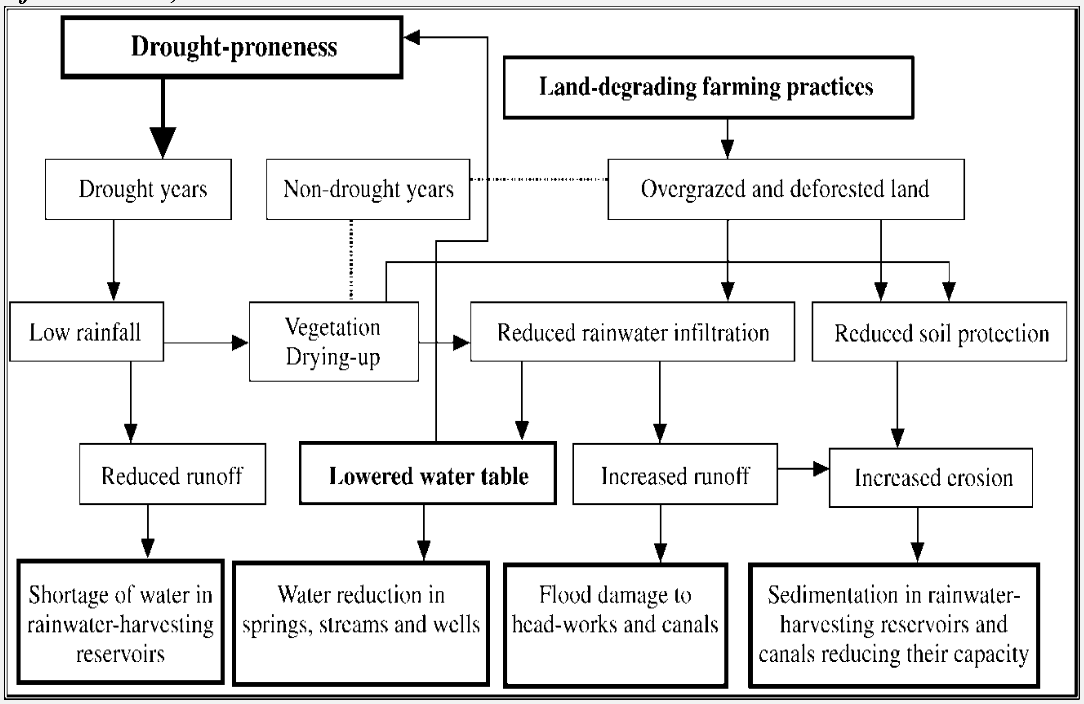
3.12 General considerations in data type selection

Another approach useful to determine data type for the study is the consideration of problems and solutions associated with small-scale irrigation systems. The success stories of small-scale irrigation systems and their performance challenges are fundamental in proving clues for information leading to determination of data type for the study.

Carter (1989) observed that successful irrigation development interventions have been those which concentrate on improvements to existing (traditional) practices rather than introducing new technologies to farmers who have no experience with them. This probably means that small-scale irrigation systems have succeeded mainly because they support traditional social structures that allow very little social change (Funnell, 1994). Initiated, controlled and managed by farmers themselves (Turner, 1994), many small-scale irrigation systems are a success story. Opened up in numerous floodplain wetlands across Africa (Thompson and Polet, 2000), supporting significant human populations, small-scale irrigation systems are not immune to problems (Aberra, 2004).

Studying in Zimbabwe, Manzungu (1999) showed that small-scale irrigation systems operate with no clear legal rights to land and water, creating management problems which results in low production. Under these circumstances, combined with pressure on water resources from growing population (Ragab and Prudhomme, 2002), emphasis to increase yields rather than expand harvested area (Rosegrant et al., 2002) can prove to be difficult. As a result proper planning management of these systems is always a challenge for African governments. Two main categories of problems associated with small-scale irrigation were revealed by Aberra (2004). The first category included problems that are associated with specific environmental characteristics of the agro-ecosystem, depicted by a concept map that has been compiled based on literature survey (Box 3.3). The second category included common problems that drought-prone and degraded areas share with all other small-scale irrigation systems, irrespective of their agro-ecological context (Box 3.4). From these two categories, the study extracts some useful information for inclusion as data type.

Box 3.3: Concept map: Impacts of drought-proneness on small-scale irrigation.
After: Aberra, 2004.



Box 3.4: Some problems of small-scale irrigation systems. ***After: Aberra, 2004***.

a. Problems related to the physical nature of the irrigation systems, e.g. loss of water through seepage.

b. Problems related to the application of irrigation water, e.g. upstream users abstracting too much water.

c. Problems related to marketing produce, e.g. transportation issues.

d. Policy-related problems, e.g. security of land tenure.

e. Engineering-related problems e.g. lack of experience in planning and designing irrigation systems.

f. Problems related to the irrigation economy, e.g. competition between rain-fed and irrigated agriculture.

g. Community issues, e.g. levels of farmer participation.

3.13 Principles of data analysis

Data analysis is an important stage in research. Data analysis provide ways of discerning, examining, comparing and contrasting, and interpreting meaningful patterns or themes, determined by the particular goals and objectives (NSF, 1997). Thus one set of data can be analyzed in different ways depending on objectives of the study. There were three main methods selected to analyze data in order to meet the study objectives. These are:

- Descriptive statistics,
- Cluster analysis, and
- Gross margin analysis

3.13.1 Descriptive Statistics

Descriptive Statistics is a method to describe quantities and provide simple summaries of data. There many examples where this method has been used to describe data quantities. In Malawi, Wiyo and Kasomekera (1994) used this method to analyze data for dambo farming communities. Studying the effects of land tenure on agricultural productivity in Kenya, Obunde et al. (2004) used descriptive statistics to analyze their data. Also in Uganda, Sserunkuuma et al. (2004) used the method to analyze data in their study for 'collective action in canal irrigation system management.' This study also uses descriptive statistics in part to analyze some of the data.

3.13.2 Cluster Analysis

Cluster analysis is a technique used to identify groups of data with similar characteristics. This method has wide applications across many fields of science. For example, Wang and Zhou (2009) used the method in computer science. Boryczka (2009) used the method in biology. Biglari et al. (2009) used the method in food science, while Simon (2008) used the method in agriculture, and also Al-Bassam (2006) used the method to evaluate ground water quality in Saudi Arabia. In Sri-Lanka, Amarasinghe et al. (2005) used the method to map poverty and food insecurity. In studies involving irrigation, the method has also been used by many researchers. Hussain et al. (2006) used the method to assess the quality of logged water at an irrigation project in Saudi Arabia. El Kholy et al. (2005) used the method to show trends for irrigation water quality in Egypt. With its wide applications in science, and its ability to group data with similar characteristics, it was therefore decided that cluster analysis be used in this study.

3.13.3 Gross Margin Analysis

Gross margins per hectare of irrigated area are one of the most commonly used indicators of economic benefits in irrigation schemes (DFID, 1997). The gross margin analysis involves an assessment of benefits by comparing input costs of production and yield (Bos et al., 2007), resulting in a measure of economic benefits (Fox et al., 2005). In general, gross margins indicate the difference between crop revenues and crop production costs (Kuhlmann, 2006).

Fox et al. (2005) used gross margin analysis to work on risk analysis and economic viability of water harvesting for supplemental irrigation in semi-arid Burkina Faso and Kenya. He showed that improving water and fertilizer management in crop production in rain-fed farming systems resulted in increased economic benefits for households with positive impacts on future food requirements in sub-Saharan Africa. Shumba and Maposa (1996) used gross margin analysis to evaluate the economic performance of six irrigation schemes in Zimbabwe. Studying the changing farming environment in Tanzania, Bee et al. (1997) used gross margin analysis. In South Africa, Ishmael et al. (2002) used gross margin analysis to assess the economic benefits of smallholder cotton growers. Senkondo et al. (2004) used gross margin analysis to study the profitability of maize, rice, and onion, under rainwater harvesting techniques in semi-arid Tanzania. Woyessa et al. (2006) chose gross margin analysis as a method to compare the benefits of upstream and downstream water users on Modder River basin in South Africa. The study adopts the gross margin analysis technique used by Kundhlande et al. (2004) in their socioeconomic study on water conservation techniques in semi-arid areas (Box 3.5).

Box 3.5: Gross margin analysis technique. Source: Kundhlande et al., 2004.

GROSS MARGIN PER HA (R)

MAIZE — **Glen-** Stone mulch in the basins and organic mulch in runoff strip

Country: South Africa
Province: Free State — **Farming area:** Bloemfontein
Ecotope: Glen/Bonheim-Onrus
Clay (%) in A-horizon: 45%
Plant Population: 22 000 plants per hectare — **Target yield:** 2 750 Kg/ha
Cultivar: PHI 3394 — **Seasons:** 1999/2000, 2000/2001, 2001/2002

	UNIT	PRICE OR COST PER UNIT(R)	Average over 3 years Quantity	Cost
Gross receipts from production				
Maize grains	Ton	570.00	5.37	**3060.90**
VARIABLE COSTS				
PREHARVEST				
Planting				
Seed	Kg	11.40	4.00	45.60
Labour	Days	15.00	8.13	121.98
Fertilizers				
Ammonium Nitrate	Kg	1.82	150.00	273.00
Superphosphate	Kg	1.79	39.21	70.19
Pest Control/Pesticides				
Bulldog	L	237.00	0.10	23.70
Application (labour)	Days	15.00	5.73	85.90
Weed Control/Herbicides				
Turbo	L	79.60	1.50	119.40
Application (labour)	Days	15.00	5.79	86.90
Maintenance (labour)				
Repair basins	Days	15.00	2.28	34.15
HARVEST and POST HARVEST (labour)				
Labour	Days	15.00	3.02	45.30
Threshing	Days	15.00	3.08	46.23
Remove maize stems	Days	15.00	1.97	29.62
Total Allocatable Variable Costs				**981.97**
Margin Above Allocatable Variable Costs				**2078.93**
Total Pre harvest Costs				**860.82**
Total Harvest and Post harvest Costs				**121.15**
Gross Margin Above Total Allocatable Costs				**2078.93**
FIXED COSTS				
LAND PREPARATION				
Energy				90.00
Repairs and maintenance				114.35
Construct basins (labour)	Days	15.00	10.35	155.25
Pack stones (labour)	Days	15.00	3.69	55.35
Pack mulch (labour)	Days	15.00	7.71	115.65
Total Fixed Costs				**530.60**

Prices are for the base year , 1999/2000
All activities done by hand and/or hand tools except soil preparation
Fertilisers applied by hand at time of planting
Chemical and hand control of weeds and pests

3.14 Methods adopted for the study

As shall be discussed in chapter 4, field surveys were used to collect information using a questionnaire. Where farmers were asked to describe a situation, no interruptions were made until they finished. In some case probing questions were used to follow up on a point made by a farmer. In which case, elements of both qualitative and quantitative approaches were used. Some forms of observations were also used to capture data. In the analysis of data, descriptive statistics were used to compute averages, standard deviations, and percentages where applicable. Gross margins were used to compute farmer benefits. Gross margins emphasize labour as the key factors for determining the economic benefit for a farmer, as can be seen from the analysis carried out by Kundhlande et al. (2004) in Box 3.5. Since in the Shire Valley land and water resources are generally considered not scarce, labour was a key factor in the analysis. Therefore gross margin analysis was chosen to calculate the farmer benefits.

3.15 Chapter summary

Due to weather failures, small-scale irrigation development in wetlands is regarded as a way forward to achieve food security in many parts of Africa. Previously, governments and donor agencies promoted large-scale irrigation systems, which have failed in many parts of Africa. Increased need for small-scale irrigation development calls for strategies that will avoid mistakes previously encountered during the promotion of large-scale systems. This chapter has discussed the promotion of treadle pumps as an irrigation technology, and some economic reforms that took place in Malawi within the last two decades. The chapter has also reviewed some approaches for data collection and analysis; then ends by indicating which methods were adopted for this study giving reasons where necessary.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Chapter overview

This chapter discusses in detail the research tools used, for collection, and analysis of data. The study was divided into two phases where both qualitative and quantitative data were collected by interviewing farmers. The questionnaire was the main data collection tool (Frongillo Jr., 1999), as used by Drimie (2002) and Twyman et al. (2004). Thus the farmer interviews were based on the questionnaire (Shreck et al., 2006). Limitations of the methodology are given at the end of the chapter. The methods opted in the study were introduced in section 3.14.

4.2 Formulation of questionnaire questions

One crucial area for the study was the decision on what type of questions should make up the questionnaire in phase I of the study. There were a number of issues considered. Issues of environment, economic and human behaviour played a role in deciding the research guide questions. Environmental issues included access to land and water, while economic issues included main income sources for households, and human behaviour issues included family composition and sizes and gender. The Integrated Household Survey of Malawi (NSO, 2005) report played a guiding role in formulation of the questionnaire questions.

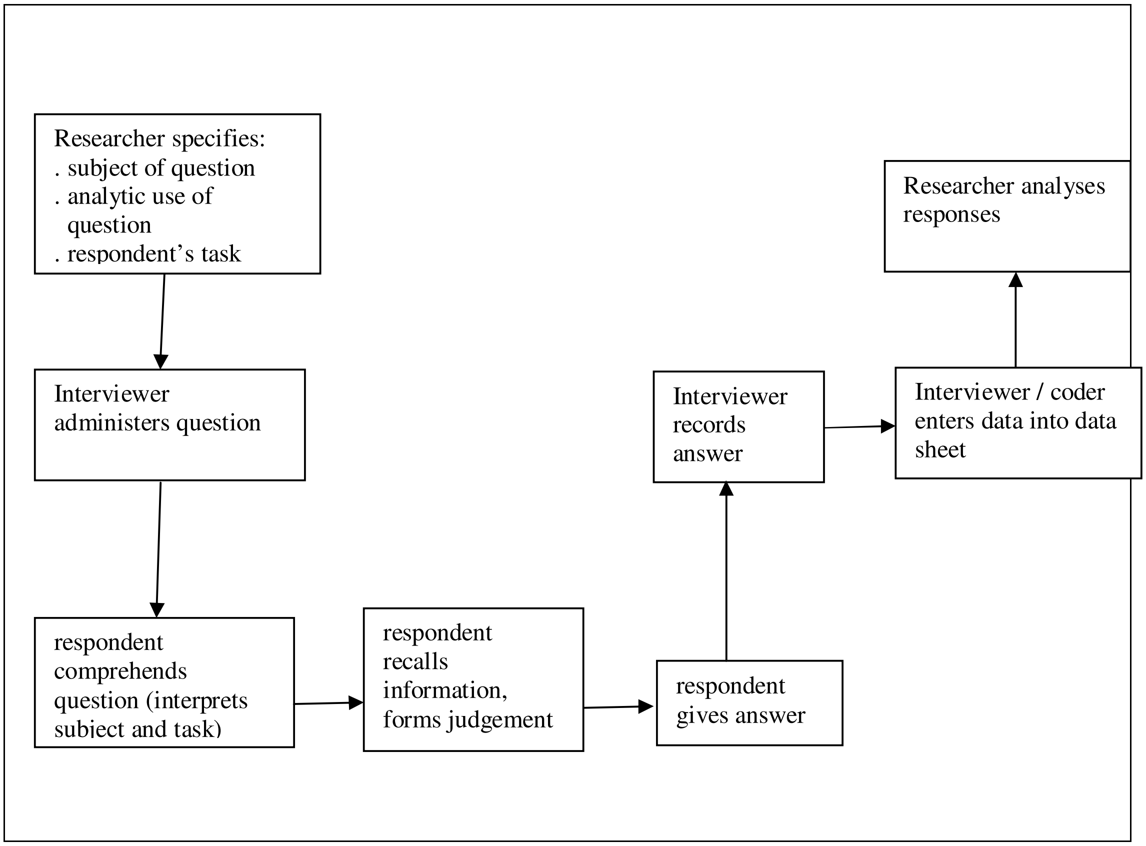
4.3 Outline of research methodology

The outline of the research methodology is given in Table 4.1. The methodology was divided into two main phases. Phase I included research design and field surveys. Then analysis of data collected from phase I was done before phase II. Using results from phase I, field surveys for phase II were done. Both field survey phases took approximately four months. Generally field surveys involved interviewing farmers, and capturing their responses. The interviews were done in the national language, Chichewa. The farmer responses were written down. Analysis involved coding the respondents' responses. The survey and data collection process followed the model suggested by Robson (2002), presented in Box 4.1.

Table 4.1: Outline of research methodology

Activity	Output
Formulation of questionnaire questions: • Problem definition • Formulate research questions • Formulate objectives of study • Defining data collection tools • Formulate questionnaire for Phase I of study	• Research questions formulated • Study objectives formulated • Questionnaire for Phase I of study formulated
Phase I: • Questionnaire pre-test • Phase I field visit • Phase I field survey • Phase I questionnaire administering • Key informants meetings (where necessary) • General Phase I data collection • Phase I data analysis • Identify agriculture technologies • Discuss socioeconomic characteristics • Produce farming groups or patterns (clusters) • Fulfillment of study objective I • Review of Phase I results • Select farmers to interview for phase II using cluster analysis • Formulate research questionnaire for Phase II of study	**Study objective I met**: • Secondary data collected • Agriculture technologies identified • Socioeconomic characteristics discussed • Farming groups or patterns produced • Questionnaire for Phase II of study formulated • Farmers to be interviewed for phase II selected
Phase II: • Questionnaire pre-test • Phase II field visit • Phase II field survey • Phase II farmer interviews • General Phase II data collection • Key informants meetings (where necessary) • Study objectives I & II fulfilled • Produce gross margins for farming groups • Fulfillment of study objective II	**Study objective II met**: • Phase II data collected • Gross margins of farming groups produced • Study objective II fulfilled
Study objective III: • Analysis and discussions of Phase I & II results • Recommend areas (issues) that need intervention / improvement • Suggest new policy areas	**Study objective III met**: • New policy areas recommended • Study objective III fulfilled • Conclusions made

Box 4.1: Model of survey and data collection process
Source: Robson, 2002.



4.4 Phase I field survey

Phase I field survey started by identifying research assistants who could help in data collection process. The research assistants had to be those with a prior knowledge of the study area, and could speak both English and Chichewa. Those with knowledge of Sena (a language in the study area) had an added advantage. There were four research assistants identified. They all had previously worked in the study area. They all had agriculture related qualifications (one had a BSc from Bunda College of Agriculture and the rest had diplomas from Natural Resources College). After identification of the assistants, training on the questionnaire begun. Training was done to make sure that the assistants fully understood the question, both in English and Chichewa. The questionnaire was in Chichewa since the language is regarded as a national language in Malawi and is widely spoken and understood in the study area. However, it was important for the assistants to understand Sena as well since many people in the Shire Valley mix Sena and Chichewa.

Pretesting of the questionnaire was done outside the study area. This was done to further make sure that the assistants fully understood the questions. Although the assistants were trained, it is possible that different people may present the questions and probe differently. This would result in respondents answering wrong questions, leading to errors in the collected data. To avoid this, I encouraged the assistants to write down farmers' responses in whole without leaving out some information. By reviewing the written responses I was able to check if the questions were presented properly. I also made sure the questions were short and simple, and that I should do more interviews than any of the research assistants.

In the field, interviews with farmers and key informants were conducted. Key informants included local leaders, government and NGOs staff working in the study area. The information from key informants was mainly used to clarify areas which needed clarification. Thus key informants were consulted to explain issues which the study team needed clarification. For this reason the questionnaires for farmers and key informants were pretty similar. Phase I data collection process lasted for about four months, with a total of 200 farmers interviewed. The data collection process followed the format presented in Box 4.2 for all the farmers interviewed.

Before interviewing the farmers, the study team had to consult government officials in the area. These officials knew where to find the farmers because they are employed as extension workers in the study area. Even after finding the farmers, it was not a simple task to let them agree to be interviewed by strangers. It must be remembered that this is a vast bushy area inaccessible by road. We had to travel long distances to meet farmers in the thicket of bushes. This means that the study team had to rely on these officials for identification, choosing, and convincing farmers to be interviewed.

My main concern with this methodology was that the government officials may have selected the farmers that they knew and interacted with; these may have been their friends or those that they considered 'good' farmers. It was also possible that the government officials may have alerted the farmers to be in their best fields in readiness for the interview. Clearly strictly random sampling was not possible under these circumstances. This meant that, the selection of respondents with equal chance of being represented in the study (Bernard, 2005), would eventually not be possible. I was fully aware of the bias this sampling technique would create. To solve this problem, I decided to interview as many additional farmers as possible. Furthermore, sometimes while in the field, I could ask to interview farmers that were not among those recommended by the government officials.

Box 4.2: Phase I data collection process

PHASE ONE

Meeting with officials at Ministry headquarters
- Introduce the aim of the study
- Obtain permission to visit the study area, ADD headquarters
- Collect relevant literature
- Questionnaire pre-test

In the field
- Meeting with ADD officials
- Introduce aim of the study and discuss way forward
- Set criteria for identification of farmers
- ADD officials identified farmers using existing list
- Travel to EPAs
- EPA officials direct study team to the selected farmer fields
- EPA assist explain our aim to farmers before interview
- Interview takes place if farmer accepts
- After interview, field measurements taken, and location recorded using a GPS instrument
- Name and village of the farmer also recorded
- An interview lasted one to two hours
- Data entered in a spread sheet at the end of each day
- Process starts all over the following day
- Where farmer key informants were involved, group meetings were arranged at EPA headquarters

For each farmer interviewed, field dimensions were taken at the end of the interview. Using a GPS instrument, the geographical positions of farmers' fields were recorded and plotted in ArcView computer program (Figs. 4.1 and 4.2). Since it was required to take farmers' fields measurements during the interviews, it was decided the collection period should coincide with the growing period in the wetlands, in order for the study team to meet the farmer in-situ. The key informants were interviewed separately from the farmers. Key informants interviews were mainly carried out to provide clarification or additional information which I felt needed further explanations. It was emphasized that the interviewed farmers should be those who had the right of ownership of the current plot under traditional rules.

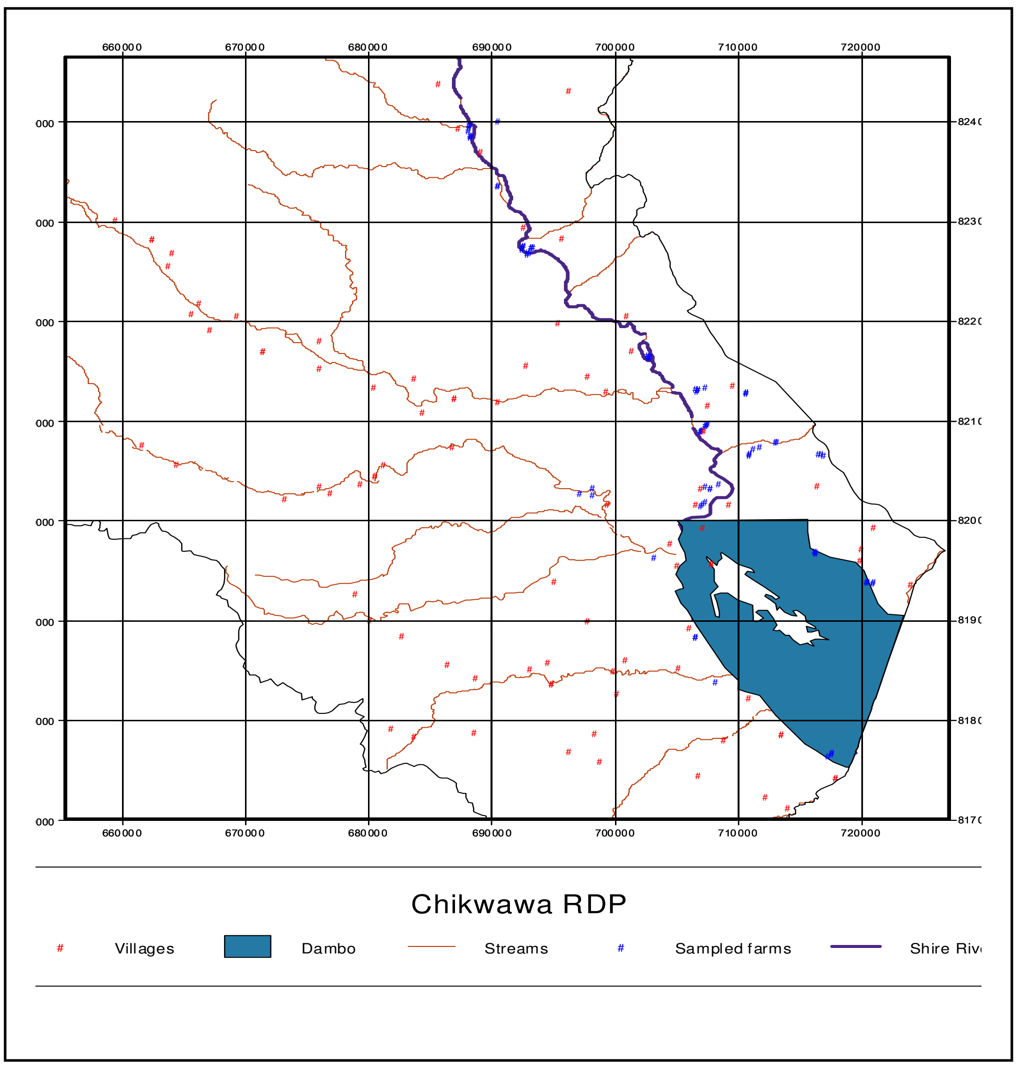


Fig. 4.1: Chikwawa RDP showing locations of phase I farms

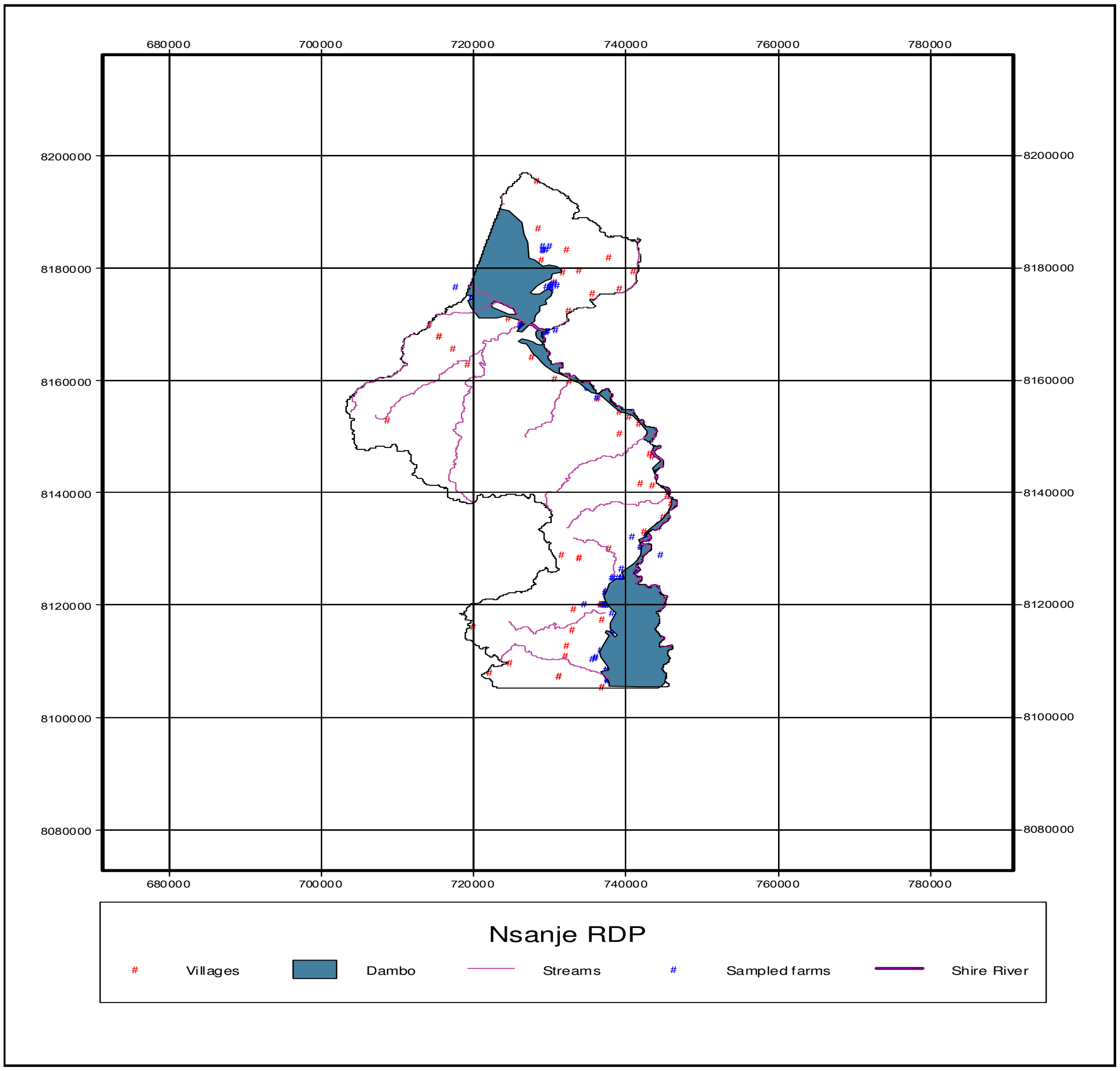


Fig. 4.2: Nsanje RDP showing locations of phase I farms

4.5 Phase I data coding

At the end of each interview day, the descriptions or responses given by farmers had to be coded for ease and uniformity of analysis. There were 200 entries altogether, each with seventeen variables which were relevant to social issues in wetland farming as documented in the Integrated Household Survey of Malawi NSO (2005) and also related to socioeconomic factors for farmer's decision-making as described by Ngigi et al. (2005) in Box 3.2. The questionnaire was a mixture of both open and close ended questions. For the open ended questions, the codes were determined from the responses given by the respondents. Each variable had different responses (codes) which could be numeric, scalar or ordinal. The respondents were plot owners. The codes for each of the variables are described below.

Farming or irrigation technology

Under this question, respondents were asked to describe their main technology of supplying water to crops in their plot. This question allowed the study to document the most prevalent method of irrigation in the study area. The answers were coded in five different choices (1= flood recession agriculture, 2= treadle pump, 3= river diversion, 4= watering can, 5= motorized pump).

Land ownership

This question was designed to determine whether the respondent was the permanent owner of the plot or not (0= no, 1= yes). The response to this question revealed the proportion of permanently owned land versus temporarily owned land.

Land acquisition modes

Land acquisition mode is the procedure for obtaining land. There are many ways one could obtain land. There were six ways in which respondents could acquire land (1= inherited from parents, 2= borrowed from chief, 3= bought from someone, 4= rented from someone, 5= borrowed from someone, 6= bought from chief).

Period on the plot

In this question farmers responded by given an estimate of how long the current plot had been in use by the current farmer. Many farmers were not able to remember, but could only give an estimate of how long they had been using the current plot. From the estimates three periods were developed (< 10 years, 10 to 15 years, and > 15 years).

Main crop grown

This involved documenting the main crop grown by the respondent during interview time on the current plot. This would assist to know which crops were common in the wetlands. Respondents were asked to mention the major or main crop grown on the current plot (1= rice, 2= maize, 3= sweet potatoes, 4= vegetables, 5= beans, 6= tomatoes, 7= sugarcane).

Plot size

In literature review, it was shown that subsistence farmers in the developing world own small fragments of land (typically of not more than 0.5 ha). This is so because agricultural activities in developing world are mainly manual. In which case land size has to be small enough to be manually managed. Does this also apply to Shire Valley wetland? As it was difficult for many respondents to give precise area of their land, the research team took rough estimates by physically measuring the plot. The approximate area was recorded as a numeric value.

Farming groups

Governments and NGOs encourage farmers to form farming groups or associations. The groups could be registered or not, with an elected committee that can run the affairs of the group. This makes it easy to access loans for inputs from micro finance lending institutions. This question aimed at exploring the presence of those groups in the study area. So the respondents were asked if they belonged to any farming group (0= no, 1= yes).

Water source

There is no farming without water. The Shire Valley being a flood plain wetland, many water sources exist. Of those water sources, which ones do farmers mostly use? Respondents made five choices (1= floods (swamps), 2= shire river, 3= small streams, 4= ditches, 5= shallow wells).

Water source reliability

Water source is one thing; how reliable is the source is another. Farming or irrigation is only possible if the water source can supply water to the crops when it's needed throughout the growing period. Adequate water supply ensures adequate yields. In this question respondents were asked if their water source was reliable enough to last a growing season (0= no, 1= yes).

Start of active farming season

During the rainy season, farming activities are absent in most areas of the flood plains due to water logging problems. Farming activities become active during dry periods of the year. Although the rainy season varies from region to region in the country, generally November to March is the peak period across the country, as discussed before. This question gives an indication of the end of a rainfall period and beginning of active irrigation period in the Shire Valley. When the rainy season ends, respondents were asked to mention when they normally start the farming season in the wetlands. The season starts with land preparation and planting (1= January, 2= February, 3= March, 4= April, 5= May, 6= June, 7= July, 8= August, 9= September, 10= October, 11= November, 12= December).

Multiple plots in the wetland

This variable allows the study to find out if farmers own several pieces of lands at different locations in the same wetland. The respondents were asked if they own another plot in the wetland (0= no, 1= yes). If yes, then a follow up question of why was asked.

Multiple plots both in the wetland and the upland

This question gives an indication of where do farmers regard as their main agricultural area, wetlands or uplands? The respondents were asked to mention if they own plots in both upland and wetland zones (0= no, 1= yes). If yes, a follow up question of, why is it significant to own plots in both upland and wetland zones?

Main source of income for the farmer

The study also found out if farming was the main income for the respondent (0= no, 1= yes).

Household composition

The number of people living in a household was one of the important questions as it would provide clues on how farming decisions are made in a household. So, respondents were asked to mention how many people lived in their household and how decisions are made.

Level of farmer education

The study included education as one of the socioeconomic factors. The idea was to find out how education influences farmer decisions at household level. There were three levels of education from which respondents were asked to chose from (1= never, 2= primary, 3= secondary).

Gender

Sustainable water management and gender equality are interdependent. A gender perspective in the water for nature sector would give an appreciation of the manner in which men and women share roles and responsibilities regarding the use and management of natural resources (GWA, 2003). In developing countries women play a huge role in agricultural development. In this regard, it was necessary to include gender as a variable in the grouping process in this study. The respondents were categorised as either male or female (1= male, 2= female).

Main problem or challenge

Finally, the respondent were asked to mention what could be the main problem associated with farming or irrigation agriculture in the wetlands (1= floods, 2= salinity, 3= lack of irrigation equipment, 4= pests and diseases, 5= hippos destroying crops, 6= too much moisture, 7= domestic livestock destroy crops, 8= moisture drying quickly, 9= dambo fires, 10= thieves, 11= lack of land, 12= lack of extension services, 13= lack of inputs, 14= no problem, 15= siltation, 16= don't know, 17= lack of capital, 18= manual labour tiresome, 19= lack of moisture).

4.6 Phase I data analysis: Descriptive statistics

In order to describe wetland farming and small-scale informal irrigation characteristics, thereby fulfilling part of study objective I descriptive statistics were used. Descriptive statistics are used to present quantitative descriptions in a manageable form, by describing the basic features of the data in a study (Trochim, 2006). Typical examples of descriptive measures as described by Bickel and Lehmann (1975) include mean, standard deviation, and interquartile ranges. Descriptive statistics are widely used in agricultural sciences. In Kampala, Uganda, Maxwell et al. (1998) used descriptive statistics to analyze the household characteristics to determine the influence of urban agriculture on the nutritional status of children under five. Parikh et al. (1995) also used descriptive statistics to compare farmers on small farms and large farms by their holding sizes, education, credit, and subsistence needs.

4.7 Phase I data analysis: Cluster analysis

The codes created during data entry represented agriculture technologies, and socioeconomic characteristics of wetland farming and small-scale informal irrigation. Using the codes, cluster analysis sorted cases into groups or clusters of respondents with similar characteristics using a computer program, SPSS. The resulting classification showed trends or patterns of a given data set by defining the class to which its members belonged. More important to note is the fact that cluster analysis groups together cases rather than variables. In this case it grouped together farmers based on their responses to variables.

The main reason for cluster analysis was to identify farming groups from which samples of phase II of the study would be taken. It was impractical to do an economic analysis with all the 200 farmers. After all, their selection was biased since it was based on government officials' decisions. In which case, I wanted to create farming groups, from which I would make a selection that would represent the farmers without the influence of the government officials.

Cluster analysis is often adopted as an approach for preliminary and descriptive data analysis and classification (Wang and Zhou, 2009). StatSoft (2008) describes cluster analysis as a method that encompasses a number of different methods for grouping objects of similar kind into respective categories, and was first used by Tryon in 1939. StatSoft (2008) further describes cluster analysis as an exploratory data analysis tool which aims at sorting different objects into groups in a way that the degree of association between two objects is maximal if they belong to the same group and minimal otherwise. Tucker et al. (1992) used cluster analysis to determine dietary patterns of elderly in Boston. In Nebraska, Bernhardt et al. (1996) used cluster analysis to estimate and compare economic, environmental, and sociological characteristics of conventional versus alternative production systems. In Spain, Berbel and Rodriguez-Ocaña (1997) used cluster analysis to classify irrigated farms according to crop patterns. Analyzing the differential impact of pricing policy on irrigation water, Gómez-Limón and Riesgo (2003) used cluster analysis in their approach. In Kenya, Corbett (1998) used cluster analysis to classify maize production zones.

Much as cluster analysis is used to organize observed data into meaningful structures, its major disadvantage is that, it does not explain why discovered data structures exist but just put together objects according to defined rules (StatSoft, 2008). Since cluster analysis is able to group data structures using defined rules, it was felt in this study that the method satisfies the objectives.

4.7.1 Cluster analysis compared to other methods

This section highlights why cluster analysis was chosen as the method for identifying farming groups in the Shire Valley. The section presents advantages and disadvantages of cluster analysis and alternative methods, such as grouping the sample by the observed variables, say agriculture technology or water source.

Cluster analysis is a statistical method that can be used to group data with similar properties. One of its advantages is that the analysis can show the statistical significance of each variable used in the grouping process (Stockburger, 1996; and Wielkiewicz, 2000). This allows the researcher to identify the critical variables used in the grouping process. Another advantage of cluster analysis is that the analysis can show 'distances from cluster centre,' which are similarities of cases within a given cluster (Ben-Israel and Iyigun, 2008). Distances from cluster centre can be used to identify outliers within a cluster. However, the accuracy of clusters may depend on the representativeness of the sample. Without a representative sample, ''fit to data may be poor'' (Bacher, 2002), leading to formation of groups that may not be a true reflection of the data. The main disadvantage of cluster analysis is that the method identifies cluster centres by only using critical variables. Non-critical variables are not used in creating the cluster centres. Thus with non-representative sample the cluster centres may not show the dominant groups (Bacher, 2002).

Apart from using cluster analysis it would have been possible to group the data according to the observed variables manually, for example, by agriculture technology, water source or crop. From these groups, samples for the economic analysis would have been drawn. If the data had been grouped by this method, the number of the groups created would be the number of characteristics of the variable chosen for grouping. For example, if water source was chosen to group the data, the number of groups created would be the number of water sources. The advantage with that grouping would be that the final clusters would show all the different water sources. However, using that method the critical variables would not have been identified.

While there were disadvantages, but since cluster analysis involves statistical methods of grouping, it was felt that the study should adopt this method. Which means that the statistical process involved in the identification of groups was the main factor to decide which method to use.

4.8 Phase II field survey

Phase II started by selecting a sample of farmers from phase I. Using the 17 variables in phase I, six patterns or groups were identified by cluster analysis. From each of the six groups, seven to ten farmers were selected to participate in focus group discussions in phase II. The sample size from each group was based on Bernard (2005) recommendation. He recommended 6 to 12 members per group as ideal for discussions. Too little a group may make some members over-speak, and tool large groups may be difficult to manage.

I preferred to use the same assistants as used in phase I, since they had an experience of the area. The data collection process involved assembling farmers in one place where the questionnaire was explained and discussed in detail. After the discussions, members of the groups were separated to be interviewed as individuals. The discussions were done in the EPA near the selected members of each group. Where necessary, local leaders, government officials, and NGO representatives in the study area, were consulted to provide information or clarification on issues that needed to be so. At the end of the interview, arrangements were made to visit the farmer's field to measure the area. Some interviews were too long so a later date was arranged for field measurements. During field measurements, it was found out that some fields changed dimensions. This was so because; wetland fields become waterlogged and bushy during rainy season. When farming starts in dry season, farmers start by clearing the bush. Since phase II was done in rainy season, access and measurement of bushy fields was a difficult task and tiresome. In the rainy season the wetland areas are usually flooded and the grass grows thick. Most fields become engulfed with grass. The quantitative information collected in phase II referred to the previous season.

4.9 Phase II questionnaire questions

The questionnaire questions in phase II included those for calculating production and input costs per farmer's plot. The task therefore was to gather as much information as possible, both from farmers. During this task data were mainly collected in numeric form. Where farmers were unable to provide numeric data, the local government officials who always accompanied the study team were asked to assist.

The most difficult quantity for farmers to remember was yield, which they usually quantified in local units. Government officials assisted in the conversion of such local units to metric units. Yield estimates were a problem due to the fact that most farmers do not keep records. To reduce this problem, farmers were asked about quantities during the previous season, not many seasons ago. However, when it came to quantification, most farmers mentioned the number of sacks or pails. Sacks or pails are a common way of measuring yield in Malawi, (confirmed by local leaders and government officials). When maize is harvested, it is shelled and stored in sacks or pails. Sacks weigh about 50 kgs, and pails weigh about 15Kgs. From the number of sacks or pails mentioned, yield estimates were calculated. At the beginning of phase II a questionnaire pre-test was carried out. Fortunately, few adjustments were made.

4.10 Summary of phase II data collection process

Although farmers were interviewed separately, explanations of the questionnaire were done in a group, where farmers were allowed to interact and discuss. The advantage of this process is the fact that participants can learn from each other, and the researcher can gain insights about farmer perceptions (King et al., 2000). In this study, farmers were allowed to discuss a particular question based on the individual point of view, the technique used by Minten and Barrett (2008), and recommended by Bryant et al. (2000). In South Africa, Ziervogel et al. (2006), and Thomas et al. (2007) used the technique. In summary, phase II data collection process is outlined Box 4.3.

Box 4.3: Phase II data collection process

PHASE TWO

In office
- Prepare questionnaire for phase II
- Select sample from groups identified by cluster analysis in phase I
- Seven to ten farmers for each pattern were selected to be re-interviewed

Meeting with officials at Ministry headquarters
- Re-introduce the aim of the study
- Meet with research assistants (same as in phase I)
- Brief research assistants on questionnaire
- Questionnaire pre-test
- Obtain permission to visit the study area, ADD headquarters
- Collect relevant literature
- Same research assistants as in phase I used

In the field
- Meeting with ADD officials
- Briefed ADD officials which farmers to be re-interviewed
- Travel to EPAs
- Farmers asked to converge at EPA headquarters, where possible to brief them on the questionnaire
- Meet key informants also at EPA headquarters, where possible
- Group discussions in an informal manner
- explain the questionnaire
- Participants allowed to ask questions where necessary
- Individual interviews conducted
- Field measurements done, or arrange a later date

4.11 Phase II data analysis: Gross margin analysis

Gross margins, used as a measure of profitability of the patterns, were calculated as the difference between the monetary values of gross production (yields) and total annual costs for each pattern. Adopted from Kundhlande et al. (2004), but modified to meet local situations, the gross margin template used is given in Table 4.2. There are three main categories of the template, as discussed below.

The gross production (yields) value was obtained as a product of average yield per pattern and the market value of a given crop. The market value of a crop is a price at which farmers are supposed to sell their commodities.

Annual costs involve all costs of production including inputs such as seeds, fertilisers, chemicals, structure materials, irrigation services, and materials for storage structures. It also included labour costs for planting, fertiliser application, pesticides spraying, weeding, watering, treadling, harvesting, threshing, and storing. There were two analyses used in the gross margin calculations; one without labour costs, and another with labour costs. This was so because, it was found out during the study that labour was mainly provided by members of a household. Where labour costs were included, a government daily rate of MK200 per 8-hour day per individual was used.

Capital costs included those costs for equipment, land and water. These included onetime costs for buying land, including fees for rights to water. Other onetime costs included were irrigation equipment costs, labour and material costs for construction of irrigation structures (canals).

Table 4.2: Gross margin template
Source: Kundhlande et al., 2004, but modified to meet local situations.

PARAMETER	UNIT	PATTERN					
		1	2	3	4	5	6
AGRICULTURE TECHNOLOGY							
AVERAGE AREA							
CROP							
AVERAGE GROSS PRODUCTION (YIELD):							
Gross yield @ MK25/kg for maize	MK						
Gross yield @ MK24/kg for sweet potato	MK						
AVERAGE ANNUAL COSTS:							
Preharvest costs:	MK						
Seed costs	MK						
Planting labour costs	MK						
Fertilizer costs:							
23:21:00	MK						
UREA	MK						
CAN	MK						
Fertiliser application labour costs	MK						
Pesticide costs:							
Chemical costs	MK						
Spraying labour costs	MK						
Manual weeding labour costs	MK						
Irrigation costs:							
Watering labour costs	MK						
Treadling labour costs	MK						
Maintenance costs:							
Structure repair labour costs	MK						
Spare parts costs	MK						
Maintenance materials costs	MK						
Harvest/ Post harvest costs:							
Manual harvesting labour costs	MK						
Threshing labour costs	MK						
Parking/ storage labour costs	MK						
Packaging material/ structure costs	MK						
TOTAL ANNUAL COSTS	MK						
GROSS MARGIN ABOVE ANNUAL COSTS:							
When maize sold @MK25/kg	MK						
When sweet potatoes sold @MK24/kg	MK						
CAPITAL COSTS:							
Land (price, rent) costs	MK						
Equipment cost	MK						
Construction of structure labour costs	MK						
Structure materials costs	MK						
Excavation labour costs	MK						
TOTAL CAPITAL COSTS	MK						

4.12 Limitations of the methodology

There were a number of problems encountered during the study, of which some are outlined below:

- As described in section 4.4, the possibility of creating a biased sample was one of the main concerns during the study, as the respondents were chosen by extension workers (government officials in the study area). One way to solve this problem was to interview a large sample. This was the main reason why I decided to interview 200 farmers.

- Many of the respondents thought the study team was a government delegation taking count of who should receive free inputs from government. Unfortunately, phase I data collection was done at a time when government was registering farmers for free input distribution nation-wide. During the early days of data collection, it was difficult to judge whether the respondents were giving genuine answers or not. Fortunately, the study team was always accompanied by a government official working in a particular area. So the study team always cross-checked the facts given by farmers with the government official, although it was not possible always.

- After data analysis of phase I of the study, it was found out that the less popular patterns had too few members to be re-interviewed for phase II. So the study team had to find additional respondents who fulfilled the criteria for that particular pattern. This was not an easy task. It was tedious and time consuming. The situation was different for those popular patterns with enough respondents for phase two. Since their names and locations were captured in phase I, it was just a matter of locating where they were, although a problem arose when a group in phase II was composed of members of different villages or different RDPs. When this situation arose, the selected members from one pattern were grouped according to their locality. So, sometimes a group discussion was only composed of two farmers from the same locality.

- During phase II group discussions, it was noticed that active members always wanted to talk, while non-active members were somewhat shy and therefore could just agree with what other members said. In which case it was difficult to judge how representative the information collected from the farmers was. In order to capture representative views, the facilitating team had to probe non-active members for their input.

- The methodology was based mainly on farmers' answers to questions. As most farmers do not keep records, the answers were purely dependent of the ability of the farmers to remember issues. Many farmers could not remember beyond two or three farming seasons ago, especially where figures were concerned. The government personnel who always accompanied the study team, the Integrated Household Survey of Malawi report, literature from district assemblies, and data from FEWS Malawi, were some of the means through which some of the data were verified. For example, when farmers mentioned that they used sacks or bags as the units of measurement, I needed to cross check if that was true.

- Measurements of areas and yields were a problem. Although farmers were able to mention the standard units for yield used in the area, this was mainly based on their ability to remember. For this reason, where quantities were concerned, I always asked about the previous season, which they could easily remember.

- Area measurement during phase II was tedious, due to the fact that the survey was done during the rainy season, when the wetland farms were covered by bushes. Most field boundaries for previous season were difficult to trace. Where this happened, to avoid errors in area measurements, I tried to carry out field measurements on a different day (not soon after interviewing the farmer, as was the case with fields where measurements were easy to take).

- In some cases, farmers refused to be interviewed. In other cases government officials were unwilling to accompany the study team. Where this happened, the study team offered to pay the government officials for time spent in the field. On the positive note, the interaction between the farmers and the study team was good without any major problems reported.

4.13 Chapter summary

The study was carried out in two phases. Phase I involved farmer interviews. The farmers were selected by government officials in the study area. To avoid bias of the sample, the study team decided to interview a large sample (200 farmers). Analysis of phase I data included cluster identification. From the clusters or groups, a sample of farmers was selected to be re-interviewed for phase II. Seven to ten members of each group were selected. For each group, discussions on phase II questionnaire were done. After the discussions, farmers were interviewed separately. The problems of the methodology include, biased sampling techniques, lack of farmer records, difficulties in accessing farmer fields especially in phase II. In general, farmers and government officials were cooperative during the data collection process. Some of the data was gathered through general observations during the study and some literature gathered from various government departments.

The findings of the study will be made available to the parties concerned. These parties include: farmers, government officials both at ADD and national levels, students at the agricultural colleges of Bunda and Natural Resources, and the general public. One way to communicate the findings with farmers is through agricultural shows that are normally held across ADDs while the general public can access the findings from Bunda College library.

CHAPTER FIVE

RESULTS I: AGRICULTURE TECHNOLOGIES AND SOCIOECONOMIC CHARACTERISTICS OF FARMING SYSTEMS IN THE SHIRE VALLEY WETLANDS

5.1 Chapter overview

This chapter identifies and describes agriculture technologies and socioeconomic characteristics of farming systems in the Shire Valley wetlands. Farming systems refer to wetland farming and small-scale informal irrigation systems. The chapter begins by identifying agriculture technologies currently used by small-scale farmers. Then socioeconomic characteristics of the farming systems are described. Throughout the chapter, it is important to remember that the Shire Valley wetland is a large area characterized by swamps, small streams, and scatters of family farms surrounded by grass. Historically the uplands have been the main agriculture areas. However an increased cultivation of wetlands has been noticed since early to mid 1990s. In the wetlands, farmers are largely subsistent, mainly acting without assistance from government.

5.2 Agriculture technologies in the Shire Valley wetlands

This section describes the agriculture technologies used by small-scale farmers in providing water or moisture to their crops. The description does not include government-run schemes, but only those systems set-up and managed by farmers as described in section 1.6.1. There were five agriculture technologies identified among the respondents (Fig. 5.1). These are: flood recession agriculture (which uses moisture from recessing floods), river diversions (where farmers construct temporary dams across small streams and divert water into earth canals), treadle pumps (where farmers use manual pumping devices to draw water from canals or shallow wells), watering cans (where farmers use cans or buckets to draw water from streams or wells), and motorized pump (where fuel-powered pumps are used to pump water from streams). Of the five agriculture technologies, three (flood recession agriculture, river diversion, and treadle pump) were more common than motorized pump and watering can technologies.

During the survey, many respondents indicated that they preferred technologies where water can flow by gravity or those where little or no running costs are involved. Many respondents also preferred to manage their plots without influence from chiefs or government. It was therefore not surprising to see flood recession agriculture, river diversions, and treadle pumps, as the common agriculture technologies among the respondents. A study carried out in Zambia, by Daka (2006) also found out that low-cost agriculture technologies were common among small-scale farmers for similar reasons.

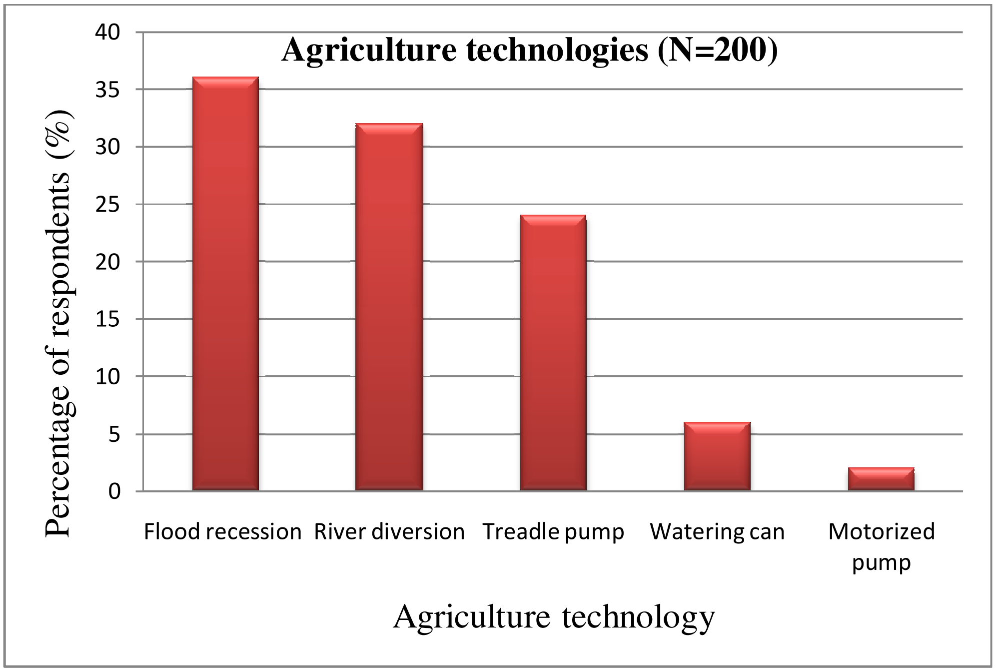


Fig. 5.1: Agriculture technologies used by small-scale farmers in the wetlands of the Shire Valley. Low-cost technologies with little or no running costs were common among respondents. Motorized pump technology (presumably with high running costs) were no longer in use during the survey.

5.2.1 Flood recession agriculture

Flood recession agriculture technology involves the use of the moisture that remains as the seasonal flood water disappears. When floods rescind at the start of the dry season, they leave behind enough moisture and at a high enough level, to grow crops in wetland areas. Crops are planted immediately after the floods disappear. As different land altitudes have different times for floods to disappear, crops under this method mature at different times corresponding to the period when the floods disappeared. Respondents indicated that in many cases, crops mature before the soils are completely depleted of moisture. To maximize moisture use, farmers under this method start the growing season as soon as the rainy season ends. In the Shire Valley, flood recession agriculture mainly depends on the seasonal flooding of the Shire. Floods in the Shire Valley do not only depend on the amount of rainfall received in the Valley. They mainly depend on the rainfall received in the catchment area of Lake Malawi, which is the source of Shire River. This explains why the Shire Valley may still experience floods even during erratic rainfall conditions within the Valley. Availability of water makes the Shire Valley wetland one of the important agricultural areas in Malawi. During the study, there was no indication of the technology being promoted by government or NGOs.

As explained by government officials, one of the problems with flood recession agriculture is the fact that farmers follow the moisture as it recesses all the way to the stream banks. In so doing, areas around stream banks get cultivated, thereby encouraging erosion of silt into the Shire River. So far, there is no documented evidence of siltation encouraged by stream bank cultivation in the Shire Valley. However, a study conducted along Amazon River wetlands by Mertes et al. (1993) indicated that swamps and levees along rivers influence the rates of sediment transfer between main channel and the flood plain areas; thus sediment concentration rates decrease with distance away from the main channel, suggesting that clearing river banks may increase the volume and spread of sediments across the flood plain areas.

Fig. 5.2: Crops growing under flood recession agriculture. Crops are planted as moisture recesses, therefore creating different crop heights. In the picture, crops towards the bottom of the picture were planted earlier than those near the top. Land is sloping towards the top.

5.2.2 River diversion technology

River diversion methods involve changing the direction of small rivers or streams through the use of simple earthen water-control structures. These are often temporary dams are constructed across small rivers or streams to redirect the flow into agricultural fields (Fig. 5.3). During the rainy season, farmers divert their attention to upland agriculture, and the dams may wash away by fast moving river flows. New temporary structures will be built during the next wetland farming season in the next dry season. Main canals, which are unlined and thus also merely built out of soil, carry water from the control structure to the agricultural fields by gravity. The main canal may further divide into furrows which feed into the farmers' fields. The diverted streams may originate from an underground source, small stream, or tributaries of Shire River, and may be perennial or seasonal.

Main canal construction usually involves groups from a village or more, since the canal may pass through fields belonging to individuals from different villages. Village committees are usually set up to oversee the construction and management of the canal which includes water distribution. Although the Malawi law requires that an individual or a group of individual must have abstraction rights before diverting a stream, none of the respondents had such rights. Some respondents indicated that they were not aware of the existence of the law, while some indicated that as long as chiefs are involved in the construction of the canal then they considered the law is observed. For the study, this was an indication that water abstraction rights are visible on paper but do not get enforced at farmer level. Although the construction of the main canal may involve group efforts, the management of farmer plots is mostly individual. Each farmer or household manages their plot independent of the other. The study found out that only those farmers or households that participated in the construction of the main canal are eligible to use water from the canal. During the study, it was observed that there was no monitoring as to how much water each farmer may divert from the main canal. Chiefs reported that sometimes they receive complaints of inadequate water supply downstream some streams, although these complaints were not common. Some river diversion technology sites were receiving technical support from government or NGOs on how to lay field furrows. Unfortunately the study could not establish the total number of users under each river diversion technology.

Fig. 5.3: A temporary dam formed by blocking a small stream. A diversion canal can be seen at the bottom right of the picture. The structure may wash away in the next rainy season.

5.2.3 Treadle pump technology

As discussed earlier in section 3.5, treadle pumps are manual devices used to pump water from its source onto the fields. Under this technology water sources can be stagnant pools, excavated canals or ditches, shallow wells, and shallow streams. Water is pumped from the source by use of suction hose and delivery hose (Fig. 5.4). The energy required to lift water is provided by people through 'pedalling': i.e., pushing up and down on two pedals which provide suction and thus lift the water. Water is then distributed in the field by a network of field canals or furrows.

During the study, it was noticed that treadle pump technology was being promoted by government and NGOs. Respondents indicated that most of the treadle pumps in use were distributed by government and NGOs for free.

The scarcity and high costs of spare parts were some of the problems mentioned during the survey to be associated with treadle pumps. To reduce the scarcity of the treadle pumps, government introduced a nation-wide programme where local entrepreneurs are trained on how to fabricate the pumps. Government officials believed when fabricated locally, the treadle pumps may be affordable to farmers. However many farmers still indicated non-affordability as one of the major problems to the technology.

Fig. 5.4: Farmers using a treadle pump to pump water from a ditch into a maize field. This ditch has been excavated manually to divert water from Shire River into a cluster of farmer fields.

5.2.4 Watering can technology

Under watering can technology, farmers use cans to scoop water from shallow sources and apply it directly to their crops, usually vegetables (Fig. 5.5). This method was popular among women as compared to men. The cans, usually holding 5 to 10 litres, were fitted with tiny nozzles to provide a sprinkling action on crops. Respondents indicated that the containers were locally sourced and affordable. Respondents mentioned that the watering process of this method is tedious as it involves lifting the containers.

Fig. 5.5: Watering can technology showing a farmer drawing water from a hand-dug shallow well. These wells are usually not more than 2 m deep, dug inside the field. One field may have one or more wells in it.

5.2.5 Motorized pump technology

The motorized pump technologies were no longer in use at the time of the survey. The respondents and key informants indicated that the motorized pumps were a donation from government to farmers. The pumps reportedly, operated for only about two farming seasons. Information from Department of Irrigation indicated that the motorized pump programme had failed not only in the Shire Valley, but also in many wetlands across Malawi. Information from farmers and key informants indicate that the main reason for the failure was the inability of farmers to meet the running costs of the pumps, which included fuel and sourcing of spare parts. Note that most of the pumps were distributed between 1992 and 1994. During this period Malawi underwent political and economical reforms (Chirwa, 2004), as discussed in section 3.8. These reforms led to increased costs of many commodities including fuel. Under difficult financial conditions many farmers were unable to sustain the pumps. As most of these farmers operate at subsistence level, they are often too poor to meet their own daily needs. Farmers operating under these circumstances, often find it difficult to meet running costs for technologies (Senay and Verdin, 2004), especially where programmes appear to be imposed.

The other problem with motorized pump technologies was the fact that the government required farmers to be in groups. Pumps were supposed to be donated to these groups. This means that individual farmers had to team up and create a group. This task was not easy as many farmers were not ready to let their plots belong to a group. Many farmers viewed this as a way of giving up their land ownership. So the system mainly worked on land given by chiefs, and farmers had to be identified within a village to share the plots within the land given by the chief. Bureaucracy was always a problem in identifying members of a village to own plots in the land given by the chief. The study found out that government of Malawi is no long promoting the technology.

5.3 Period of use of the current plot

The study wanted to document how long the respondent had been farming on the current plot. Many farmers could not remember how long they had been using the plot. Most of the farmers gave estimates of the number of years on the plot. Since the dates were not precise, the responses were coded as estimates. The figures, ten and fifteen, were common among the estimates given by the respondents. Although they could not remember precisely when they started using the plots, many farmers could certainly remember if they used the plots for less than ten years, or between ten and fifteen years, or for more than fifteen years. Therefore these responses were used as codes for the analysis.

Those that used the plots for less than 10 years were grouped in one category. Those that used the plots between 10 and 15 years were grouped in another category. And those that used the plots more than 15 years were grouped in the third category. Using these categories, about 54% of the respondents fell under less than 10 years category, while 20% of the respondents fell under 10 to 15 years category, and 26% of the respondents were under the third category of more than 15 years (Fig. 5.6). This information was only for the plot where the interview was taking place. The respondents may have other plots within the wetlands, where period on plot could be different. Even though this was the case, it was still possible to note that the majority of the farmers (74%) had been on their current plots for less than 15 years ago; and that 26% of the respondents had been on their current plots for more than 15 years.

The question did not document if the respondent used the same technology during the entire period on the plot. For this reason, it was therefore difficult to see how the agriculture technologies have grown in use over the years.

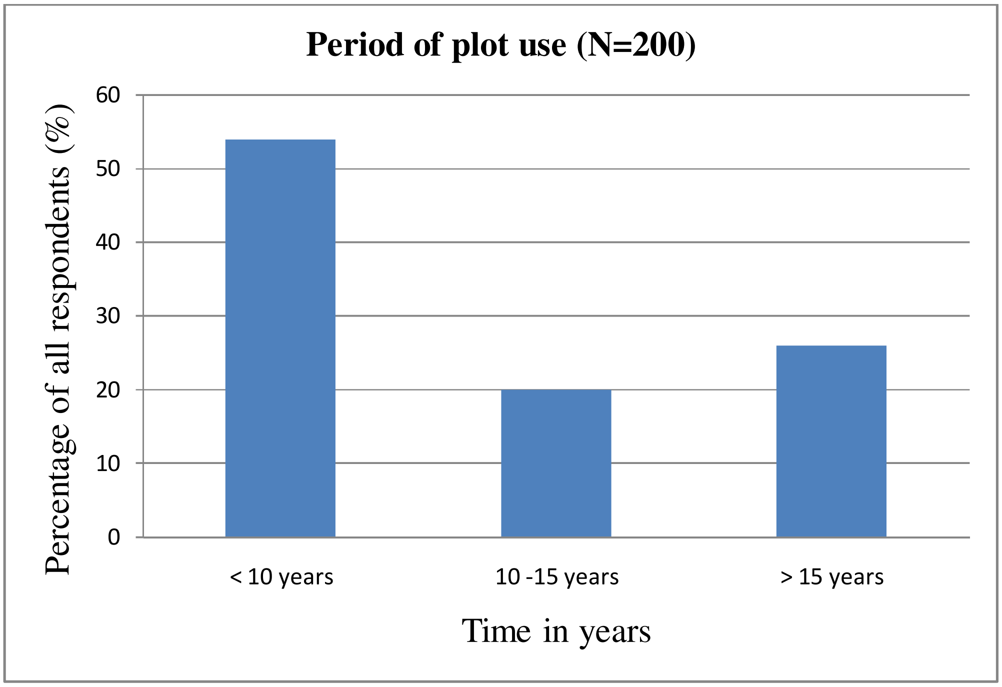


Fig. 5.6: Period on current plot. This shows how long the respondents had been cultivating on current plot.

5.4 Start of farming or irrigation season

The study documented the months for which the farming or irrigation season starts in the wetlands. The farming or irrigation refers to the growing season, which starts with land preparation and planting. So, respondents were asked about when they normally start the farming season. Fig. 5.7 shows the results. Some respondents indicated that they normally start farming or irrigation season in the wetlands immediately, after the rainy season. During short rainy seasons, farming or irrigation in wetlands may start as early as January. About one-quarter of the respondents have started the farming or irrigation season by March (Fig. 5.7), as this normally marks the end of the rainy season and wetlands are accessible enough to start farming. About three-quarters of the respondents will have started the farming or irrigation season by May (Fig. 5.7).

From the responses it can be seen that generally, farming activities start as early as January (Fig. 5.8), and continue to rise to about May, when about 75% of the respondents will have started wetland farming. After April, the number of farmers starting wetland farming reduces. After August, very few of the respondents start farming. Those farmers that start farming after August are normally growing a second or third crop in the season. The study found out that, many farmers do not grow a third crop either because they fear their crops would be destroyed by floods during the rainy season which starts in October or November, or their lands will have run out of moisture by this period. May be that is why none of the respondents were recorded to start the farming season in September. However, a little less than 2% of the respondents showed to have started a farming season in October or November. My opinion is that, these are the farmers who cultivate on river banks where moisture may still be available after September, although their crops may be at risk of being flooded during the next rainy season. Some respondent indicated that during delayed rainy seasons, the farmers who start growing crops in October or November may have their crop reach maturity without any danger of being flooded.

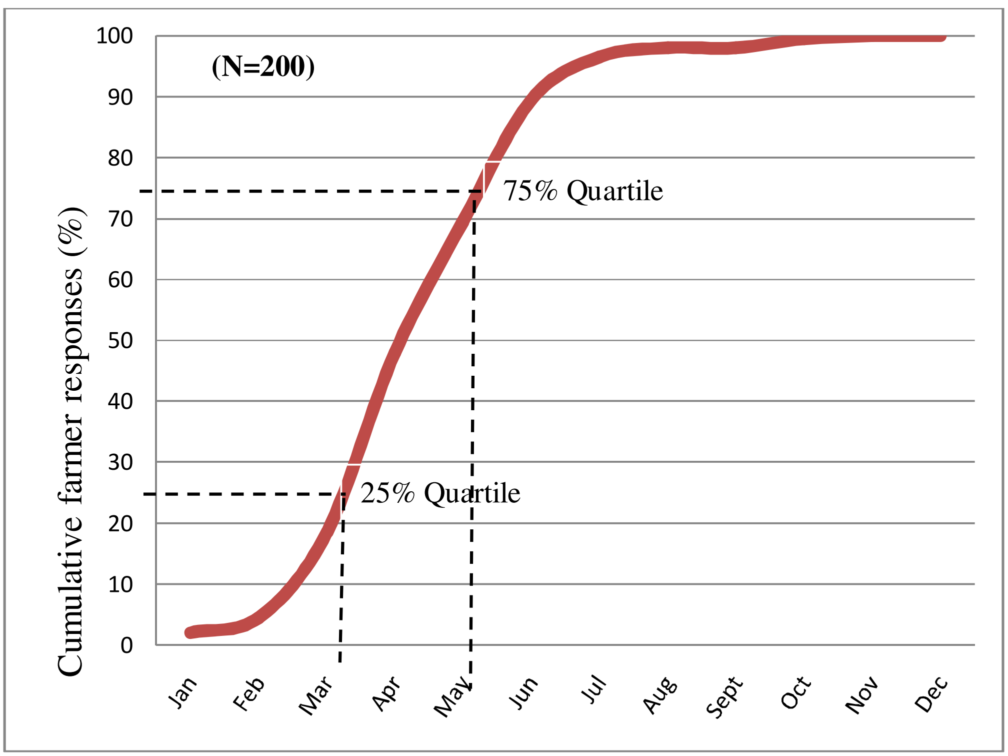


Fig. 5.7: Farmer cumulative responses for the start of farming or irrigation season in wetlands

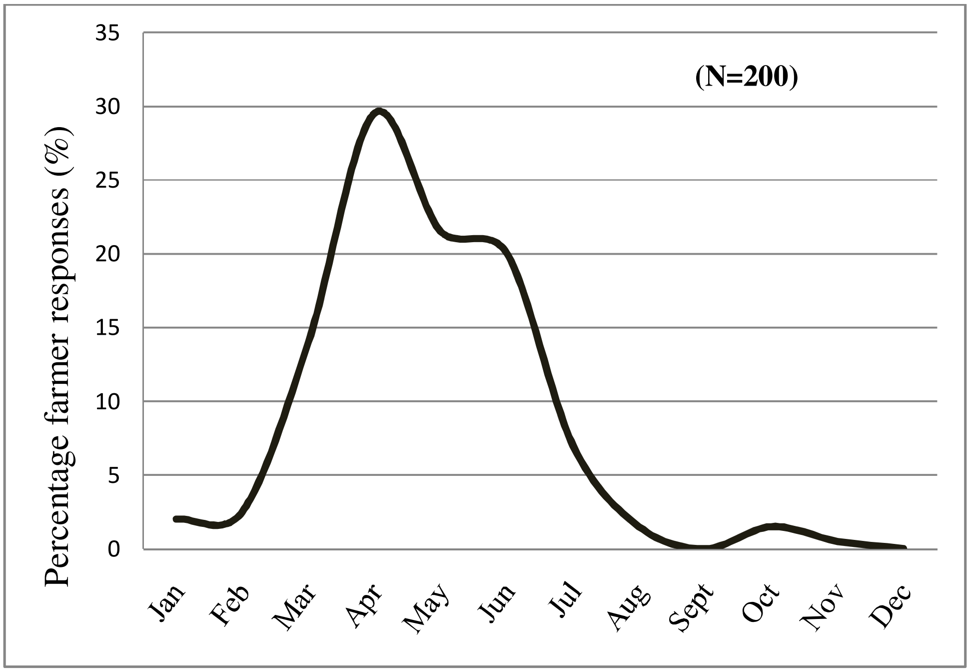


Fig. 5.8: Distribution of farmer responses on the start of farming or irrigation season in wetlands

5.5 Farming practices

The study documented general practices of farming in the wetlands. This section outlines some of those practices.

5.5.1 Individual / group farming practice

One of the farming practices of interest is whether farmers belong to a group or farm as individuals. A group could be a club or an association formed by farmers for specific interests, either to access government loans or other. The study found out that about 90% of the farmers do not belong to any farming group (Fig. 5.9). This was so because many farmers feared that if they belonged to a group then they would lose their rights to their piece of land. This was a common feeling across the valley. However, it was noticed that farmers who practice river diversion technologies were more likely to belong to a group than the other technologies. This is so because river diversion technologies sometimes require group efforts to excavate diversion canals. In most cases, a group is set up to manage the main canal only, and field plots are left to be managed by individual farmers.

Where the diverted stream may pass through a village, farmers seek the permission from the village chief, who authorizes the diversion. Farmers without a shared water source, for example, those that dig shallow wells within their plots, prefer to manage their plots individually.

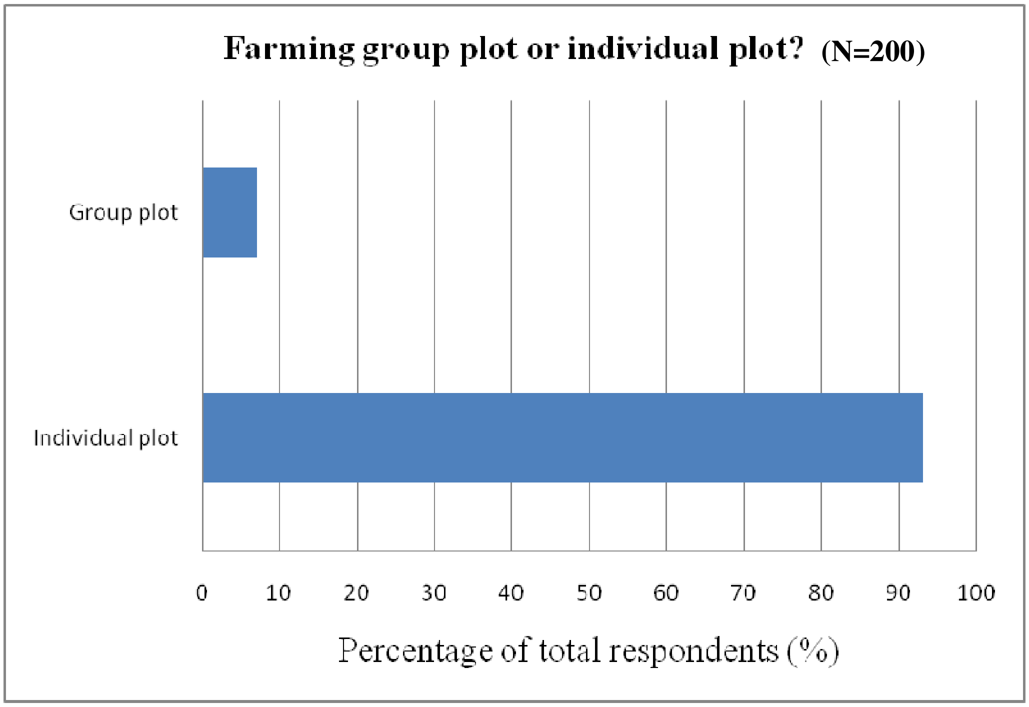


Fig. 5.9: Respondents with individual or group farms. Respondents' farms could either belong to a farming group where a committee oversees the management of the plots, or individually managed where a farmer makes his/her own decisions.

5.5.2 Multiple plots in wetlands

Another significant farming practice was farmers having more than one plot in the wetlands. More than two-thirds of the farmers admitted to have more than one plot in the wetlands (Fig. 5.10). The study found out that the main reason for this practice is the maximization on the availability of moisture. It is important to note that farmers follow moisture levels which vary with time and their proximity to the Shire River. At the end of the rainy season, areas near the river banks keep moisture (or remain saturated) for longer periods than those areas away from the banks. This means farming strategically starts in unsaturated areas (those areas away from the river banks), and finishes in areas near the river banks. To ensure increased food security, farmers acquire plots at different areas with different moisture levels. Although many respondents revealed to have other plots in the wetlands, mostly they were uncomfortable to mention their total number of plots. It was later found out from the key informants that, respondents did not reveal their real number of plots for fear of being skipped on Targeted Input Program (TIP). TIP is a government program that distributes free inputs. The program targets poor farmers. Those with many plots have large harvests, and therefore regarded as being not poor. Although this was the case, the fundamental finding is the fact that many respondents have multiple plots within the wetlands.

The study did not find out how many plots the farmers owned, and whether they used the same agriculture technology on their other plots. I felt that probing the farmer about the other plots would make the respondent uncomfortable, and eventually abandon the rest of the interview. I therefore decided to concentrate on current plot as much as possible.

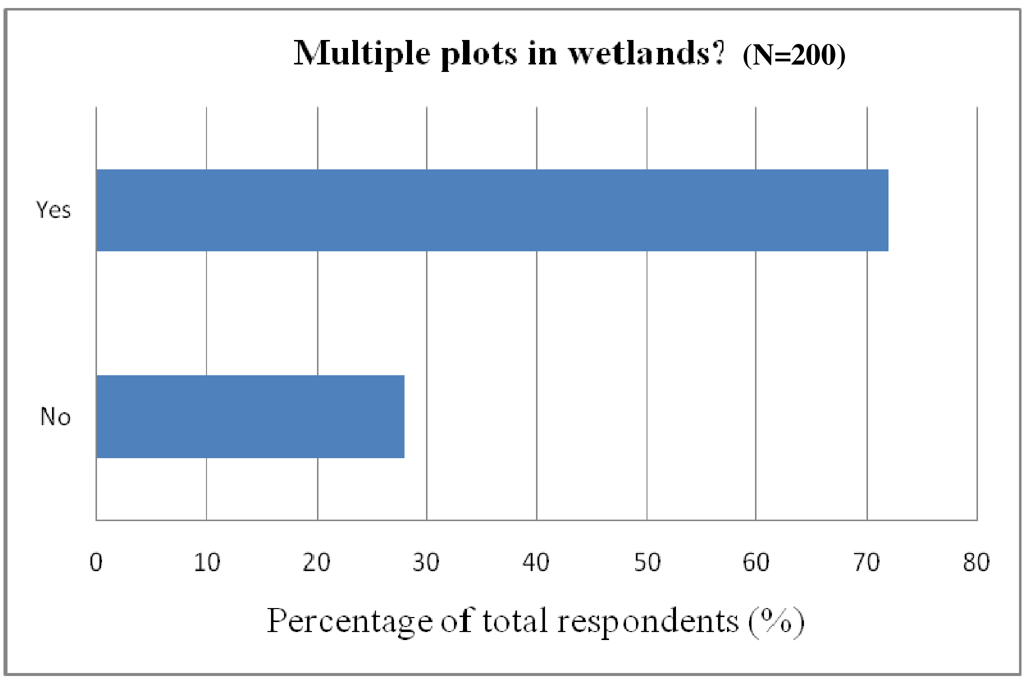


Fig. 5.10: Respondents having multiple plots elsewhere within the wetlands. Those that said 'no' had a single plot in wetlands, while those that said 'yes' more than one plot in the wetlands.

5.5.3 Uplands and wetlands plot ownership

As uplands have been the main agriculture area historically, the study wanted to find out if those farmers who have moved to wetlands still own and utilize their upland plots. And also document the reason for keeping plots in both uplands and wetlands. The results show that about 84% of the respondents own plots in both uplands and wetlands (Fig. 5.11). Essentially the uplands and wetlands are owned by the same people. The study found out that this practice is mainly a food security issue. Since food productions from the two zones come at different times, farmers do not only want an increase but a distribution that can last and spread over most of the year. It was also found out that two extreme weather conditions exist in the Shire Valley: droughts in the uplands, and flooding in the wetlands. As a precaution, many respondents indicated to prefer growing crops in both uplands and wetlands. So, if crop failure occurs in one zone, they may have food from the other zone.

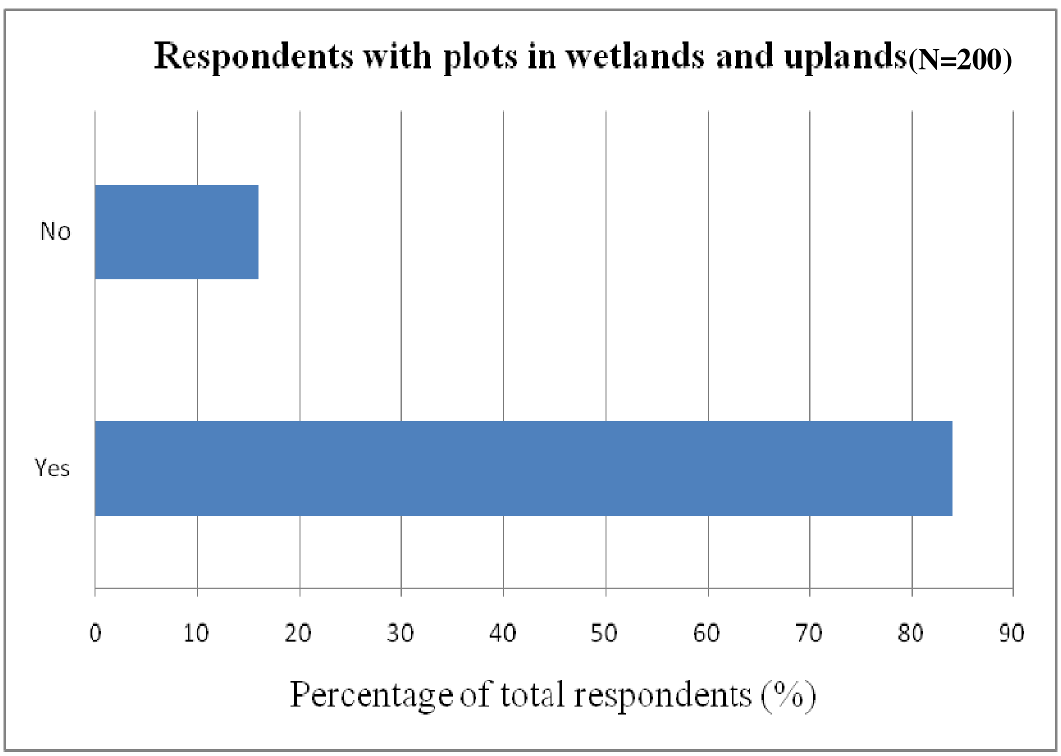


Fig. 5.11: Respondents with plots in both wetlands and uplands. Those that said 'no' had plots in wetlands only, while those that said 'yes' had plots in both wetlands and uplands.

5.6 Land resource issues

Land and water are two most important resources that make irrigation possible. The study explored how these two resources integrate into the farming systems in the wetlands of the Shire Valley.

5.6.1 Plot size distribution in wetlands

The study documented the typical land sizes of farming systems in the wetlands.
The findings in this study showed that about 90% of the respondents registered plot sizes below 1 ha, and about 75% of the respondents have plot sizes below 0.5 ha (Fig. 5.12). Many respondents mentioned that small plot sizes are easy to manage, in terms of meeting input costs, as opposed to large plots. Since farmers own multiple plots within the wetlands, presumably, farmers keep the plots small enough to be able to manage them. Perhaps the cost of inputs is also a factor in deciding how big plot sizes should be. Many farmers are merely subsistent, and cannot afford inputs for large plots. It therefore makes sense to keep the plots small.

Literature shows that, plot sizes for farmer-managed subsistence farming in sub-Sahara Africa, typically vary between 0.1 to 1 ha (Shah et al., 2002), and (Mangisoni, 2008). Subsistence farming is characterized by small farms (Senay and Verdin, 2004), because farmers generally perceive small farms to be more efficient than large farms (Parikh et al., 1995). Thus, small farms can benefit the farmer if managed properly (Fraenkel, 1986). The farming systems described here refer to general small-scale farming systems, not necessary wetland farming systems. However, the findings show that the farm plots in the Shire Valley wetland are similar in sizes to those described by Shah et al. (2002) and Mangisoni (2008).

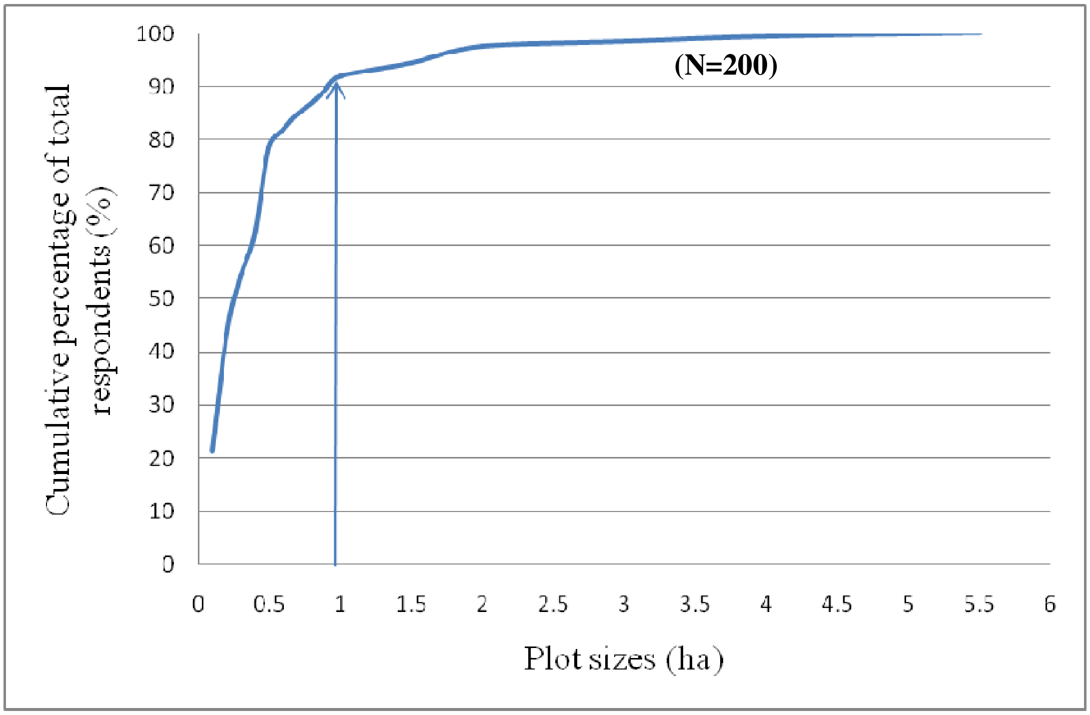


Fig. 5.12: Cumulative distribution of plot sizes

5.6.2 Household family sizes

The Sena and Mang'anja people in the Shire Valley have extended family systems. During the study, some respondents reported to have some orphans as part of their family. These orphans were often children of relatives who had died of HIV/AIDS. Thus a household family may consist of both immediate and extended members of the family.

The study found out that the mean household family size was 6 persons per household, with a standard deviation of 2.7. Three-quarters of the respondents have family sizes of 7 persons and below (Fig. 5.13), with a normal distribution about the mean (Fig. 5.14).

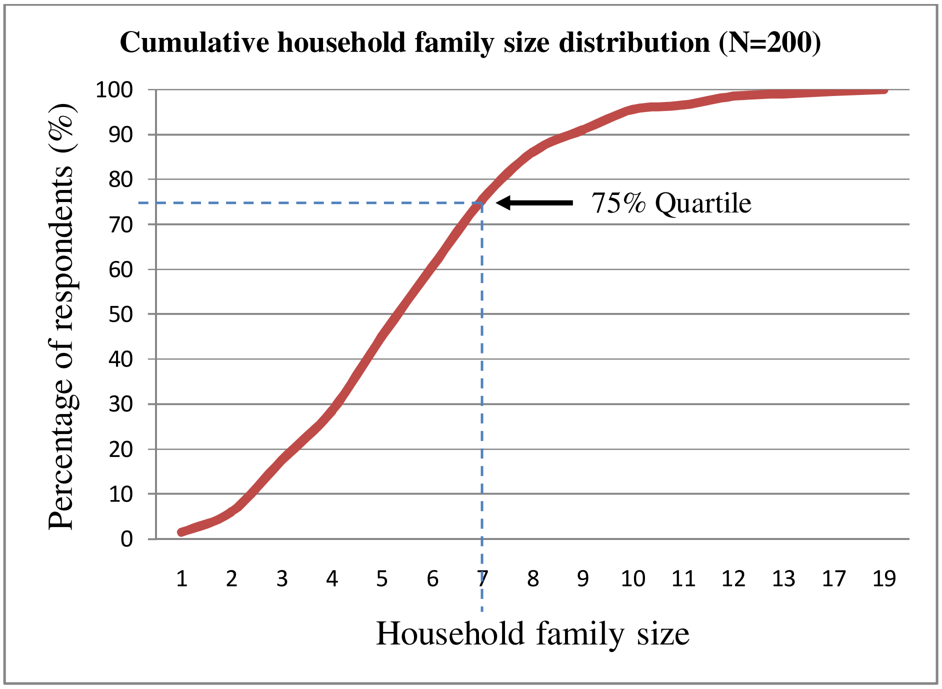


Fig. 5.13: Cumulative distribution of household family sizes

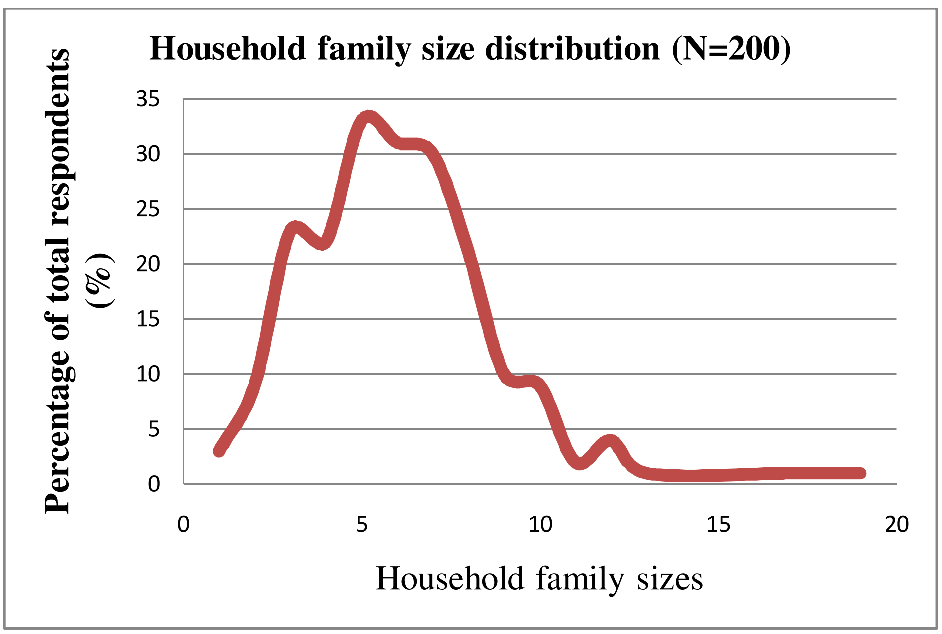


Fig. 5.14: Distribution of household family sizes

5.6.3 Plot sizes as related to household family sizes

As some respondents reported to have extended family members as part of their household, I wanted to find out if some relationship exists between household family sizes and plot sizes. Plotting family sizes against plot sizes, it was evident that some relationship exists (Fig. 5.15). Generally, Fig. 5.15 shows that as households increase in size, plot sizes are likely to increase. The relationship can be explained as:

- In extended family cultures, those that have large plots were likely to extend support to other members of their clan, in so doing, increasing their family sizes.
- Large families had enough labour to manage large plots.
- Large families needed large plots to meet the food requirements of the families.

Although it was not clear which variable influences the other, the fundamental finding is that large families had large plots, and small families had small plots. Plotted on log-log scale, (family sizes as the independent variable, and plot sizes as the dependent variable), the relationship follows the form: $y = 0.006x^{2.181}$, with a correlation factor, $R^2 = 0.941$.

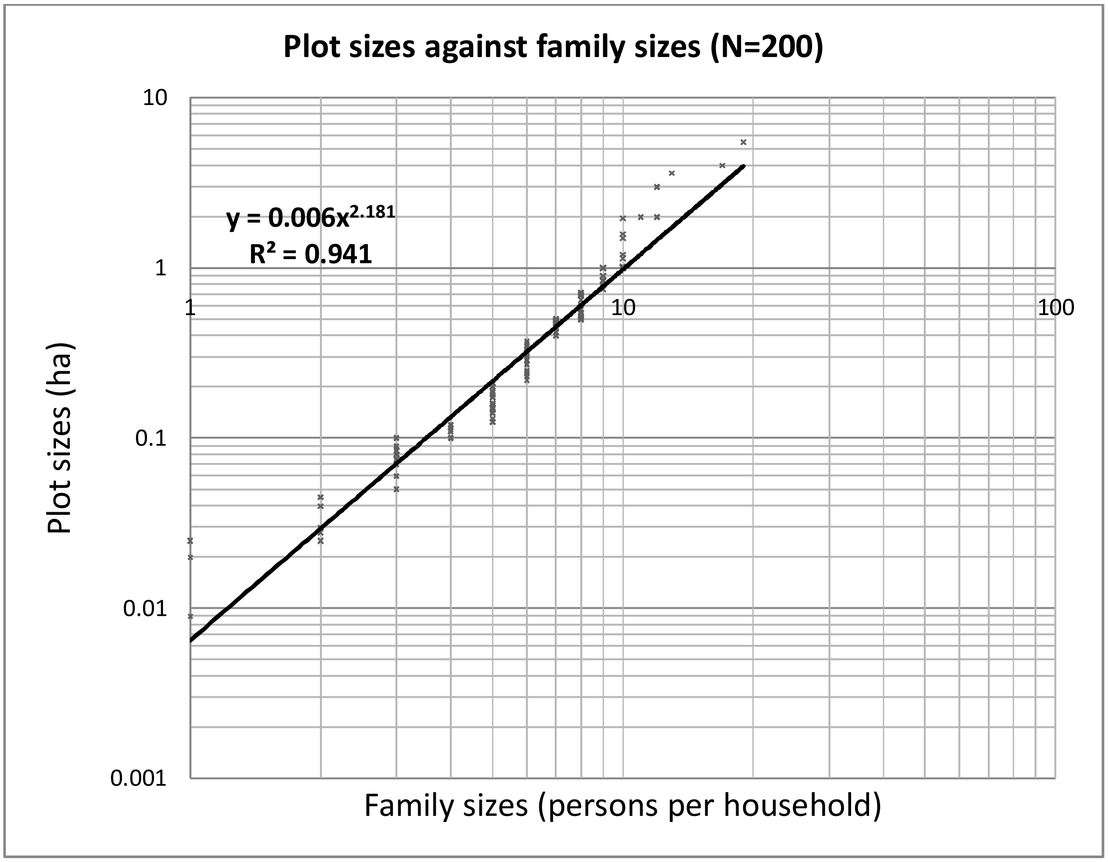


Fig. 5.15: Plot sizes versus household family sizes

5.6.4 Plot acquisition modes

Plot acquisition refers to the way in which farmers acquire their land. There were six ways in which respondents acquired their land. These ways are:

- Inherited (from parents), where plots were passed from parents to children. Historically, these plots may have been distributed by chiefs to his subjects. Once distributed, the land becomes the permanent property of the family and will only be passed on within family members.

- Rented (from someone else), where a family member may temporarily rent out land to other farmers. The temporary owner may pay back the original owner in cash or by giving part of the harvest. When part of the harvest is used to pay back, farmers call this system *ntchoche*. This type of land is also mostly inherited.

- Borrowed (from chief), where a farmer may ask a chief for some piece of land in exchange for part of the harvest. This is also called *ntchoche*. This type of land is mostly under the control of the chief. Borrowing may be for one growing season or more.

- Bought (from someone else), where individuals may decide to permanently sell their land to other farmers.

- Borrowed (from someone else). This is similar to land borrowed (from chief) except that individuals borrow from each other without involving the chief.

- Bought (from chief), where a chief may decide to permanently sell some of the land under his control. Under this case, money is usually involved.

Overall, more than 50% of all the respondents acquired their land through inheritance from their parents (Fig. 5.16). As explained earlier, land acquired in this manner is customary, passed on from generation to generation. Fig. 5.16 also shows that less than one-quarter of the respondents acquired their land through chiefs. It was learnt during the survey that, chiefs only allocate land which has never been allocated before. Once land is allocated a household, it will belong to that household for generations to come, and chiefs no longer have control over it. If a member of a household dies, the surviving members of the family decide what to do with his or her land. The decisions may include selling the land without notifying the chiefs, without taking any offence. The findings show that, most of the customary land is under the control of individuals, not chiefs (Traditional Authorities) as described in the new Malawi Land policy, GoM (2002h), in the two extracts given below:

Communal land rights in Malawi are closely connected to ethnic identity and Traditional Authorities (TA's). This creates a powerful system of land allocation regimes and a tenure system designed to preserve the asset base of the community for current and future *generations. People traditionally see land and kinship in a genealogical map through which access to land is reached. Families and individuals are allocated exclusive fee simple usufruct in perpetuity, subject only to effective utilization. However, the radical ownership remains in the Traditional Authority.*

Customary law restricts customary allocations to usufructuary rights because, in principle, customary title is vested in traditional leaders on behalf of the people. Total alienation of any of this land, such as by granting freehold title to non-citizens, diminishes the land assets of the community specifically affected, and by extension the nation as a whole.

Elsewhere in Malawi, at Lake Chilwa basin (another wetland in Malawi), Ferguson and Mulwafu (2004) also found out that most of the customary land was under the control of individuals. Therefore the role of chiefs over land as defined in the new Land Policy is worth revisiting. In my own opinion I believe that this is one of the reasons for failures of some of the irrigation development projects. Policy makers tend to design these projects while assuming chiefs as controllers of land. Fig. 5.16 further shows that the practise of selling or renting out land, by chiefs or individuals, definitely exists in the Shire Valley. Once individuals buy land, it becomes privately owned under traditional rules, even though the new land owner may not have legal title to support his possession. In summary, chiefs are not the main custodian of wetlands. In fact their control seems to diminish once land is passed on to someone either through selling or for free.

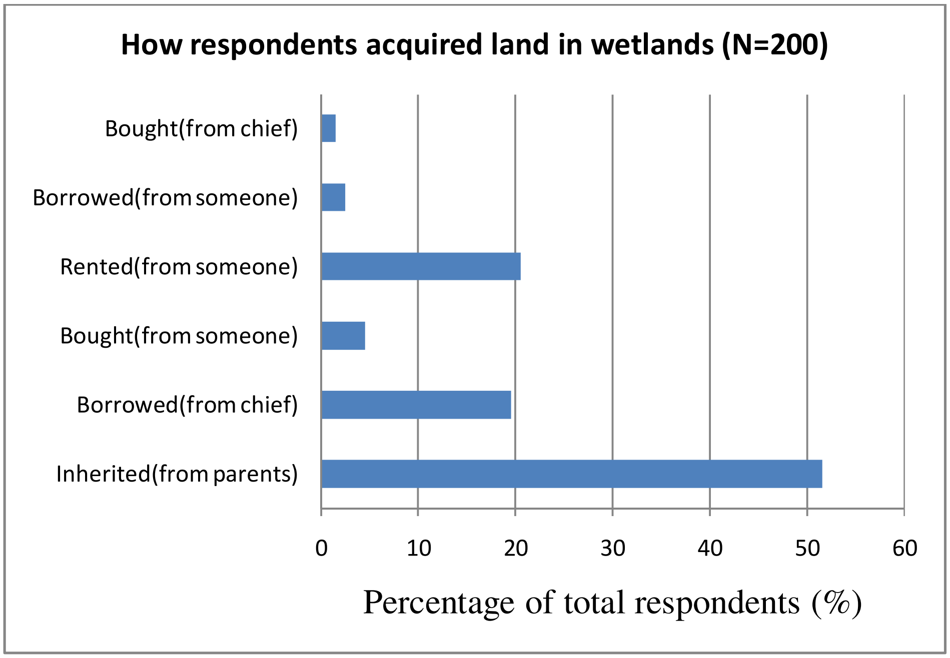


Fig. 5.16: Land acquisition modes

5.6.5 Gender of respondents

About 60% of respondents were male, and the rest were female (Fig. 5. 17). The study tried to find out why there were more male than female farmers. Although there was a possibility that the sample was biased (discussed in section 4.12), men are generally expected to be bread winners in the study area (as described in section 1.8). Since farming is the main source of income (as describe later in section 5.8.2), it was therefore not surprising to see more male than female farmers. The other reason (also related to the description in section 1.8), land ownership is mainly passed from father to son. Under this tradition, it is likely that there would be more male than female farmers. The reader should remember that the respondents were those with ownership rights under traditional rules.

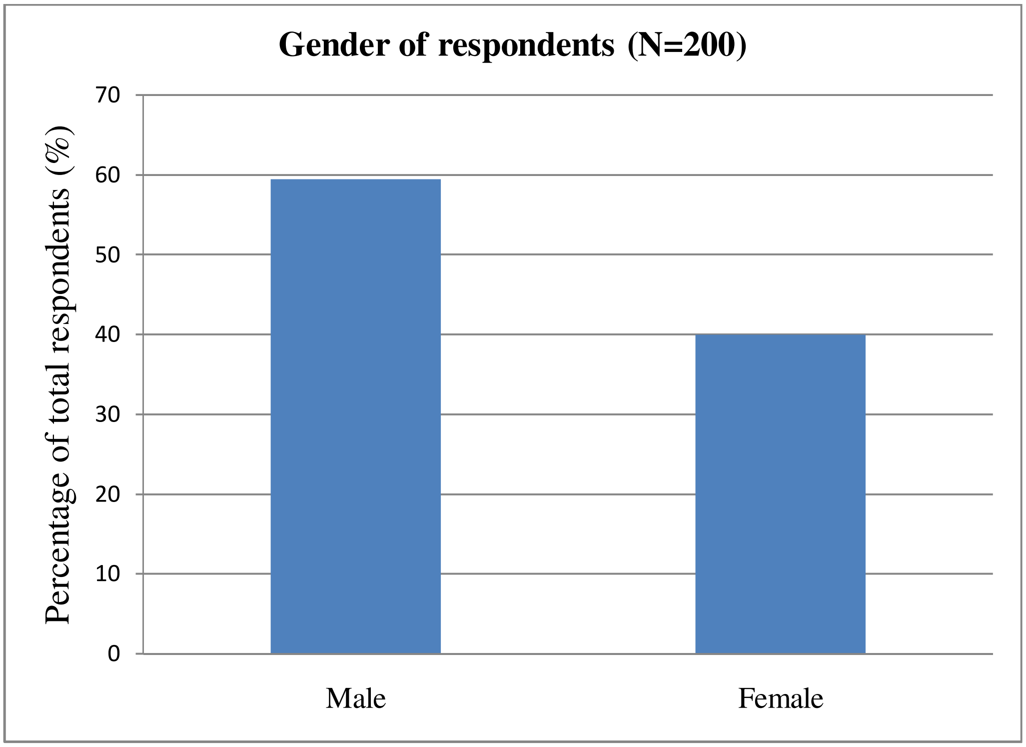


Fig. 5.17: Gender of respondents

5.7 Water resource issues

Although some issues concerning water have already been described indirectly, the study also documented the characteristics below.

5.7.1 Sources of water or moisture

There were many more farmers using surface water sources than underground sources (Fig. 5.18). Swamps, which include stagnant water pools filled by floods in rainy season, contributes more than 60% of the water sources. Small diversion canals may be used to direct the water from these stagnant pools to farmers' fields. Sometimes treadle pumps are used to pump direct from the pools. Farmers may also grow crops around the pools where residual moisture is available. The study found out that the use of underground ground sources (shallow wells) was not very common (less than 15% of the respondents). This was probably because surface water sources were generally available. More than 90% of the respondents thought that their water sources were reliable enough to sustain crop growth in a season (Fig. 5.19). It was found out that none of the respondents had rights to the use of water, although the Water Policy calls for all wetland users to have legal rights. None of the respondents seemed to know that it was required in the Water Policy for all wetland water users to have legal rights.

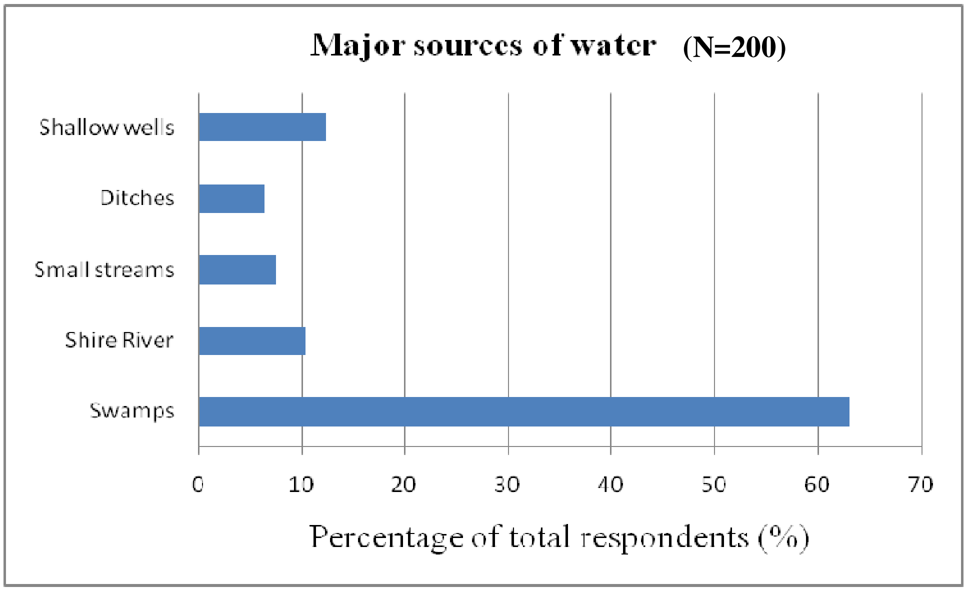


Fig. 5.18: Major sources of water or moisture

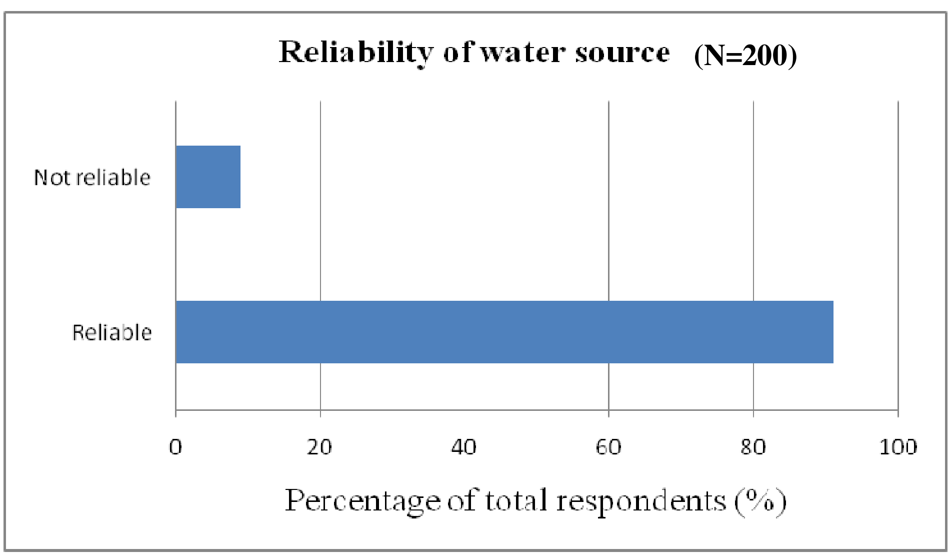


Fig. 5.19: Reliability of water sources. Reliability refers to whether the water sources were able to sustain crop grow in a season

5.8 Crop, income, and education issues

This section covers discussions on crop, income, and education issues.

5.8.1 Common crops grown by respondents

This section required respondents to mention their main crop. Almost all respondents mentioned the current crop, where the interview took place, as their main crop. Since the respondents were arranged by ADD officials, perhaps farmers were alerted to be in their main fields in readiness for the interviews. In my opinion, I think respondents did not want to mention other crops grown on their other plots, probably because they didn't want to show their crop diversity. Farmers who grow different crops may not be classified as poor; as such they could not qualify for free inputs. Using the information about the current plots, maize and sweet potatoes were found to be the most common crops grown by the respondents (Fig. 5.20). More than 60% of the respondents grew maize while nearly one-third grew sweet potatoes. Generally, as a staple food, maize is the commonest crop not only in the study area but Malawi as a whole. Dorward (2006) documented that maize accounts for more than 70% of cultivated area in Malawi. In the study area, sweet potatoes were second to maize. It was noticed during the study that sweet potatoes were particularly grown by women. The study did not find the real reason for this practice, except for the fact that women have been the main growers of sweet potatoes for generations. So, this could just be one of those practices passed on from generation to generation.

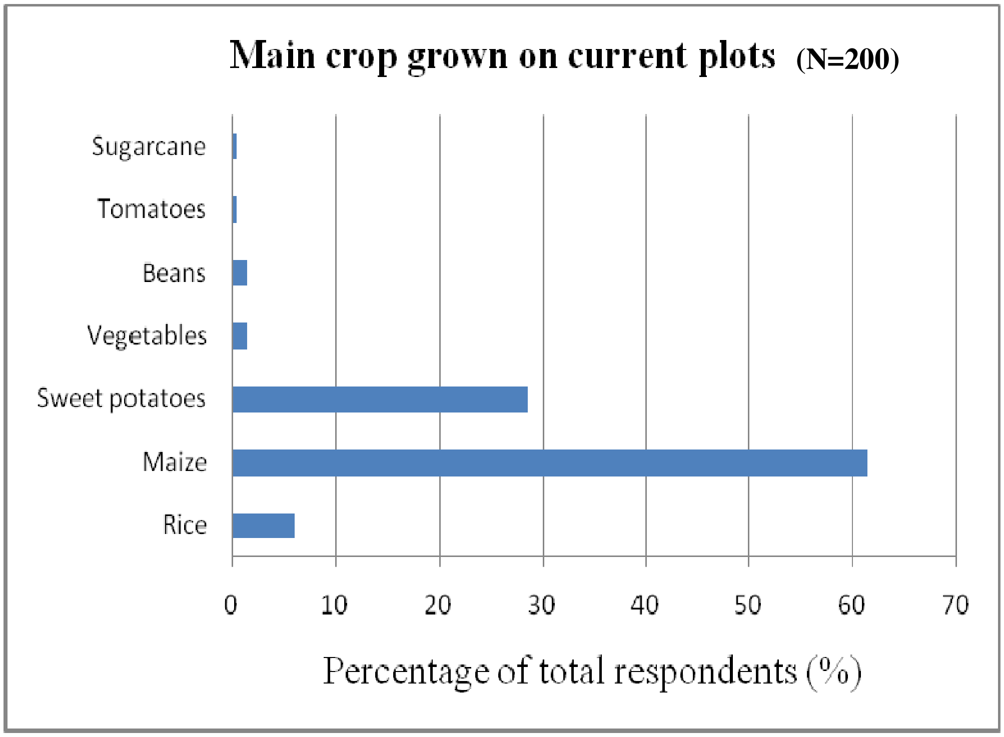


Fig. 5.20: Main crops grown by the respondents on current plot. The figure shows the percentage of respondents who grow the named crop as their main crop

5.8.2 Major income source of the respondents

Over 85% of the respondents relied on farming as their major source of income (Fig. 5.21). This was not surprising; as discussed earlier in the chapter overview that these are largely subsistence farmers. Although farming was their main income source; most of them do not get the income they require. The crops they produce are mainly for consumption. Other sources of income mentioned by the respondents included fishing.

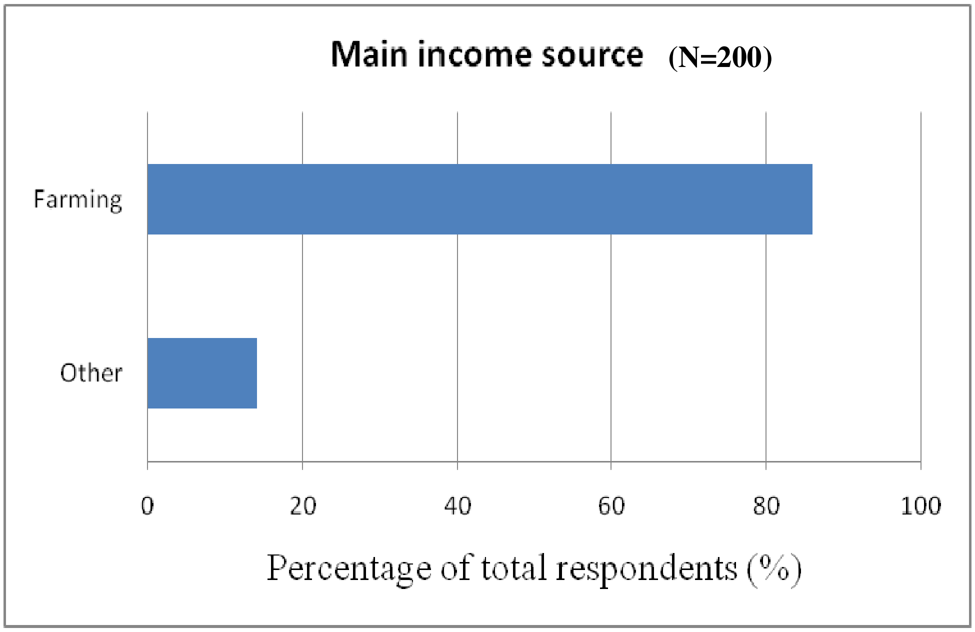


Fig. 5.21: The percentage of respondents who consider farming as their major source of income

5.8.3 Education level of respondents

There were three main levels of education captured during the study (no education (never educated), primary education, and secondary education). About one-third of the respondents never had any education (Fig. 5.22). Slightly more than half of the respondents were educated to primary level. Those educated to secondary level were just over 10%. None of the respondents were educated beyond secondary level. The findings mean that the majority of the respondents (two-thirds) were able to read and write. The majority of the respondents can therefore read extension messages or any other agriculture messages, written in local language.

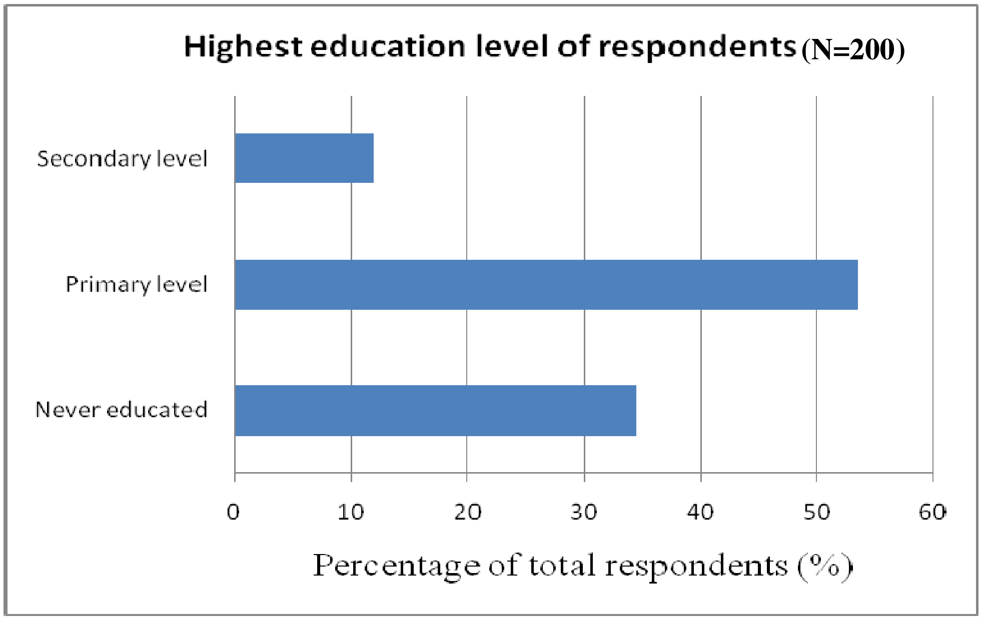


Fig. 5.22: Education level of respondents

5.9 General discussions and other observations

The discussions in this section mostly cover issues which were observed during the survey period. Some interpretations refer to the results in order to give the reader a full understanding.

5.9.1 Land resources management

Although households had no documented legal rights to their land, it was generally understood within the local context that land that belongs to households remains their property for ever. Households may pass on this type of land to their children for generations. Chiefs do not interfere with management of land which is under the control of households. Open land spaces that do not belong to any household usually fall under the control of chiefs. It is this land that chiefs may share to other members of the villages on permanent or temporary basis depending purely on chief's jurisdiction. This means that those that claim permanent ownership to land may have acquired it from either a chief or their parents. I noticed that in any one village, members of the village had more land area collectively, than their chief. In which case members of any village, not chiefs, decide most land management issues which include, irrigation methods, crop type, etc.

5.9.2 Water or moisture management

In order to use water efficiently, three main questions may be answered: how much water to apply, how to apply, and when to apply. For how much water to apply, farmers in the Shire Valley do not really have techniques of measuring the amount of water their crops need at any particular time. They usually rely on physical appearance and feel of the soil, where they judge whether the soil needs more water or not. With experience, they are usually able to judge when to stop the irrigation process.

On how much water to apply, farmers excavate small furrows in the crop fields. In the fields, the furrows are constructed with block structures which allow water to infiltrate into the soil in one section of the furrow before it spills over to the next section of the furrow. In other words the blocks increase the contact time between the water and the soil at any other section of the furrow. On when to apply irrigation water, I observed that, most farmers irrigated their crops on daily basis. Some farmers irrigated the same crop field twice a day (in the morning and late in the afternoon). When I asked the farmers why they irrigate in the morning and late afternoon, most farmers said that during these times of the day, temperatures are low and farmers feel comfortable to work. In my view, farmers irrigate during the times of the day when evapotranspiration is low, as a technique designed to reduce evaporation losses. In some cases, mulching made from grass or a various crop residue, were used to cover open spaces in the fields (Fig. 5.23). I suppose that farmers were aware of techniques on how to reduce water losses through evaporation. Woyessa et al. (2006) showed that in semi-arid areas, only about 15% of rainfall contributes to crop production; most of it is lost through evaporation. Although this claim was based on rain-fed systems, it can be related to wetland farming or small-scale informal irrigation methods as well. Underperformance of wetland farming or small-scale irrigation systems related to management aspects contribute to low productivity of such systems. Therefore practices that reduce evaporation and increase infiltration capacity may increase crop production. It appears farmers in the Shire Valley are well aware of this fact.

Fig. 5.23: Mulching made from previous crop. The idea is to cover bare ground between rows of maize plant in order to reduce evaporation

5.9.3 Crop management

The main crop grown in Shire Valley, as it is anywhere else in Malawi, is maize. In Malawi maize is grown in raised ridges mostly spaced at 75 cm apart. In Shire Valley, most farmers do not make ridges; instead they dig individual holes in rows (Fig. 5.24). About 150 mm deep, each hole acts as a planting station. Since moisture dries up quickly due to the semi-arid climate in the Valley, the holes act as moisture conservation structures where evaporation is delayed and plants have access to moisture in the soil. Sometimes, the holes are made in the field furrows (Fig. 5.25). Where water-logged conditions exist, raised ridges are made to drain away excess water (Fig. 5.26).

Fig. 5.24: Holes dug as planting stations for maize. This is meant to reduce evaporation and maximize moisture use

Fig. 5.25: Holes dug in field furrows where maize is planted. This is an example of farms or plots where no ridges were made

Fig. 5.26: Raised ridges to drain excess moisture. These were mostly noticed in sweet potato plots

5.9.4 Individuality

Although the farmers mostly manage their plots individually, it was amazing to see the organizational skills of the farmers in some of the villages. Such skills exist at one site in Makhanga EPA. At this site, farmers have constructed a canal with the help of an NGO, GOAL-Malawi. The canal is more than a kilometer long, diverting water from the Shire River into their fields. Farmers use treadle pumps to pump water from the canal into their fields. In the fields, farmers maintain their original plots as individuals. GOAL-Malawi initiated the construction of the diversion canal. The NGO also distributes free inputs to the farmers. With the assistance from chiefs, a management committee which oversees the general management of the project, including maintenance of the canal was set up. It was understood that the NGO would assist the farmers with free inputs for the first five years, after which the farmers will have to manage the project on their own. Some of the free services provided to the farmers include extension messages, treadle pumps, and seeds. Many farmers I interviewed appeared to be happy with the project, citing increased food production and therefore reduced hunger occurrences as the main advantage.

5.9.5 Major problem faced by wetland farmers

The number one problem faced by wetland farmers is that their own animals feed on the crops (Fig. 5.27). These are mostly cattle and goats, kept under free range systems. The animals normally graze in the upland areas. However, in the dry season, when wetland farming is at peak, the uplands become dry and scarce of grass. The animals therefore move to the wetlands in search of green grass to graze on. In the process they feed on the crops. During the survey, I was able to capture part of a herd of cattle feeding in the wetlands (Fig. 5.28).

Pests and diseases were among the major problems in the wetlands. Most of the respondents mentioned that inability to afford the costs of chemicals to combat pests and diseases was a major problem. This could be linked to lack of inputs, also mentioned as a problem. Notice that access to land and water resources was not the major problem reported by farmers.

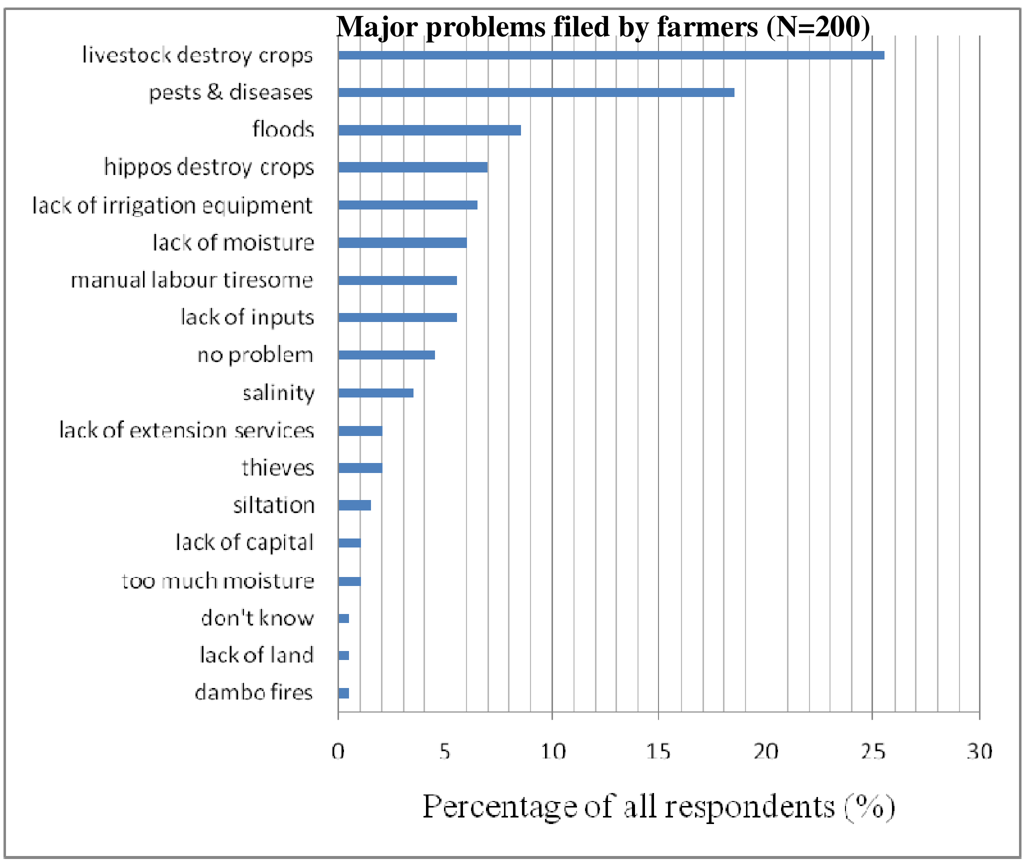


Fig. 5.27: Major problems faced by wetland farmers

Fig. 5.28: Cattle grazing on grass in the wetlands. The animals make no distinction between grass and crops.

5.10 Chapter summary

The chapter has described water management practices (agriculture technologies and their water sources), in the Shire Valley. Generally very little was known about these technologies and their water sources in Malawi, according to Marshall (1994). Also discussed in the chapter are the socioeconomic characteristics of the wetland farming systems. The findings can be summarized as follows:

- There were five agriculture technologies used the respondents. Flood recession agriculture and river diversion were the commonest, with about two-thirds of the respondents. About one-quarter of the respondents practiced treadle pump technologies. The less common technologies were: watering cans, and motorized pumps which were no longer in use at the time of the survey. Government or NGOs were mainly promoting treadle pump technologies. Despite being the commonest agriculture system, there was no evidence of government or NGOs supporting flood recession agriculture. Motorized pump technologies which were mainly promoted by the government, were no longer in use at the time of the survey. Perhaps the main reason for failure of the motorized pump technologies were due to, poor management and inappropriateness of the technology (Pereira et al., 2002).

- 74% of the respondents indicated that they started wetland farming on their current plots within the last 15 years; while 26% of the respondents used their plots for more than 15 years. Clearly this shows that wetland use has been going on for more than 15 years. However, the practice has surged from early to mid 1990s. Perhaps this is a result of farmers diversifying their livelihood strategies due to increased drought occurrences in rain-fed uplands. Note that 1991 was a drought year in the uplands as documented by Buckland (1997). Another drought season occurred in 2001/02 season as reported by Devereux (2002). FAO (2004) also reported a drought season during the 2003/04 season. Other reasons that may have possibly caused this increased wetland use are discussed in chapter 7.

  The colonisation of the wetlands was largely done on individual basis, without assistance from government, with more than 50% of respondents claiming to own land through inheritance from their parents. About 20% of respondents acquired land in the wetlands through free distribution by chiefs. Although about 90% of the respondents had plot shares of below 1 ha, about three-quarters of the respondents had more than 1 plot within the wetlands. The respondents showed to have colonised the wetlands (due to various reasons discussed in the chapter 7), about 80% of respondents still kept and used their uplands farms.

- There was an average family size of was 6 persons per household. Large families had large farms, and small families had small farms. The relationship between family size and plot size followed the trend: $y = 0.006x^{2.181}$, with a correlation factor, $R^2 = 0.941$.

CHAPTER SIX

RESULTS II:
ECONOMIC FARMER-BENEFITS OF WETLAND FARMING AND SMALL-SCALE INFORMAL IRRIGATION SYSTEMS

6.1 Chapter overview

This chapter explores the economic benefits of the wetland farming systems. The chapter begins by identifying the farming patterns. Then gross margins for each of the patterns were calculated. Two main scenarios were considered: one with family labour as part of annual costs, and the other without labour costs.

6.2 Using cluster centres to identify farming patterns for phase II

As it was not feasible to interview all the 200 farmers for the economic analysis for phase II, it was required that some form of grouping of phase I data be carried out. From the groups then a sample of farmers was drawn. Cluster analysis was chosen to be the method for defining the farming patterns after comparing the advantages and disadvantages of the method to other methods as discussed under section 4.7.1.

Cluster analysis identified cluster centres which in turn were used to define farming patterns. With the 200 cases (respondents) and the 17 variables (responses), the analysis identified six cluster centre patterns (Table. 6.1). The variables were grouped depending on which cluster centre best describes a particular case. Thus each cluster centre shows the number of cases that were grouped under it. The grouping does not mean that all cases under each cluster centre are uniform. Therefore the percentage of cases under each cluster centre should not be confused as cases with similar properties. The similarity of cases will depend on distance from cluster centre, as discussed later under this section.

Statistical significance of the variables

One advantage of cluster analysis (discussed in section 4.7.1) is the ability of the method to give statistical significances of variables. This is denoted by the sign, 'Sig.' shown under the second column in Table 6.1. Stockburger (1996) and Wielkiewicz (2000) explained that the sign 'Sig.' is used to test the hypothesis that the effects are real or that the variables are significantly different from one another. Note that if the value for 'Sig.' is greater than .05, then the corresponding variable is not significant (Wielkiewicz, 2000). ''Of all the information presented in the ANOVA table, the major interest of the researcher will most likely be focused on the value located in the 'Sig.' column. If the number (or numbers) found in this column is (are) less than the critical value (α), usually set at .05, any value less than this will result in significant effects, while any value greater than this value will result in non-significant effects'' (Stockburger, 1996). Thus, low values of 'Sig.' indicate significant effect on the cluster centres, and higher values of 'Sig.' do not affect cluster centres significantly.

The observed significance levels were therefore used to test whether removing the non-significant variables would affect the cluster groups. Notably, in Table 6.1, Land acquisition, Years on plot, Plot size (ha), Group/individual, and Plots in wetland were the statistically significant variables. Rerunning the analysis (Table 6.2) with statistically significant variables only show that the resulting groups had the same number of cases as those presented in Table 6.1. This confirms that critical variables were the main factors of the clustering process in Table 6.1. It can also be noticed that the statistical significance of the variables did not changed in Table 6.2. It appears 'plot sizes' is the most critical variable because it has the lowest value of 'Sig.'.

Table 6.1: Cluster centre patterns

Variables	Sig.	Cluster centre patterns (N = 200)					
		A	B	C	D	E	F
Cases (%)		79.5	14.5	3.5	1	1	0.5
Agriculture technology	0.2001	river diversion	treadle pump	flood recession	treadle pump	treadle pump	river diversion
Land ownership	0.0604	permanent	permanent	permanent	permane nt	permanent	temporary
Land acquisition	0.0258	borrowed from chief	borrowed from chief	inherited	bought from chief	inherited	rented from someone
Years on plot	0.0073	< 10 yrs	< 10 yrs	>15 yrs	10 to 15 yrs	< 10 yrs	< 10 yrs
Crop grown	0.4151	maize	maize	sweet potatoes	maize	maize	maize
Plot size (ha)	0.0000	0.1	0.1	0.2	0.3	0.4	0.55
Group/individual	0.0004	individual	individual	individual	individua l	individual	group
Water source	0.2841	streams/ rivers	hand-dug ditch	recession floods (swamps)	wells	streams/ rivers	streams/ rivers
Water reliability	0.9387	reliable	reliable	reliable	reliable	reliable	reliable
Growing season starts	0.4333	March	May	May	April	May	April
Plots in wetland	0.0356	> 1 plot	> 1 plot	1 plot	> 1 plot	1 plot	1 plot
Own upland plot?	0.5546	yes	yes	yes	yes	no	yes
Main income	0.8213	farming	farming	farming	farming	farming	farming
Family size	0.7577	4	10	6	7	6	5
Education	0.2760	primary	no education	no education	primary	primary	secondary
Gender	0.3899	female	male	female	male	male	male
Major problem	0.3648	pests & diseases	domestic livestock	no problem	no equipme nt	domestic livestock	siltation

Table 6.2: Cluster centre patterns (with significant variables only)

Variables	Sig.	Cluster centre patterns (N = 200)					
		A	B	C	D	E	F
Cases (%)		79.5	14.5	3.5	1	1	0.5
Land acquisition	0.0258	borrowed from chief	borrowed from chief	inherited	bought from chief	inherited	rented from someone
Years on plot	0.0073	< 10 yrs	< 10 yrs	>15 yrs	10 to 15 yrs	< 10 yrs	< 10 yrs
Plot size (ha)	0.0000	0.1	0.1	0.2	0.3	0.4	0.55
Group/individual	0.0004	individual	individual	individual	individua l	individual	group
Plots in wetland	0.0356	> 1 plot	> 1 plot	1 plot	> 1 plot	1 plot	1 plot

Distance from cluster centres

The other advantage of cluster analysis (also discussed in section 4.7.1) is the ability of the method to show the statistical distance of cases from cluster centres. Distance from cluster centres is a measure of similarity of cases within a cluster (Ben-Israel and Iyigun, 2008). Distance from cluster centre defines how ‘‘well the postal sectors fit with their clusters’’ (Debenham, 2002). Cases are said to be related if they fall within similar distances from the cluster centre; and the closer to the cluster centre the more similar is the case to the cluster centre (Debenham, 2002).

Now, how similar are the cases in the six patterns in Table 6.1? Perhaps lets us consider patterns A, B, and C, since these appear to be the large groups. Remember that not all the cases under each cluster centre are uniform in their properties. For example, pattern A (with 159 cases) has a wide variation from the cluster centre; with those close to the cluster centre being closely related than those away from the cluster centre (Fig. 6.1). Pattern B (with 29 cases), however, shows that the variation from the cluster centre is not as wide as in pattern A (Fig. 6.2). In pattern C (with 7 cases), all cases appear to fall within a similar distance from the cluster centre, except for case no.1 and case no.6. (Fig. 6.3). Perhaps this shows that cases are more likely to be similar to each other if the number of cases in a group is small. In order to increase the degree of similarity of cases for the economic analysis, cases close to the cluster centre were selected.

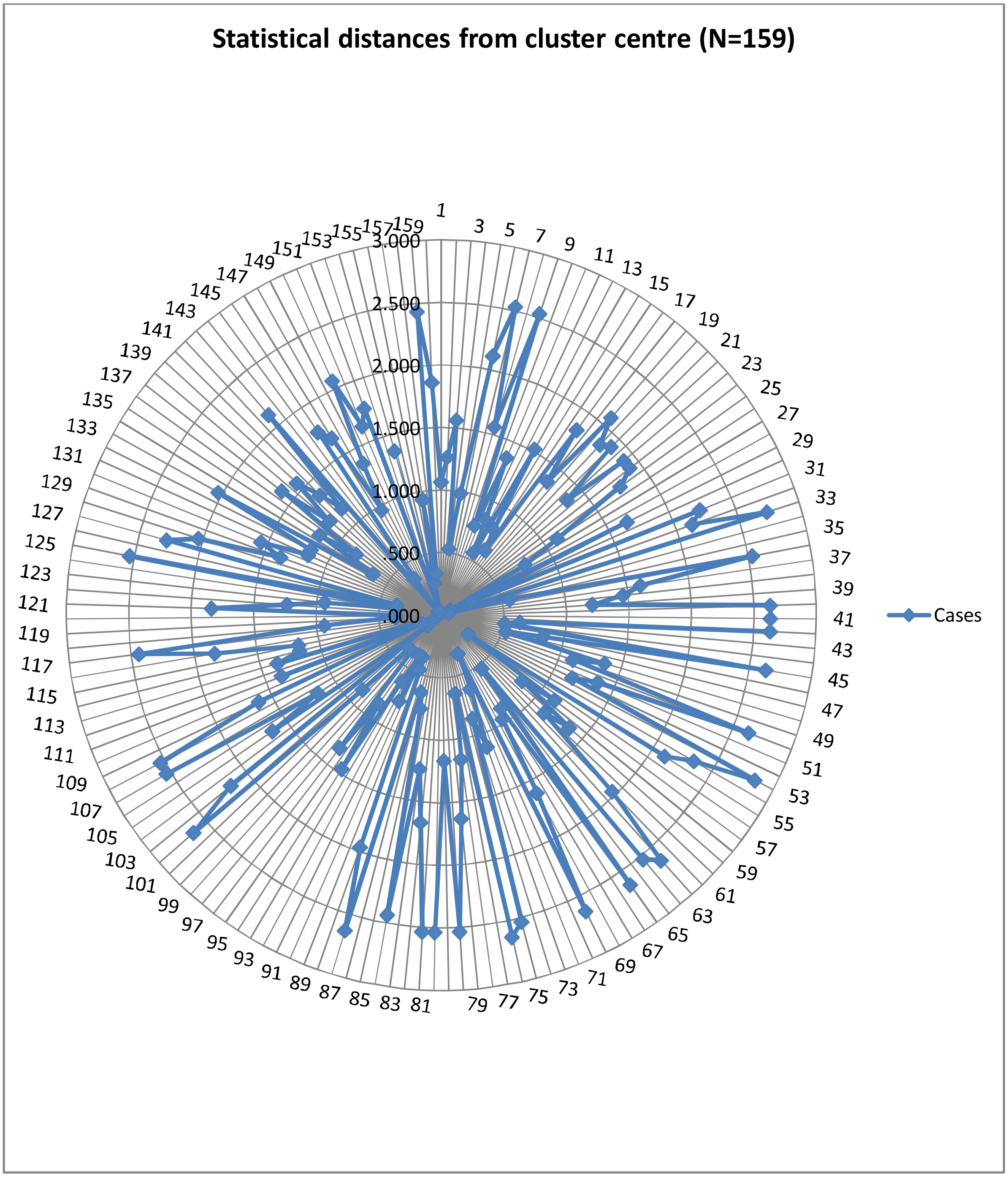


Fig.6.1: Distance from cluster centre for cases under pattern A. Cases near the cluster centre are more likely to be similar in properties to the cluster centre than cases away from the cluster centre.

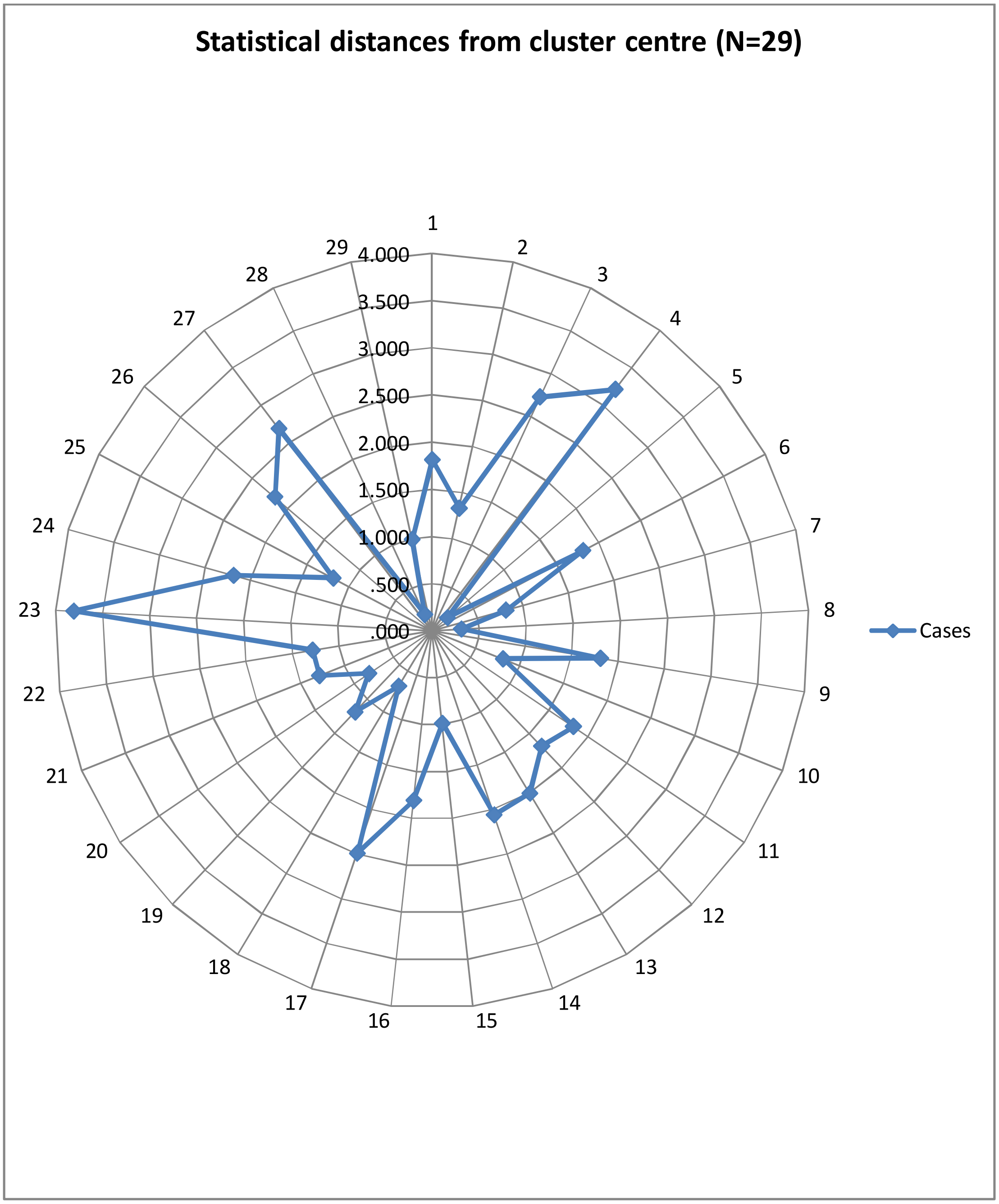


Fig.6.2: Distance from cluster centre for cases under pattern B. Cases near the cluster centre are more likely to be similar in properties to the cluster centre than cases away from the cluster centre.

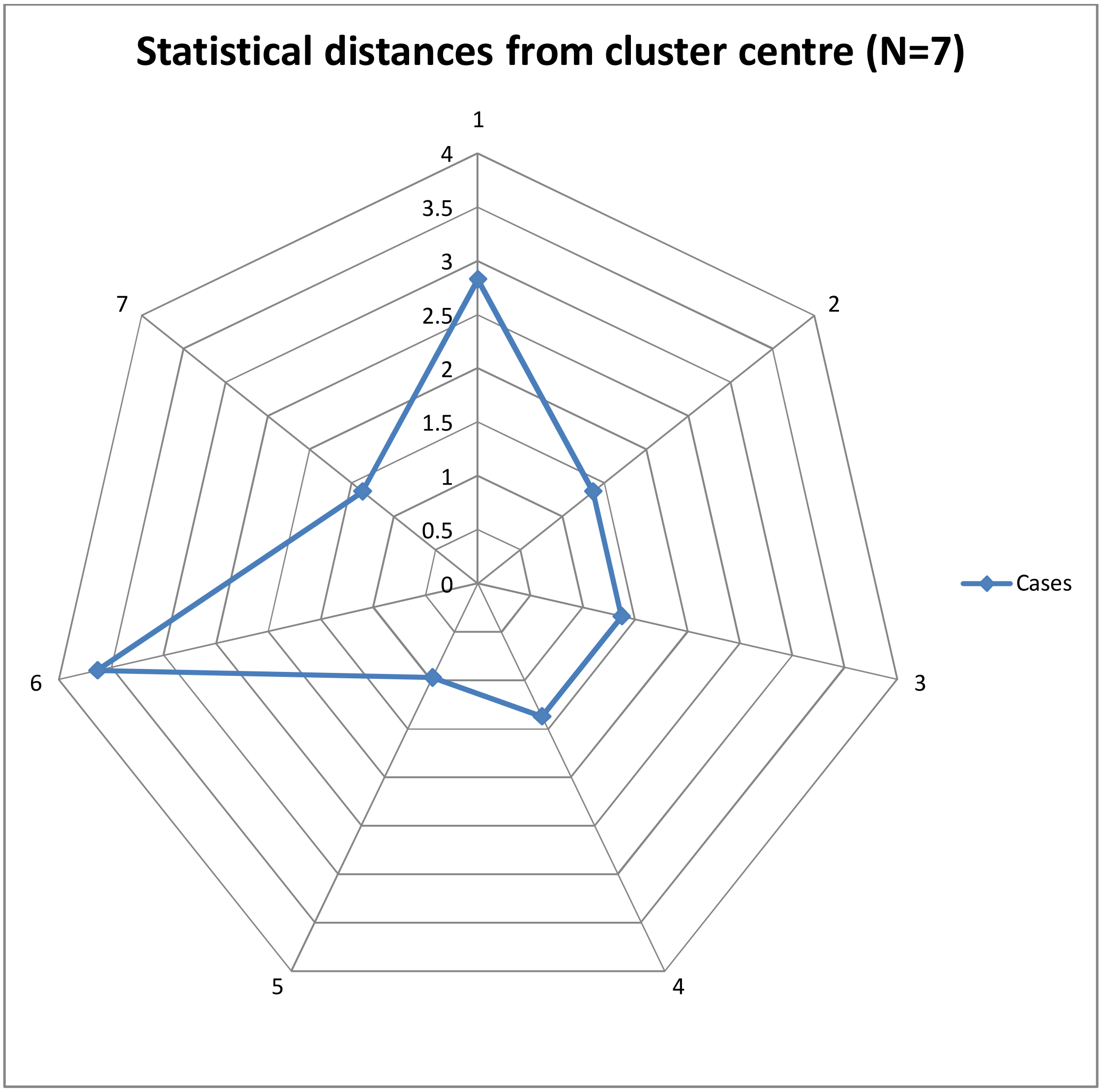


Fig.6.3: Distance from cluster centre for cases under pattern C. Cases near the cluster centre are more likely to be similar in properties to the cluster centre than cases away from the cluster centre.

6.2.1 Description of cluster centres of pattern A

Cluster centres of pattern A is composed of farmers who practice river diversion irrigation technology with permanent land ownership mainly allocated by chiefs. This group mostly start their irrigation season as early as March, just after the end of the rainy season. With early irrigation season, farmers can have a chance of two successive irrigation seasons before the next rainy season starts in November. In this way farmers maximise their possible crop production potential in a year. They are mainly composed of women owning individual tiny pieces of land. During the study women stated that they preferred less energy-requiring methods (river diversions) to more energy-requiring methods (treadle pumps). Women make most of the food security decisions in a household, and are therefore more likely to support a decision to have multiple plots in both wetlands and uplands, as a way of increasing food sufficiency in a household. This pattern has farmers with land holding size of 0.1ha.

6.2.2 Description of cluster centres of pattern B

These are mostly men with land holding sizes averaging 0.1ha growing maize. They practice treadle pump technology whose irrigation season mainly starts in May when most of the rivers and swamps are beginning to dry up. By August, most of the swamps and shallow wells will have little water to sustain another crop growing season. So, farmers in this pattern are not usually able to fit two irrigation seasons before the next rains in November. If they risk a second crop, the crop will either dry up in the middle of the dry season, or will be flooded in November. So in this pattern irrigation is only possible once a year. Farmers in this pattern site domestic livestock as their major challenge. This is mainly because, irrigation in this pattern peaks during the middle of the dry season when grazing areas are mostly dry and animal food is scarce. With the scarcity of grass for animal feed, the irrigated crop becomes vulnerable to domestic livestock. It is also worth noting that treadle pump methods, unlike river diversion methods in pattern A, are practiced within village vicinity to avoid the hassle of carrying the pump over long distances each irrigation time. The closeness to villages where domestic animals live could be a contributing factor to livestock attacks. Since treadle pumps are manually operated, farmers spend the entire irrigation time pumping water from ditches or wells to field furrows. Treadle pump farmers are mostly men. There are reports that some women complain that treadle pump activities are very physical and tiresome and therefore make their men tired and sexually inactive. This has become a big issue in some areas.

6.2.3 Description of cluster centres of pattern C

The centres of this pattern show farmers who are mainly women growing sweet potatoes under flood recession technology on plot sizes of about 0.2 hectares. Respondents indicated that before farming activities started to receive attention in the wetlands, some form of sweet potato farming was already taking place using residual moisture during dry season. This was not in response to droughts in uplands, but a way of passing time by women during dry seasons when they were not busy in uplands. Managed individually on permanently owned plots, farmers in pattern C mainly own their plots through inheritance from parents, perhaps explaining why plot sizes are larger than those in pattern A or pattern B.

The growing season starts around May when most flood waters have subsided, with suitable moisture since sweet potatoes do not require too much water. It is important to remember that sweet potato is considered a non-essential crop since it is not staple food. They are grown mainly to supplement the main crop, maize. Sweet potato farmers mostly do not own multiple plots in the wetlands. This could be due to the fact that sweet potato plots are large and time-consuming in the planting and weeding processes; and that farmers do not want to spend too much time on non-essential crop. However farmers in this group own plots in the uplands, where agricultural activities are done at different times, and therefore may not interfere with wetland activities.

6.2.4 Description of cluster centres of pattern D

These are mostly male treadle pump farmers who use shallow wells as a source of water supply. Shallow wells are usually constructed in the middle of the plot. The wells are typically not more than 2m deep. They are farmers who manage their plots individually. One plot may have several shallow wells depending on the area. The cluster centres show that the plot sizes for this pattern are about 0.3ha, a little larger than those for patterns A and B. The cluster centres also show that farmers in this group started using their plots 10 to 15 years ago, have other plots within the wetlands, and maintain their upland plots.

6.2.5 Description of cluster centres of pattern E

These are mostly male treadle pump farmers who use streams as a source of water supply. Their plots are on stream banks where they claim land ownership from parents, and manage their plots individually. The cluster centres show that their plot sizes are about 0.4ha, a little larger than those for pattern D. Farmers under this group started using their plots fairly recently, less than 10 years ago. The analysis shows that these farmers are unlikely to have other plots both within the wetlands and in the upland, maybe because they own large plots. These are perhaps farmers who now consider wetlands as the main source of crop production.

6.2.6 Description of cluster centres of pattern F

These are river diversion farmers whose plots belong to a group. A group for river diversion farming may be initiated by an NGO or a village chief as a scheme. Under these circumstances the land initially belongs to the chief who distributes it to the people. A village chief may ask his subjects to participate in the construction of structures for the system in order to qualify for land share in the scheme. A committee is usually set up to oversee the running of the affairs in the scheme. A member of the scheme may rent out his or her plot to someone temporarily (usually without the knowledge of the committee). The analysis thus shows that these are farmers with temporary land ownership. They are farmers whose plots belong to a farming group. Those that rent plots may be financially privileged, perhaps explaining why they have big plot sizes. The analysis also shows that these are farmers who started using their plots within the last 10 years.

6.3 Gross margins calculations

Gross margins were calculated as the difference between total annual costs and total yield for each farmer, after which an average for each pattern was also calculated. Where yield was given in mass, a conversion was made as if the yield were to be sold at the current prevailing local market price. These prices were the same as offered by the local traders who buy produce from farmers. As has been discussed in methodology, annual costs consist of all input costs including fertilizers, chemicals, seeds, labour etc. The first analysis was the case where labour costs were not included as part of annual costs. This was so because generally labour was provided by members of the households. Later, the case where labour costs were included as part of annual costs was also analysed. As described in section 4.11, where labour costs were included, a government daily rate of MK200 per 8-hour day per individual was used. Only farmers growing maize and sweet potatoes were included in the gross margin calculations, because these were identified as the commonest crops in cluster analysis (Table 6.1). It was observed during the study that the selling prices for maize were variable. Government recommended selling price for maize was MK17/kg (US$ 0.12/kg, using exchange rate of MK142 = 1 US$), while unregulated local markets offered MK25/kg (US$0.18/kg) for the same crop.

It was noticed during the study that farmers rarely sold their maize to government regulated markets. Instead farmers sold their maize at local markets where the price was higher. Some farmers did not sell their maize because they usually produced enough just for consumption, and normally have no surplus for sale. The local market price for sweet potatoes was found to be MK24/kg (USD0.17/kg).

The results of the gross margins for all the patterns are presented in Table 6.3. Without labour costs included, all the farmers showed positive margins. Generally the farmers with low annual costs had big gross margins, and those with high annual costs had small gross margins. As patterns A, B, and C were the commonest, they have been featured in detail in the discussion below.

Table 6.3: Gross margins without labour costs for all patterns

CODE	PARAMETER	UNIT	PATTERNS					
			A	B	C	D	E	F
			(N=10)	(N=10)	(N=8)	(N=8)	(N=8)	(N=7)
1	AGRICULTURE TECHNOLOGY		River diversion	Treadle pump	Flood recession	Treadle pump	Treadle pump	River diversion
2	AVERAGE AREA	ha	0.16	0.15	0.18	0.27	0.39	0.49
3	MAIN CROP		Maize	Maize	Sweet potatoes	Maize	Maize	Maize
4	**AVERAGE GROSS PRODUCTION (YIELD):**							
4.1	Gross yield @ MK25/kg for maize	MK	7475	6125		11107	19844	21000
4.2	Gross yield @ MK24/kg for sweet potato	MK			56963			
5	**AVERAGE ANNUAL COSTS:**							
5.1	**Preharvest costs:**	MK						
	Seed costs	MK	675	775	325	1764	2438	2107
	Planting labour costs	MK	0	0	0	0	0	0
5.2	**Fertiliser costs:**							
	23:21:00	MK	1365	2535	0	3911	2925	5014
	UREA	MK	780	2535	0	1457	3169	5571
	CAN	MK	0	0	0	0	0	0
	Fertiliser application labour costs	MK	0	0	0	0	0	0
5.3	**Pesticide costs:**							
	Chemical costs	MK	0	0	0	0	0	0
	Spraying labour costs	MK	0	0	0	0	0	0
	Manual weeding labour costs	MK	0	0	0	0	0	0
5.4	**Irrigation costs:**							
	Watering labour costs	MK	0	0	0	0	0	0
	Treadling labour costs	MK	0	0	0	0	0	0
5.5	**Maintenance costs:**							
	Structure repair labour costs	MK	0	0	0	0	0	0
	Spare parts costs	MK	0	203	0	192	0	0
	Maintenance materials costs	MK	0	0	0	0	0	0
5.6	**Harvest/ Post harvest costs:**							
	Manual harvesting labour costs	MK	0	0	0	0	0	0
	Threshing labour costs	MK	0	0	0	0	0	0
	Parking/ storage labour costs	MK	0	0	0	0	0	0
	Packaging material/ structure costs	MK	370	465	1019	230	576	464
6	**TOTAL ANNUAL COSTS**	MK	3190	6513	1344	7554	9108	13157
7	**GROSS MARGIN ABOVE ANNUAL COSTS:**							
	When maize sold @MK25/kg	MK	4285	-388		3553	10737	7843
	When sweet potatoes sold @MK24/kg	MK			55619			
8	**CAPITAL COSTS:**							
	Land (price, rent) costs	MK	0	0	0	0	0	1121
	Equipment cost	MK	793	14200	371	14186	14200	744
	Construction of structure labour costs	MK	2000	1780	1925	307	2025	2029
	Structure materials costs	MK	0	0	0	268	583	0
	Excavation labour costs	MK	2260	680	0	0	1175	0
9	**TOTAL CAPITAL COSTS**	MK	5053	16660	2296	14761	17983	3894

6.4 Pattern A: Gross margins for river diversion maize farms (without labour costs)

This group was composed of farmers who grew maize under river diversion technologies. There were ten farmers in this group. All the farmers showed positive margins (Fig. 6.4). However, one farmer showed very low gross margins, perhaps due to inability to remember production quantities. The most important finding is that 90% of farmers in this group showed substantial positive gross margins. This finding therefore shows that growing maize under river diversion benefits the farmer when labour costs are not counted.

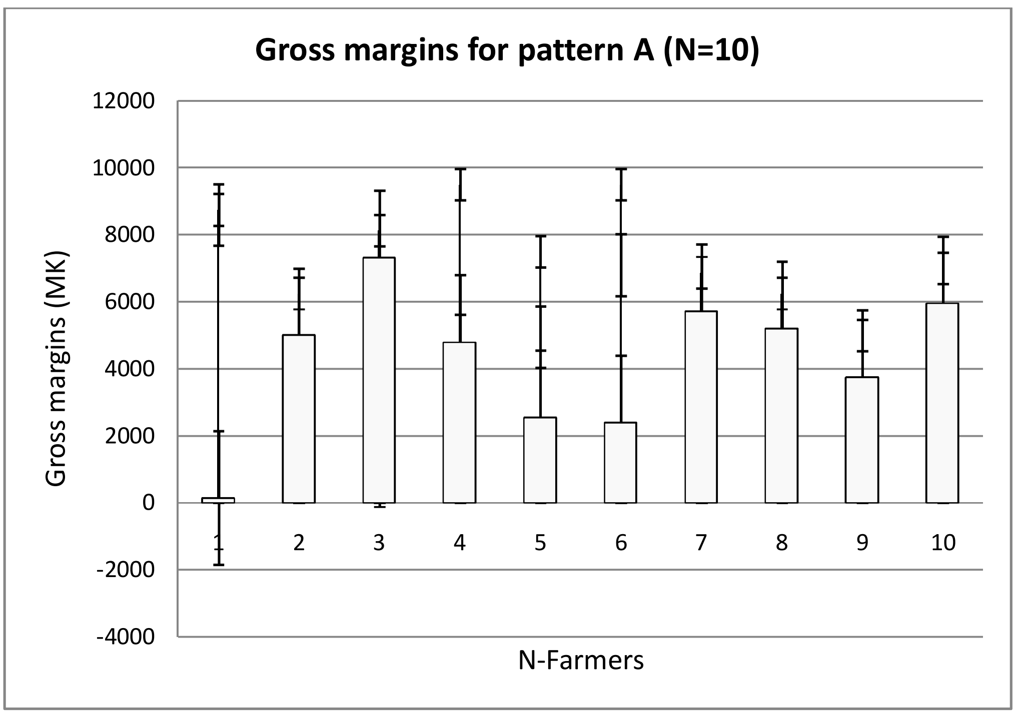


Fig. 6.4: Pattern A: Gross margins for river diversion maize farms (without labour costs)

6.5 Pattern B: Gross margins for treadle pump maize farms (without labour costs)

There were ten farmers that formed part of the focus group discussions for pattern B. They were all farmers who grow maize using treadle pump technologies. The results of the gross margins are presented in Fig. 6.5. Three out of the ten farmers (30%) show negative margins. Generally, farmers in this pattern show very low margins. The major finding here is that farmers who grow maize using treadle pumps do not benefit much even if labour costs are not counted.

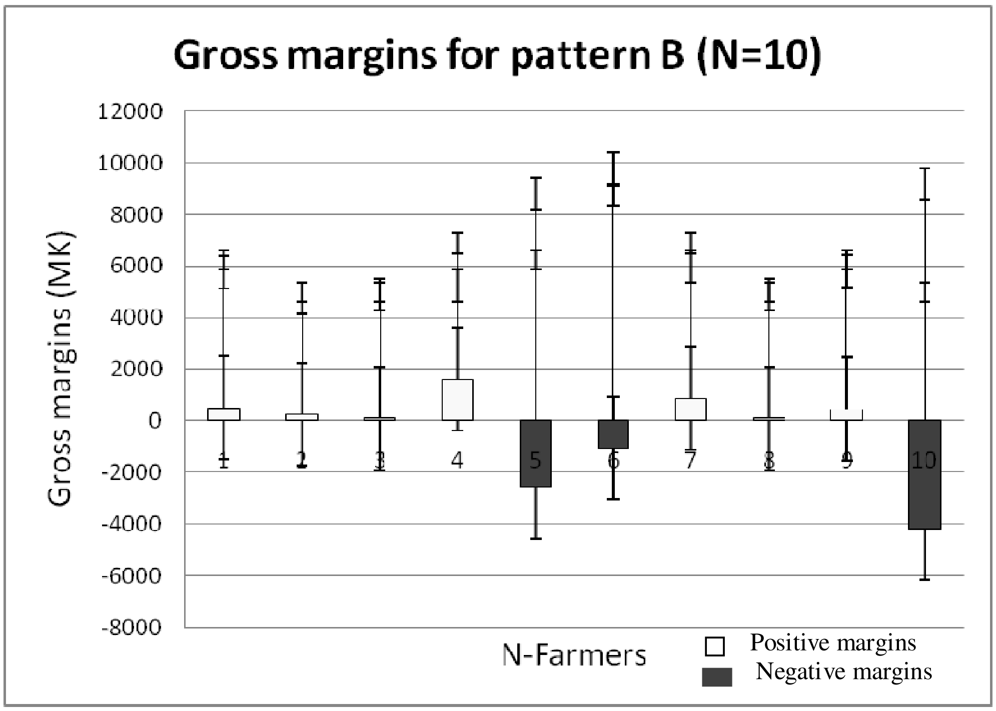


Fig. 6.5: Pattern B: Gross margins for treadle pump maize farms (without labour costs)

6.6 Pattern C: Gross margins for recession agriculture sweet potato farms (without labour costs)

There were eight farmers that formed part of the focus group discussions for pattern C. They were farmers, mainly women, who practice recession agriculture, growing sweet potatoes. The results of the gross margins are presented in Fig. 6.6. All of the farmers showed high margins. It was noticed during the study that farmers who grow sweet potatoes do not apply fertilizers or chemicals to their crops. Hence, the pattern showed very minimal annual costs resulting in high gross margins.

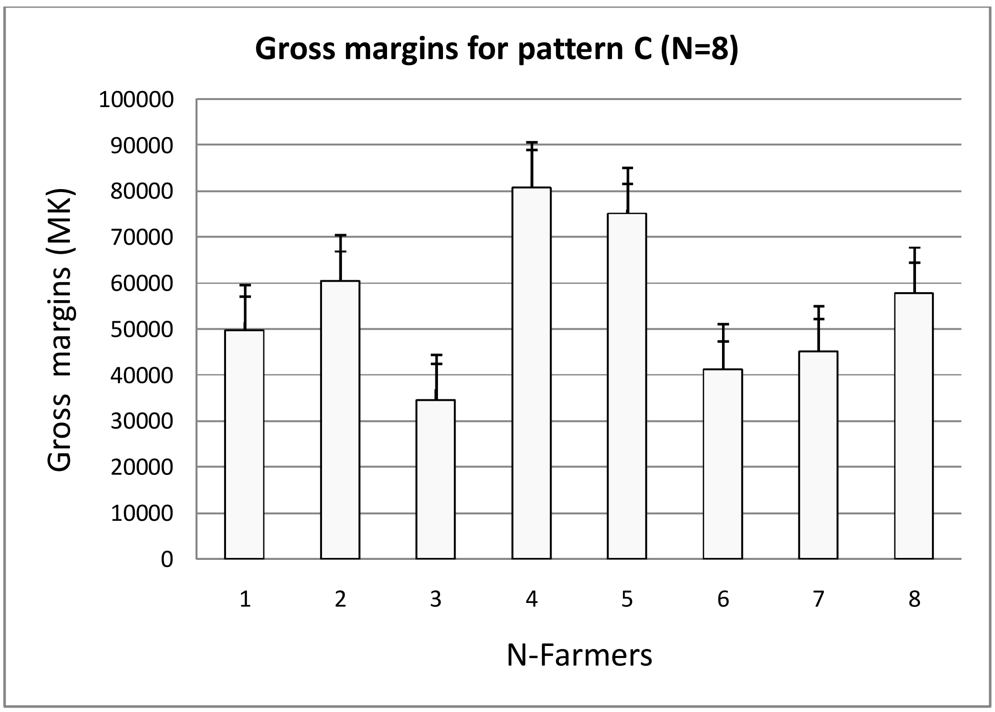


Fig. 6.6: Pattern C: Gross margins for recession agriculture sweet potato farms (without labour costs)

6.7 All patterns: Gross margins without labour costs

The averages of gross margins without labour costs for all the six patterns are plotted (Fig. 6.7). As discussed earlier, pattern A is the commonest in the Shire Valley. All patterns, except pattern C, appear to have low benefits (Fig. 6.7). Pattern C is seen to be an exception, with much higher benefits than the other patterns.

This means that those farmers that grow sweet potato under flood recession (pattern C) benefit most. Those that grow maize under river diversion (pattern A) benefit more than those that grow maize under treadle pump methods (pattern B). Further, technologies where water is distributed by gravity, like river diversion, have lower annual costs than technologies where water is pumped manually, like the treadle pump (Table 6.3).

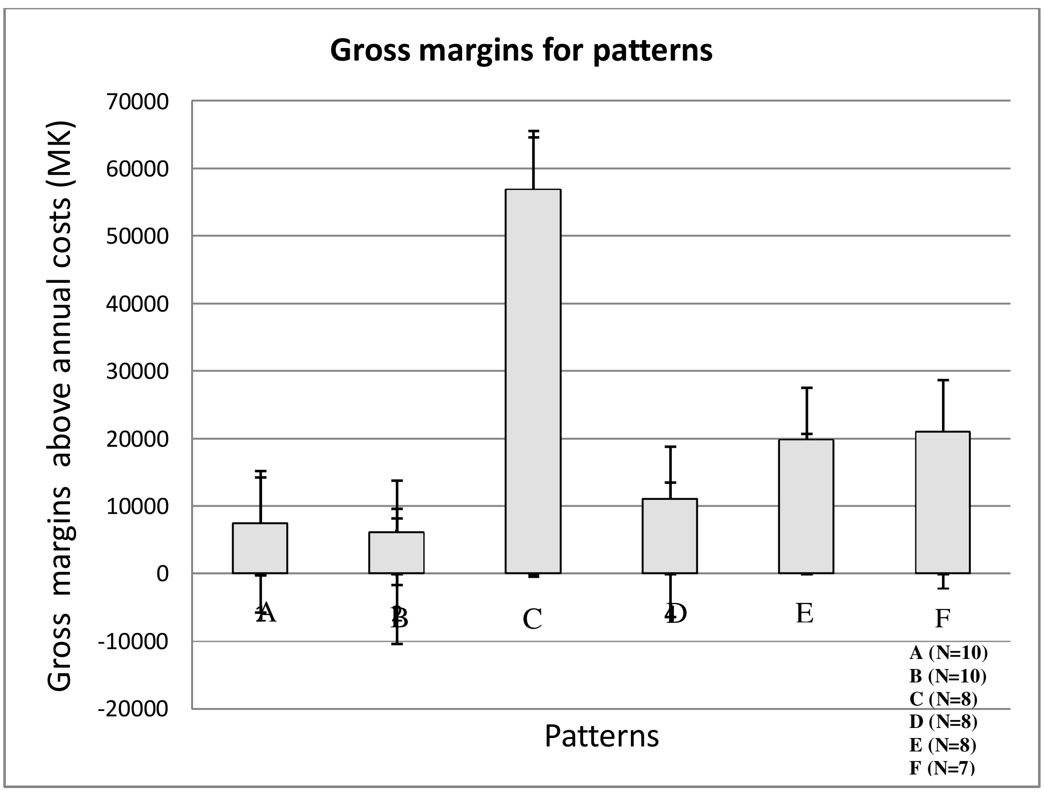


Fig. 6.7: Gross margins without labour costs for all patterns

6.8 Annual costs and gross margins versus plot size (labour costs not included)

The study explored the relationship between annual costs and gross margins versus plot sizes. Fig. 6.8 shows production costs (annual costs) for maize plotted against plot sizes, while Fig. 6.9 shows gross margins (benefits) for maize plotted against plot sizes.

Fig. 6.8 suggests that a linear relationship exists between production costs (annual costs) and plot sizes for maize growers. As plot sizes increases, production costs (annual costs) also increase. Most of the maize annual costs come from the cost of inputs like, chemicals, fertilizers, and seeds. The majority of the farmers were unable to meet these costs.

Since most farmers were unable to fund input costs, in my view, this could be one of the reasons why most of them own plots below 1 ha, to minimise those costs. However, too tiny land portions may yield negative gross margins (benefits) (Fig. 6.9). Fig. 6.9 shows gross margins rising from 0.1 ha-plot size to and appear to be falling above 0.5 ha-plot size, presumably due to increased annual (input) costs. This could mean that, in order for farmers to realise profits, plot sizes do not have to be too big or too small.

Fig. 6.10 does not show a clear relationship between production costs (annual costs) and plot sizes for sweet potato growers, probably because there were only eight respondents in this group, not large enough to show the trend. However, considering these few respondents, production costs (annual costs) appear to start high, then fall, and start to rise just before 0.2 ha-plot size. The survey revealed that most of the sweet potato annual costs come from the cost of seeds which are sold in bulks or bundles. The bundles are normally in fixed sizes which all farmers have to buy no matter the size of their plot. Those with small plots may not use all the seeds in the bundles. This could be the reason why the annual costs appear to be high, then fall, and rise with increasing plot sizes. Fig. 6.11 shows rising gross margins as plot sizes increase.

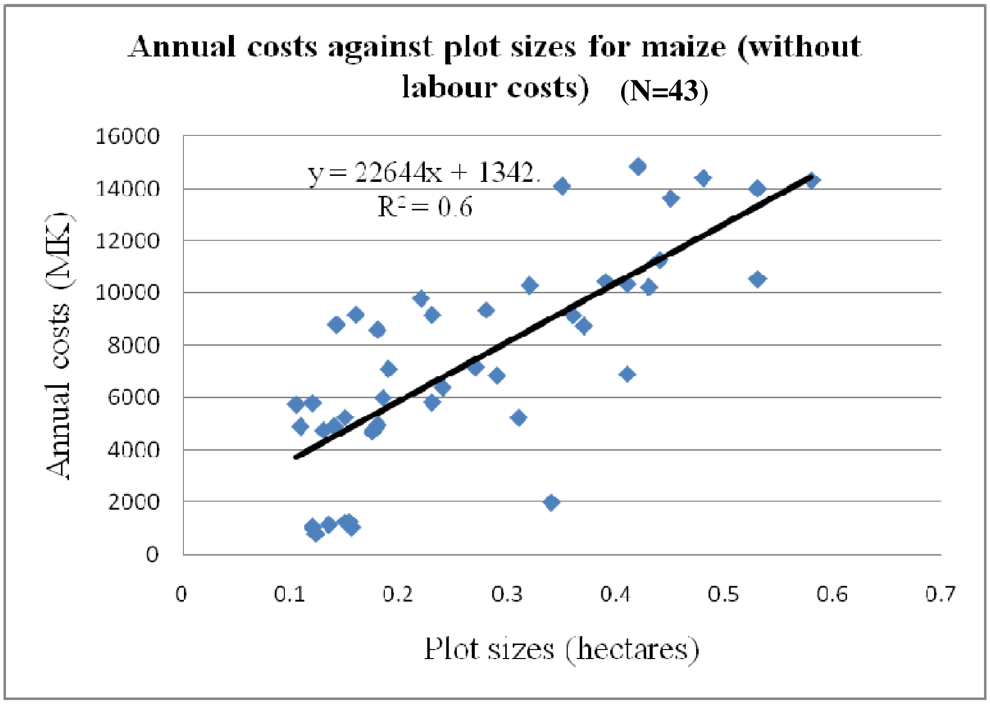


Fig. 6.8: Annual costs as a function of plot size for farmers growing maize

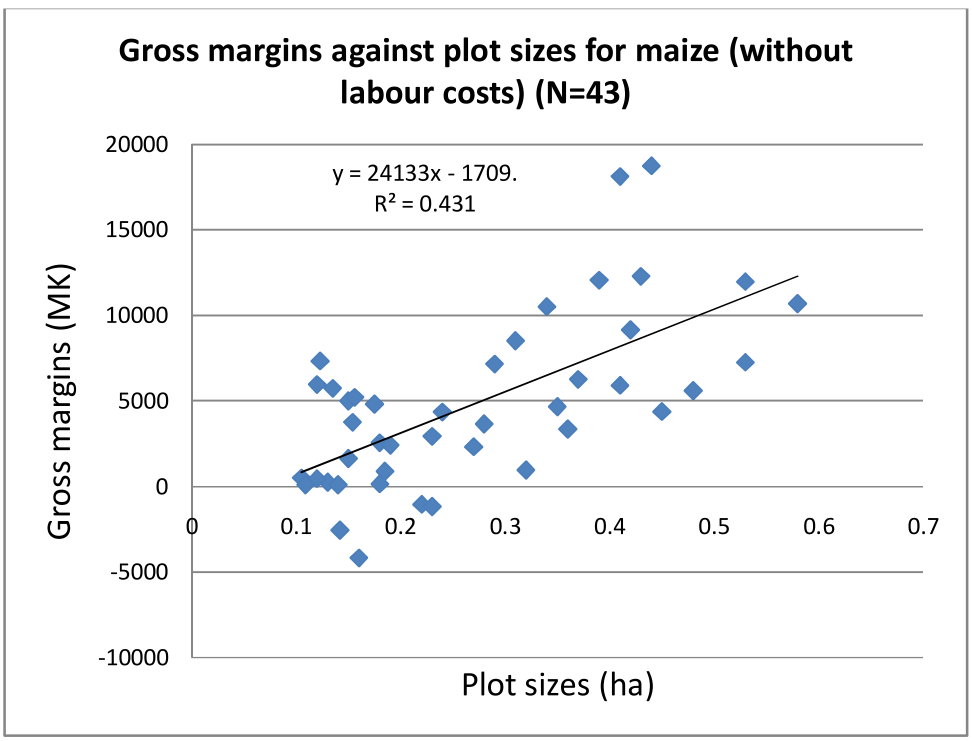


Fig. 6.9: Gross margins as a function of plot size for farmers growing maize

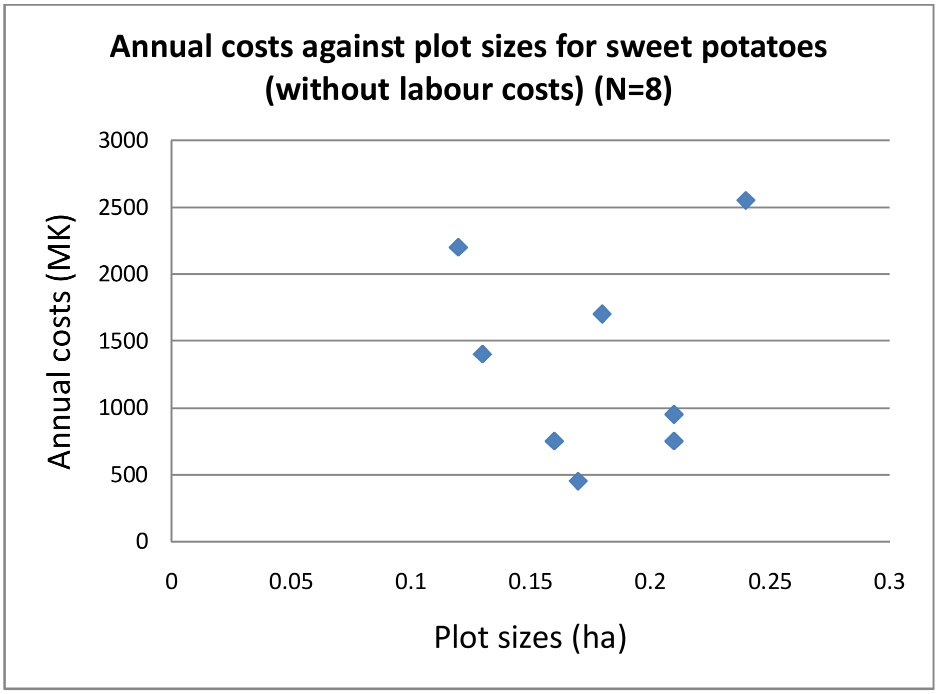


Fig. 6.10: Annual costs as a function of plot size for farmers growing sweet potatoes

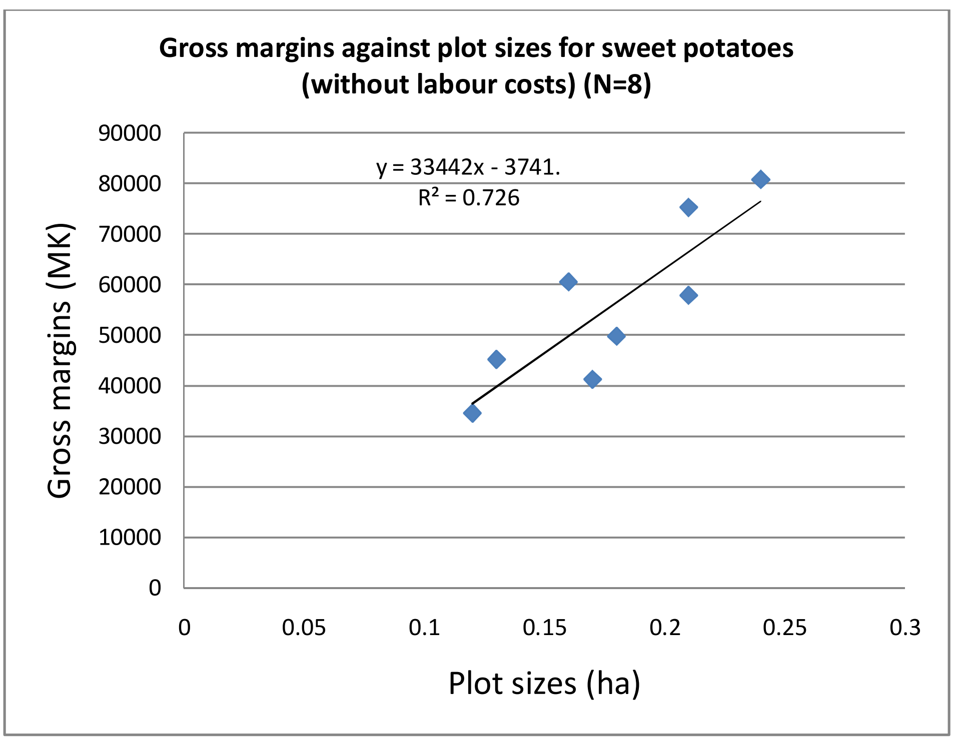


Fig. 6.11: Gross margins as a function of plot size for farmers growing sweet potatoes

6.9 Considering labour costs

Table 6.4 shows the situation where labour costs are included in the gross margin calculations. Using the government rate of MK200 per 8-hour day per person, the results show that only farmers who grow sweet potatoes under flood recession agriculture (pattern C) would benefit under this situation. Maize crop under treadle pump technologies show more irrigation labour costs than the same crop under river diversion technologies. This is so because, farmers with treadle pumps have to manually pump the water during the entire irrigation period, whereas with river diversion technologies, farmers do not necessarily have to be present during the entire irrigation period. The situation is different for sweet potato under flood recession technology where cost for irrigation is zero but costs for weeding and harvesting are higher than for the other patterns. Weeding and harvesting of sweet potatoes under flood recession technology is more difficult and time consuming than for maize under river diversion or treadle pump technologies. The variations in labour costs for the patterns necessitate the exploration of labour components. Section 6.10 describes the components of labour input for each pattern.

Table 6.4: Gross margins with labour costs for all patterns

CODE	PARAMETER	UNIT	PATTERNS					
			A	B	C	D	E	F
			(N=10)	(N=10)	(N=8)	(N=8)	(N=8)	(N=7)
1.0	AGRICULTURE TECHNOLOGY		River diversion	Treadle pump	Flood recession	Treadle pump	Treadle pump	River diversion
2.0	AVERAGE AREA	ha	0.16	0.15	0.18	0.27	0.39	0.49
3.0	MAIN CROP		Maize	Maize	Sweet potatoes	Maize	Maize	Maize
4.0	AVERAGE GROSS PRODUCTION (YIELD):							
4.1	Gross yield @ MK25/kg for maize	MK	7475	6125		11107	19844	21000
4.2	Gross yield @ MK24/kg for sweet potato	MK			56963			
5.0	AVERAGE ANNUAL COSTS:							
5.1	Preharvest costs:	MK						
	Seed costs	MK	675	775	325	1764	2438	2107
	Planting labour costs	MK	300	780	1000	1380	825	1286
5.2	Fertiliser costs:							
	23:21:00	MK	1365	2535	0	3911	2925	5014
	UREA	MK	780	2535	0	1457	3169	5571
	CAN	MK	0	0	0	0	0	0
	Fertiliser application labour costs	MK	620	600	0	882	850	1971
5.3	Pesticide costs:							
	Chemical costs	MK	0	0	0	0	0	0
	Spraying labour costs	MK	0	0	0	0	0	0
	Manual weeding labour costs	MK	1160	960	1625	2147	2550	3143
5.4	Irrigation costs:							
	Watering labour costs	MK	5500	0	0	0	0	7800
	Treadling labour costs	MK	0	7360	0	8320	7025	0
5.5	Maintenance costs:							
	Structure repair labour costs	MK	1200	80	0	115	525	2143
	Spare parts costs	MK	0	203	0	192	0	0
	Maintenance materials costs	MK	0	0	0	0	0	0
5.6	Harvest/ Post harvest costs:							
	Manual harvesting labour costs	MK	1140	980	1600	1035	775	2371
	Threshing labour costs	MK	1000	1040	0	1074	850	1457
	Parking/ storage labour costs	MK	200	520	0	767	800	886
	Packaging material/ structure costs	MK	370	465	1019	230	576	464
6.0	TOTAL ANNUAL COSTS	MK	14310	18833	5569	23274	23308	34214
7.0	GROSS MARGIN ABOVE ANNUAL COSTS:							
	When maize sold @MK25/kg	MK	-6835	-12708		-12167	-3464	-13214
	When sweet potatoes sold @MK24/kg	MK			51394			
8.0	CAPITAL COSTS:							
	Land (price, rent) costs	MK	0	0	0	0	0	1121
	Equipment cost	MK	793	14200	371	14186	14200	744
	Construction of structure labour costs	MK	2000	1780	1925	307	2025	2029
	Structure materials costs	MK	0	0	0	268	583	0
	Excavation labour costs	MK	2260	680	0	0	1175	0
9.0	TOTAL CAPITAL COSTS	MK	5053	16660	2296	14761	17983	3894

6.10 Breakdown of labour costs

Table 6.5 does not only show labour components but also average time required to execute each component under each pattern. Irrigation-time is one of the major components making up labour requirements (Table 6.5). Irrigation-time defined here as the total time required irrigating a crop in a season. The average times shown in the table are for 8-hour days. It is evident from Table 6.5 that the irrigation-time component requires more labour than any other labour component. Pattern A for example, shows about 50% of its labour requirements come from irrigation-time. Irrigation-time labour requirement for river diversion patterns involves opening and closing diversion structures, while for treadle pump patterns it involves the actual manual operation of the pumps. For residual moisture patterns, there is no irrigation-time labour requirement involved. If irrigation-time makes up a greater part of labour requirement per pattern, and given that labour costs make up a greater part of the annual costs per pattern, it can safely be concluded that irrigation-time labour is the most expensive component of the patterns, when labour costs are counted.

Why are labour costs for irrigation-time high? Perhaps high costs in labour for irrigation-time, may come from the fact that farmers over irrigate their crops. This means farmers spend more time irrigating their crops than necessary due to lack of proper irrigation scheduling techniques. Further examination of Table 6.5, it can be seen that the average irrigation-time is nearly 30 days for river diversion pattern A, while other patterns have more irrigation-time, about 42 days for treadle pump pattern D. This means farmers spend one-quarter to one-third of a 120-day maize growing period irrigating their crops. If an active growing period of 90 days is considered for maize, then irrigation is roughly done on a 1-day or 2-day interval. During the study some farmers were seen irrigating the same plants twice a day, in the morning and in the afternoon. This in my view could be over irrigation. With proper assistance, labour costs can be tremendously reduced if correct irrigation intervals are followed.

Table 6.5: Average number of days spent on each labour component

PARAMETER	PATTERNS					
	A	B	C	D	E	F
	(N=10)	(N=10)	(N=8)	(N=8)	(N=8)	(N=7)
Agriculture technology	River diversion	Treadle pump	Flood recession	Treadle pump	Treadle pump	River diversion
Plot area	0.16	0.15	0.18	0.27	0.39	0.49
Crop	Maize	Maize	Sweet potatoes	Maize	Maize	Maize
Planting	1.5	3.9	5.0	6.9	4.1	6.4
Fertilizer application	3.1	3.0	0.0	4.4	4.3	9.9
Chemical spraying	0.0	0.0	0.0	0.0	0.0	0.0
Manual weeding	5.8	4.8	8.1	10.7	12.8	15.7
Irrigation-time (river diversion)	27.5	0.0	0.0	0.0	0.0	39.0
Irrigation –time (treadle pumps)	0.0	36.8	0.0	41.6	35.1	0.0
Structure repairing	6.0	0.4	0.0	0.6	2.6	10.7
Manual harvesting	5.7	4.9	8.0	5.2	3.9	11.9
Threshing	5.0	5.2	0.0	5.4	4.3	7.3
Packing/ storage	1.0	2.6	0.0	3.8	4.0	4.4
Total annual labour time	55.6	61.6	21.1	78.6	71.0	105.3
Total annual irrigation time	27.5	36.8	0.0	41.6	35.1	39.0
Annual irrigation time as a percentage of annual labour time	**50**	**60**	**0**	**53**	**49**	**37**

6.11 Maize breakeven market price

The average selling prices for maize in each of the patterns with margins assumed as zero were worked out. Note that this analysis was for patterns growing maize only, as these were the patterns with little margins. Patterns growing sweet potatoes had high margins, as discussed already.

The price at zero-margins suggests a price above which farmers in each pattern can start benefiting. This is the price if gross production equals annual costs. The price considers all annual costs, including labour costs (Table 6.6). It is shown that farmers under treadle pump pattern B need to sell their crops at nearly five times the government regulated price in order to begin to realize a net profit. While those farmers under the most common river diversion pattern A should sell their crops at more than three times the government regulated price in order to begin to realize profits.

Table 6.6: Recommended breakeven maize selling price (situation where gross margins are zero) when all costs including labour are considered

PARAMETER	PATTERNS				
	A	**B**	**D**	**E**	**F**
	(N=10)	(N=10)	(N=8)	(N=8)	(N=7)
Agriculture technology	River diversion	Treadle pump	Treadle pump	Treadle pump	River diversion
Average plot size (ha)	0.16	0.15	0.27	0.39	0.49
Crop	Maize	Maize	Maize	Maize	Maize
Average yield (kg)	299	245	444	794	840
Total annual costs with labour (MK)	14310	18833	23274	23308	34214
Annual gross margins (MK)	0	0	0	0	0
Market price @ 0-margins (MK/kg)	48	77	52	29	41
Regulated government price (MK)	17	17	17	17	17
Prevailing local market price (MK)	25	25	25	25	25

6.12 Labour value for maize farmers

Assuming that farmers were paying themselves for the labour, what is the value of labour, without considering the government recommended value of MK200/day? The results of this analysis are shown in Table 6.7. The analysis was only for those patterns that show little margins, i.e., those that grow maize. The results show that farmers under river diversion pattern A were earning more for their family labour than treadle pump farmers in patterns B. However, farmers in all patterns that grow maize were paying themselves less than the government recommended figure.

Table 6.7: Labour value for maize farmers

PARAMETER	PATTERNS				
	A	B	D	E	F
	(N=10)	(N=10)	(N=8)	(N=8)	(N=7)
Agriculture technology	River diversion	Treadle pump	Treadle pump	Treadle pump	River diversion
Annual costs without labour (MK)	3190	6513	7554	9108	13157
Total labour time (days)	55.6	61.6	78.6	71	105.3
Production (without labour) (MK)	7475	6125	11107	19844	21000
Margins without labour (MK)	4285	-388	3553	10737	7843
Value of labour per day, when margins set to zero (MK)	77	-6	45	151	74

6.13 General discussions on low margins

The study has shown that farmers have low margins, meaning that they have very little benefits. This discussion suggests some of the issues that may contribute to the low margins experienced by farmers. With various reasons, little benefits are not unique to the Shire Valley. In Zimbabwe, Shumba and Maposa (1996) found low margins for irrigation farmers. Inability to afford inputs, limited market outlets, and unreliable water supply, were among the major constraints contributing to low margins in Zimbabwe. Note that in this study water supply was not a problem to most of the respondents (Fig. 5.19). A study carried out in Tanzania by Bee et al. (1997) found out that many farmers could not afford the cost of inputs such as fertilizers and chemicals; as a result their yields were very low resulting in low margins. Elsewhere in Tanzania, Senkondo et al. (2004) reported negative gross margins for maize were due to the fact that farmers were not able to cover their production costs. In South Africa, low crop margins were also reported by Ishmael et al. (2002). Also in South Africa, the study carried out on farmers on Modder River basin by Woyessa et al. (2006) who compared the economic benefits of upstream and downstream communal land water users, showed very low margins, although the downstream users had better margins than upstream users.

Low margins are usually the case of farmers being unable to afford inputs. Perhaps it is worthy to explore why many farmers, not just in the Shire Valley, but Malawi as a whole, are unable to afford inputs. During late 1990s, Malawi underwent structural adjustment program, where subsidies of many commodities including agricultural input products such as chemicals, fertilizers were removed. With subsidies removed many farmers became unable to afford the cost of inputs. As a result, many farmers grow crops without or with little inputs. Realizing how difficult it was for smallholder farmers to afford inputs, the government of Malawi introduced the Targeted Input Program (TIP). Under TIP, only selected farmers receive free inputs such as seeds, fertilizers, chemicals, etc. Farmers have to fulfill certain conditions in order to qualify for TIP. Since this study shows many farmers in the Shire Valley cannot afford the cost of inputs such as chemicals for pests and diseases (section 5.9.5, and Fig. 5.27), it is possible TIP does not reach out to all that need it.

One question that may be asked is, if farmers experience such low margins, why do they engage in small-scale irrigation agriculture. There could be three possible answers to this question. Firstly, many farmers have no choice since agriculture is their main income. In other words they are subsistence farmers heavily relying on agriculture for their livelihoods. Secondly, many farmers may not realize that they are making losses or little profit. Since farmers do not keep records, it is very difficult for them to calculate their benefits at the end of each growing season. Thirdly, it may mean that farmers are not concerned with the financial benefits as calculated in the study. Financial benefits may be misleading since farmers may be concerned more with producing enough for consumption than for sale. Farmers make sure they produce enough maize for consumption. Apart from selling, sweet potatoes are strategically used to back up maize reserves when they when run out.

6.14 Chapter summary

There were six farming patterns identified in the Shire Valley wetland. Of the six, three were the major ones; where flood recession agriculture, river diversions, and treadle pumps, were the main methods used by farmers to supply water or moisture to crops.

The economic analysis showed low farmer-benefits, except those that grow sweet potatoes under flood recession agriculture. With low input costs, sweet potatoes are silently unnoticed as the crop with more benefits than maize. In general, annual costs of technologies resulting from inputs and running costs have a bearing on the benefits. Even though the benefits are considered low, technologies where farmers have to incur little in their operation appear to have more benefits than those where farmers may have to incur some costs in their operation In other words, technologies that require low labour inputs (e.g. flood recession and river diversion) are more beneficial than those that require large labour inputs (e.g. treadle pump). Gross margins increase with increasing plot sizes for both maize and sweet potatoes under all agriculture technologies.

CHAPTER SEVEN

DISCUSSIONS AND CONCLUSIONS

7.1 Chapter overview

Despite the fact that there were a number of limitations in the data collection process, as discussed in the methodology, this chapter summarizes the main findings of the study. The chapter also describes the limitations and applicability of the results.

7.2 Major findings under objective I

Objective I: *To identify and describe agriculture technologies and socioeconomic characteristics of farming systems currently in use in the Shire Valley wetlands. Agriculture technologies here refer to the water management practices used by farmers to supply water or moisture to crops in wetlands.*

The following were the major findings under objective I:

7.2.1 Agriculture technologies

Flood recession agriculture, river diversion and treadle pumps were the common technologies among the farmers interviewed. The study showed that about 68% of the respondents preferred flood recession and river diversion (Fig. 5.1) to treadle pumps, citing capital requirements and running costs as major obstacles. However, the government and NGOs were promoting treadle pump technology (mostly) and river diversion, but not recession agriculture. Other technologies included watering cans and motorized pumps. At the time of the study, motorized pumps, introduced under various government schemes, were no longer in use due to farmers' inability to meet fuel costs and repairs. In general the technologies preferred by farmers could be referred to as 'traditional' as described by Kay (2001) and Brown *et al.* (1995) who showed that these technologies are linked to farmers' decision making. Thus under these technologies, water management decisions are made by farmers.

This shows that energy is critical in wetland agriculture. The costs and means of providing energy appear to be the main determining factors in adoption of irrigation technologies. The technologies that require less energy are more likely to be adopted than those that require more energy. Treadle pumps and motorized pumps require farmers to provide more energy (physically for treadle pumps, powered by fuel in case of motorized pumps) than gravity methods (flood recession and river diversion). Flood recession and river diversion technologies are more likely to be adopted than treadle pumps and motorized pumps.

7.2.2 Wetland use not new

The study shows that although wetland use intensified within the last 15 years, the practice was not new. Out of the 200 respondents, 74% indicated to have started using their plots within the last 15 years, while 26% used their plots for more than 15 years (Fig. 5.6). Perhaps this is a proof that wetland use was not a new phenomenon, but rather it has been intensified within the last 15 years, as also claimed by Peters and Kambewa (2007) and FAO (1996) as discussed in section 1.7. Later in this chapter, attempts have been made to try to explain why there has been such a surge in wetland use within the said period.

7.2.3 Inheritance plot ownership

Land ownership was mainly controlled by farmers who pass on ownership to their children under traditional custom. The study showed that more than 50% of the 200 respondents owned their plots through inheritance. Inheritance could be direct from parents to children or from grandparents to grand children. Some respondents explained that their grandparents had originally obtained the land from chiefs who had the power to distribute land to their villagers on permanent basis. Once distributed by the chiefs, land usually becomes the permanent property of the family; and can only be passed on to a member of that particular family. Owning land through inheritance is not only common in the Shire Valley, but in other areas of Malawi as well. Generally, Peters and Kambewa (2007) showed that 60% of wetland farmers own their plots through inheritance. Sustainability of development projects in wetlands should therefore consider integrating this type of land ownership in their planning.

7.2.4 Individuality

The study showed that 90% of the respondents were individual farmers, as opposed to group farmers (Fig. 5.9). Many farmers preferred to manage their land as individuals, and not belonging to a farming group. This was so because, many farmers regarded group farming as a surrender of their land ownership rights. Individuality of farmers may be linked to the fact that most of the land is owned through inheritance.

In order to ensure that the land remains the property of the family, farmers prefer to utilize their land as individuals. Thus farmers feel more secure to access their land as individuals than as a group, in order to maintain their rights as a family property. It is important to remember that during the one-party rule (1964-1994), the state forced some farmers to surrender their customary land for the construction of settlement schemes. When Malawi changed to multi-party democracy in 1994, farmers wanted to be treated as individuals, perhaps fearing that the state might force them out of their land again. Studying the Lake Chilwa basin, Ferguson and Mulwafu (2004) also observed that individuals were in control of most of the land, and Peters (2004b) showed that the majority of farms in Africa were the control of individuals. However, the study observed that some form of group cooperation existed mainly during construction of canals that traverse over different farmers' fields, for example in river diversion technologies where a canal may feed different farmers' fields.

7.2.5 Plot and family sizes

The majority of the respondents (about 90%) had plot sizes below 1 ha, typical of smallholder farming systems in Africa (Shah et al., 2002). The study found out that there was a general relationship between family sizes land plot sizes and family sizes. As family sizes increase plot sizes also increase (Fig. 5.15). One possible explanation for this relationship could be: as family sizes increase, the need for household food security also increases; hence they opt for large plots to increase food security. Another explanation could be: large family sizes have enough labour at their disposal to manage large plots. At this point it may be important to examine the factors that make families to have large households.

The study showed the average household members in the Shire Valley to be 6, while FAO (1996) reported the general average members per household in wetland areas in Malawi as 5.7. Note that the Shire Valley, particularly Nsanje district, has a high prevalence rate of HIV/AIDS. Estimated at 32.9%, the HIV/AIDS prevalence rate in Nsanje was above the national average of 19.8%, and was the highest among all the 27 districts in Malawi (NAC, 2003). When parents die of AIDS, the orphaned children are usually taken care of by the immediate members of the family. It was therefore not surprising to see large family sizes.

7.2.6 Renting and sale of land

The study also established that the practice of renting and selling land was common in the Shire Valley. Some farmers rent out or sell land in exchange for cash while others do so in exchange for crop produce. There were about 20% of the 200 respondents that showed some form of renting.

7.3 Major findings under objective II

Objective II: *To assess the economic costs and benefits of various farming and small-scale informal irrigation systems. Costs and benefits of wetland farming systems are fundamental to the formulation of guidelines and strategies for their promotion. Gross margins, which are the difference between costs for production and total value of yields, will be used as the economic indicators.*

Generally, the study revealed that farmers who grow maize using treadle pump technology had very little benefits. About 30% of treadle pump farmers showed negative benefits (pattern B, Fig. 6.5). However, those that grew maize on river diversion showed some benefits. 90% of river diversion farmers who grew maize showed positive margins (pattern A, Fig. 6.4). It was noticed that all the farmers that grew sweet potatoes on recession agriculture had positive margins (pattern C, Fig. 6.6). It is important to remember that the analysis above considers the situation where labour costs are not included.

When labour costs were included in the analysis all the patterns (except pattern C) showed negative margins (Table 6.4). The major finding here is that the technologies that appear to be labour-intensive, for example, treadle pumps, appear to benefit the farmer less than those that are not labour-intensive such as river diversion and recession agriculture. These findings are consistent with recommendations by Woodhouse (2002). ''While it is possible that investment in technology might raise farm productivity, such technology should be labour-saving, not labour-intensive'' (Woodhouse, 2002). Perhaps because of labour intensity required by treadle pump technology, it explains why this technology was not popular technologies among farmers (Fig. 5.1), as discussed earlier.

The study also revealed that, in general for all patterns, gross margins increase with increasing plot sizes (Fig. 6.9 and Fig.6.11). The benefits for bigger plots were more than those for small plots. This means that in order for farmers to benefit they need to move away from tiny plots to large plots. Unfortunately the treadle pump technology, promoted by government is mainly designed for small plots. Perhaps the study should have established the relationship between plot sizes and agriculture technology. Other researchers, Polak and Yoder (2006) also suggested that small-scale farmers need new agricultural methods ''customized for 1 ha farms'' and gain access to inputs and credit in order to move out of poverty.

Critical observation of the findings shows that farmer benefits are largely linked to labour, input costs, and availability of markets. For example the farmers that produce sweet potatoes have minimal input costs but with readily available markets from local traders. As a result these farmers show some benefits. Those that produce maize under treadle pumps require considerable amount of inputs and labour to operate the pumps. In the end these farmers make little benefits. The fixing of maize prices by government markets further compounds the problem. However, the main reason for wetland cultivation could be to provide for sufficient food for consumption rather than economic production maximization.

7.4 Major findings under objective III

Objective III states: *To identify issues related to increased farmer attention to wetland use since early to mid 1990s, and determine how best could the government provide for appropriate and sustainable forms of support to wetland use.*

Objective III addresses two questions: one that deals with the explanation of why there has been an increased attention to wetland use, and the other that suggests how government could best assist the current agricultural systems.

7.4.1 Why increased attention to wetland use?

Hunger and droughts

Cases of crop failure due to drought are very common in Malawi. For example in 1991, it was reported crops failed in rein-fed uplands due to drought (Buckland, 1997). Another drought occurred in 2001/02 season. FAO (2004) also reported crop failure due to drought. The droughts in early 1990s may have caused farmers to diversify their food security strategies. Note that the study found out that more than 80% of the respondents still maintained their upland plots despite the droughts in the uplands (Fig. 5.11), and 72% of the respondents had more than 1 plot within the wetlands (Fig. 5.10). Perhaps this shows that farmers want to maximize their food sources. Woodhouse (2002) observed that diversification tend to ''improve storage and provide reserves with which to confront the risk of dry periods.'' Droughts were among those factors that villagers in Malawi perceived as causing poverty (FAO, 1996). The increase in food insecurity and poverty as caused by droughts increases the dependency on wetlands (FAO, 1996). Therefore this increase in wetland use may have been caused by the increase in food insecurity and poverty caused by droughts.

In the Shire Valley food insecurity is also caused by the occurrence of floods. Informal interviews with key informants confirmed that flood occurrences increased within the last two decades. Some respondents identified floods as being among the problems associated with farming in wetlands (Fig. 5.27). Floods occur during the rainy season and often destroy crops (late planted crops in wetlands). Overflow of rivers and streams also destroy upland crops. FAO (2001) reported ‘in Malawi, continuous heavy rains from late January to early March, and high water levels in the Shire river, resulted in serious flooding in southern and central areas, displacing 200,000 people and leaving 60,000 homeless. Serious damage to infrastructure and crop losses was reported.’’ The situation was reported serious in Nsanje and Chikwawa districts (Shire Valley), where many villages were said to have been completely submerged (FAO, 2001). No doubt the occurrences of droughts and floods during rainy seasons lead to food insecurity and poverty among the farmers who mainly subsist on agriculture. After the flooding season, farmers often engage into farming activities in areas where crop production is possible. With residual moisture left after the floods, and the existence of streams and water pools, wetlands become the ideal place. This means that farmers intensify agricultural activities in the wetlands during dry season to increase food security.

High demand of out of season crops

The Shire Valley is about 50km away from Blantyre, the largest commercial city in Malawi. Blantyre city is in high altitude areas while Shire Valley is in low altitude areas. As the climatic season for the two places are different the cropping calendar is also different. Crops grown in the Shire Valley wetland (in dry season) are normally out of season in Blantyre. For example, sweet potatoes grown in dry season in the Shire Valley wetland will be harvested at a time when they are out season in Blantyre.

Remember that the prices of many commodities increased in 1994 when Malawi changed from one party-rule to multi-party rule. The devaluation of the Malawi Kwacha in 1994 resulted in increased prices of basic commodities, especially food; wages and employment for low-income households were significantly reduced; and food price increases forced both the urban and rural poor to reduce their consumption or switch to lower quality foods (Chilowa, 2005). Many city dwellers use sweet potatoes for breakfast as an alternative to high priced bread. The Shire Valley is the main source of out of season sweet potatoes in Blantyre. The demand for sweet potatoes in the city may have increased the need to grow more in the wetlands. During the study, sweet potato traders from Blantyre city were noticed in the Shire Valley. This means the market for the crop was available. The availability or increase in ‘‘market opportunities’’ as observed by Woodhouse (2003) lead to intensification of water use.

The increase in private traders was mainly due to the deregulation of agricultural markets since 1996 which led to the abolishment of the system that required private traders to obtain licenses to conduct trade in the rural areas (Chirwa, 2004). As traders offered high prices, farmers were therefore, motivated to engage with the market and higher farm gate prices (Lankford, 2005). Increased production in wetland may therefore be a ‘‘response to market opportunities’’ (Woodhouse, 2003).

Although none of the respondents reported to have sold green maize, it was noticed during the study that some farmers were selling green maize to private traders who also came from Blantyre city. Like sweet potatoes, green maize was out of season in Blantyre while it was in season in the Shire Valley. The demand in the city created a readily available market. Once again, this shows the urban centre constitutes the principal market for the agricultural produce in the rural areas, as observed by Woodhouse (2009).

HIV/AIDS related issues

As explained in section 7.2, large family sizes induced by the high prevalence rate of HIV/AIDS in the Shire Valley may have increased the need for household food security; hence families may have turned to wetlands to increase food security.

Aftermath of refugee repatriation program

The one million Mozambicans refugees who crossed into Malawi and mostly settled in the Shire Valley were repatriated between 1994 and 1995 UNHCR (UN, 1995). However some remained as they intermarried with the locals (see section 1.8). During their stay in the Shire Valley, the refugees were supported by UNHCR. After repatriation, those that remained were no longer supported by UNHCR. They therefore had to find the means of supporting themselves. Although there is no documented evidence, but the general feeling is that most of them became farmers just like the locals. Note that the year of repatriation (1994) was a drought year in uplands. This drought year in the uplands may have influenced the remaining refugees and their families to turn to wetlands for food production.

Farmers perceive wetlands as more fertile than uplands

This study found out that a large number of farmers in the wetlands did not apply fertilizers, partly because of their inability to afford the high prices, and partly because they perceived wetlands as fertile. Similar findings by FAO (1996) suggested that the increased fertilizer prices between 1994/95 and 1995/96 growing seasons due to removal of subsidies and the devaluation of the Malawi Kwacha, was another factor that influenced many farmers to turn to wetlands which are generally perceived as more fertile than uplands. Kambewa and Nyembe (2008) also observed that the collapse of agricultural credit in 1994, combined with the escalation of prices of inputs made the growing of maize difficult. As a result some farmers diversified away from maize into non-cereal root crops such as sweet potatoes. In the case of Shire Valley, sweet potatoes were grown in wetlands, hence increased wetland use.

7.4.2 How could government provide support to wetland farmers?

Promotion of relevant technology

Obviously there are success stories of the treadle pumps as noted elsewhere in Malawi by Mangisoni (2008). Despite being promoted by government the study showed that the treadle pump technology was ranked third among the agriculture technologies used by the respondents. Evidence from the study further suggests that most of the treadle pumps were distributed for free either by government or NGOs. One would easily ask: if there was no free distribution, would treadle pumps exist in the Shire Valley? Although the study was not able not answer this question, but it can be seen that the treadle pumps existing in the study area were those distributed for free. None of the farmers showed willingness to buy a treadle pump. The reasons for non adoption of treadle pumps have been described earlier. The technologies preferred by farmers were flood recession and river diversion. Perhaps government could also consider promoting these technologies.

Provide access to inputs and credit to individual farmers

As has been discussed earlier, the study has shown that most farmers operate as individuals on inherited land with little benefits from current agriculture technologies. The issue of benefits is linked to farmers' inability to afford inputs. Further existing credit organisations require farmers to be in groups in order to access credit. Since farmers want to be treated as individuals, the government should consider providing access to individual farmers.
While it can be appreciated that government is committed to promotion of small-scale irrigation technologies in wetlands, it should be known that irrigation technology is not the only factor to increase farmer benefits. Polak and Yoder (2006) argued that access to affordable irrigation water should be complimented by providing access to inputs, credit, and 'new intensive agricultural methods customized for 1 ha' in order for smallholders to move out of poverty. Provision of subsidized inputs may also assist farmers to increase their benefits.

Reduce control of produce prices

The government should reduce control of produce prices. The presence of traders in the Shire Valley was an indication that private traders were the preferred buyers and not the government. It may therefore be appropriate of government lessens control of prices of produce.

7.5 Limitations and applicability of phase I results

The sampling technique used in phase I was one of the major problems encountered. Government staff (extension personnel in the study area) assisted to identify the respondents. Likely, this technique had some elements of bias. It was not possible to interview the farmers without the help of the government officials; they were the people who knew where farmers were. Given this limitation, I decided to interview as many farmers as possible in an effort to counteract and possibly overcome any selection bias that may have been created.

The study team was sometimes mistaken as government enumerators, who enrol farmers for free inputs. Under this limitation, farmers may have given information that would advantage them for free inputs. Before each interview, government officials explained to the respondents the main reason for the interview. For this reason I made sure that government officials always accompanied the study team. However, these officials were not present during the interviews.

Lack of farm records was one of the limitations. Most farmers did not keep records of their farming activities. Where quantities were involved, it was difficult to judge the accuracy of the responses. Where this happened, respondents were urged to explain in details.

Although there were these limitations phase I results still showed that the Shire Valley wetland is a complex flood plain landscape with small streams, where farmers have increased cultivation since early to mid 1990s. Farmers mainly open up small farms on their own using different water management techniques, and that government or NGOs are trying to assist them in some instances.

7.6 Limitations and applicability of phase II results

As observed in phase I, many farmers lack record-keeping skills. Most of the information captured was based on what the respondents could remember. Many respondents could not remember quantitative information several seasons in the past. They mostly remembered information in the preceding season or year. Quantities involving yields were an example where farmers had no documented information. Although there were standard units used for measurements of yields, the ability to remember those units was the main concern.

Under these limitations however, it is still possible from phase II results to note that farmers' benefits are low, with exception of where flood recession is used to grow sweet potatoes. It is also possible to note that the water management technologies preferred by farmers receive little or no attention from government or NGOs.

7.7 General applicability of the results

Wetland use has generally increased in recent years, due to rainfall failures in the uplands which historically have been the main agricultural areas. Agriculture technologies with indigenous elements, such as flood recession, small river diversions, are common among wetland farmers. As wetlands continue to be alternative sources of crop production, there is need to understand these farming systems to advance their promotion sustainably under local conditions. The results provide a platform or baseline information for future studies.

7.8 Lessons learnt from the study

Some of the lessons learnt from the study include:

Interviewing farmers is a complex process, sometimes with problems often ignored during planning process. Some issues arise in the field, and the researcher has to learn on how to adapt or solve those problems as they are encountered.

A researcher perceives a research problem differently from a farmer. What a researcher views as a problem may not necessarily be a problem to the farmer.

Important issues omitted in the questionnaire may arise during interviews. Under these circumstances it is better for the interviewer to capture the farmer responses including issues not originally on the questionnaire. It was therefore important to do a qualitative study prior to explore relevant issues to be included in the survey.

Where small groups are involved, it is better to go through the questionnaire as a group, and then individual interviews can be performed later. This ensures that all members of the group have understood the questions, and chances of answering them correctly are likely.

7.9 Chapter summary

With limitations of the study as have been discussed, the study has been able to show; what agricultural systems exist in the Shire Valley wetlands, and how those systems are managed. The study has shown that the Shire Valley wetland is a large complex bushy flood plain area with small farms, where farmers use different water management techniques. The wetland use has increased since early to mid 1990s, as farmers try to diversify their livelihood strategies. After farming in rain-fed uplands, where sometimes crops fail due to droughts, households diversify by including wetland agriculture during dry season, as an ‘‘attempt to expand existing activities’’ (Dorward et al, 2009). This is done to ensure that households have enough food for consumption.

The increased wetland use is also linked to the worsening economic situation caused by structural adjustments in mid 1990s which included increases in food prices. Wood and van Halsema (2008) observed that significant increases in food commodity prices have the capacity to transform agrowetland systems.

Although government or NGOs are trying to assist the farmers, most techniques have low benefits, except where flood recession is used to grow sweet potatoes. Access to credit by individual farmers, promotion of less labour intensive technologies, and increased liberalization of markets, may assist to increase farmer benefits. As a matter of policy, government need to analyse these systems in order to effectively promote them. The study has been able to fulfil the objectives for which it was meant. In summary the study agrees with some existing literature.

CHAPTER EIGHT

RECOMMENDATIONS

8.1 Chapter overview

Based on the findings, this chapter presents the recommendations of the study. The recommendations will be communicated to the farmers, government officials, NGOs and other interested stakeholders that include students at agricultural colleges in Malawi.

8.2 Recommendations

Based on the results, informal interviews (both with farmers and key informants) and observations, the study makes the following recommendations:

8.2.1 Promotion of labour saving technologies

Since the study established that labour was a critical factor, both in the adoption of agriculture technologies and in increasing farmer benefits, it is important that government and NGOs should include labour saving technologies in their wetland agriculture promotion programmes. Such technologies include river diversion and flood recession. These technologies require little capital investments affordable by smallholder irrigation farmers. The other advantage of river diversion and flood recession is that they can be used on large plot sizes, thereby increasing food production and farmer benefits. Clearly, the study showed that the treadle pump was not a priority technology.

8.2.2 Increase access to inputs and credit

Inputs and credit play a pivotal role in increasing crop production. The study showed that lack of inputs and credit was linked to low farmer benefits. Currently it is difficult for farmers to access credit from the existing agricultural lending institution. Most of those institutions require farmers to form groups which are not popular not only in the Shire Valley but Malawi as a whole. In which case, the lending institutions should consider providing credit to individuals. Remember that currently the government of Malawi is implementing the Target Input Programme (TIP) where selected poor farmer receive free inputs. While there are success stories of this programme, the problem is that the programme does not reach out to all farmers that need it. By allowing agricultural lending institutions to provide credit to individuals, a wider population of farmers may be reached. Therefore it is recommended that government should consider putting in place a legislation that can allow individual farmers to access inputs and credit from agricultural lending institutions.

8.2.3 Introduce subsidies of farm inputs

Government must be seen to encourage farmers to participate in irrigation programs not only by making irrigation resources available and affordable, but also by not regulating the price of crops in institutions that buy the crops from farmers. Marketing institutions set up by government must not be profit-making institutions by dictating the buying and selling prices of agricultural products. Instead, those institutions must support the small scale irrigation farmers by offering low-priced inputs. In other words, government should consider re-introduction of subsidies on agricultural inputs.

8.2.4 Farming timing

Those patterns that start farming or irrigation season around May should be encouraged to adjust their calendar and start irrigating around March, soon after the rainy season. This will increase the irrigation seasons per year, and thereby increase production, consequently increasing food security. Adjusting the start of irrigation seasons to March increases the overlap period with the upland crop, thereby reducing the period without food in a year. This recommendation may not sound feasible but with proper farmer awareness it may be possible.

8.2.5 Formation of associations where possible

Where possible, farmers can form associations or cooperatives. Through these groups micro finance institutions can now come in and assist farmers with small loans for inputs or for capital. Since farmers want to operate as individuals, these groups should only be for the purpose of accessing inputs and loans. In order to remove the fear of infringement their land rights, farmers should form these groups on their own without any external influence. Under these conditions the management of their farms would still be maintained at individual level.

8.2.6 Promotion of sweet potatoes

It has been shown that sweet potatoes have huge advantages over maize. Advantages range from less input costs, less labor requirement, to large margins. Unfortunately, traditionally the crop is not regarded as essential. Promotion for change of eating habits can be encouraged, so that sweet potato can be as essential as its counterpart, maize. With such economic benefits, sweet potatoes could lead to prosperity of farmers in the area.

8.2.7 Land and water rights

Land and water shares are still based on the traditional ways of acquisition. With increasing pressure on land and water, these traditional ways can easily be a source of conflicts in the near future. Farmers and traditional leaders should be made aware of the existing land and water laws. Since the law exists, it is therefore a question of bridging the gap between what the law says and what is the reality on the ground. Perhaps the extension messages should include legal messages on the use and management of natural resources.

8.2.8 Use of fertilizers

Farmers must be encouraged to use fertilizers. Nobody disputes the fact that inorganic fertilizers are expensive, but certainly organic manure can be easily made in an area where animal litter is plenty. Promotion of organic manure made from animal waste could work well in this area where domestic animals are plenty.

8.2.9 Training of extension workers

Extension workers bring the gap between the farmers and policy makers. They disseminate agricultural messages to farmers. For this reason, it is important that they are well trained and equipped for their job. Unfortunately most of them do not have proper training, especially in water resource management. With changing environment in the wetlands these workers may perform well if they are aware of the issues affecting the wetland farmer today.

8.2.10 Selling produce on demand

In order to increase crop profits farmers can temporarily store their produce and release it into the market when the produce is out of season when the demand is high. During this period the produce may be sold at higher prices than during the harvest season. In this case, farmers should have storage facilities that can safely store the produce without being attacked by pests. Chemicals may be required where maize is stored for a long time.

8.2.11 Possible future research areas

The findings of the study will assist in teaching at agricultural colleges in Malawi including Bunda College. For example, it is important to make students aware that sustainable small scale-irrigation in wetlands involves the supply of water to crops using acceptable and suitable technology. The acceptability and suitability of technologies depend on a number of factors which include access to labour and the means for providing energy for irrigation technologies. Based on the strengths and weaknesses of this study the students may also formulate possible future research areas. These may include:

- Understanding the link between the upland and wetland crop productions. How crop production in uplands affects the extent of wetland use per season was not clearly articulated in this study
- Exploring how each of the agriculture technologies has grown in use over the years
- Information about other plots in the wetlands. If farmers have multiple plots in the wetlands, what are the characteristics of the other plots?

- The possibility of calculating gross margins if farmers sold their maize green
- The alleged sexual implications of using treadle pumps
- Possibility of designing energy efficient pumps
- Possibility of using low cost maize storing structures to increase profits

8.3 Chapter summary

The chapter has covered a number of issues, some which may be considered by policy makers in order to increase benefits of wetland or small-scale informal irrigation agriculture farmers, while others are recommendations for possible future research areas.

CHAPTER NINE

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APPENDIX 1

ENGLISH VERSION OF QUESTIONNAIRES AS USED IN PHASE I OF THE STUDY

FOR FARMERS

Describe the water management or irrigation technology you use on this plot

How do you describe your land ownership of this plot (permanent, temporary)?

Describe how you acquired this plot

For how long have you been using this plot?

What is the main crop you grow on this plot?

What is the size of this plot? (measurements taken after interview)

Is your plot part of a farming group?

What is your main source of water or moisture?

How reliable is your source of water or moisture?

When do you normally start the irrigation season?

Do you have other plots elsewhere in the wetland?

Do you have plots both in the wetland and the upland?

What would you say is your main source of income?

How many people live in your household?

How do you describe your education level?

How do you describe your gender?

Describe the main problem or challenge associated with wetland farming?

Probing questions

How important is irrigation in wetland to you?

Why do you still keep upland plots?

How many irrigation seasons do you have in a year?

Why do you have other plots elsewhere in the wetland?

Are there any conflicts about land and water, how do you resolve them?

FOR KEY INFORMANTS

Information about the plot

How and why did you start farming in the wetlands?

What problems have you experienced so far?

How does irrigation benefit the community?

Are there any conflicts regarding land and water?

If there are any, how are they resolved?

Land allocation

How are plots normally acquired?

Who is normally responsible for land allocation?

Do some households rent out their plots and why?

What is the average rental value?

Crop yields

What crops are grown in uplands and wetlands?

Are there any differences in yields in upland and wetland?

If yes what are the contributing factors to the differences in yields?

Are the crops being grown now the same as the case was before?

Marketing

Are there any problems in marketing produce?

What are these problems?

Water or moisture management

Are there any problems with regard to water management?

If yes what are these problems?

Is there any fee that people are suppose to pay and how much?

Do you have water rights?

What problems are experienced with regard to water distribution?

Is the water enough in seasons?

Extension services

Are there any extension services provided?

Are farmers satisfied with the extension services being provided?

What problems if any are associated with the extension services?

Farmer organizations

What farmer organizations (clubs, associations, and cooperatives) exist in this area?

How have farmers benefited from these organizations?

APPENDIX 2

ENGLISH VERSION OF THE QUESTIONNAIRE FOR PHASE II OF THE STUDY

(Questions mainly referred to preceding season)

Household composition

Gender?

Number of people in a household?

Main occupation?

Land issues

How did you acquire your plot?

Do you pay rent for your plot, how much?

Did you buy your plot, how much?

Irrigation activities

Describe the irrigation methods you used

List the irrigation activities involved, and how long you spend on each?

How do you pay for each irrigation activity, how much?

What structures are involved?

How do you pay for irrigation structures, how much?

Crop production

What is the main crop you grow in the wetlands?

For what purpose do you grow this crop?

What is the total area?

What activities are involved in crop production, and how long you spend on each?

How do you pay for each irrigation activity, how much?

What is the total quantity that was harvested?

How much was kept for household consumption

How much was sold?

Fertilizer use

What type of fertilizer or manure do you use?

How much is the quantity of fertilizer you use?

How much do you spend on fertilizer?

What is the source of the fertilizer?

Chemical use

What quantities of chemicals do you use?

How much do spend on chemicals?

What problems do you experience in sourcing inputs?

What is the source of the chemicals?

Farm implements

What type of farm implements do you own?

How many?

How much did you buy /pay for each?

What is the source of the implements?

Credit

Do you have access to credit?

Who provides credit?

Marketing

Where do you sell the crop?

To whom do you sell?

How do you transport the produce?

What was the market price?

How much do you pay for transporting the produce to the market?

What problems do you face in marketing your produce?

Crop storage

What storage structures do you use?

How do you pay for materials?

How much did it cost you to build?

How long did it take to build?

Crop processing

How do you process your produce to add value?

What type of processing equipment/tools do you own as a household?

What type of processing equipment is available in the area?

Do you have access to this equipment?

How much does it cost you to have your produce processed?

What problems do you face in processing?

Extension

Is there an extension agent in your area?

If yes who employed the agent?

What are the sources of extension messages in this area?