A case study of the impact of irrigation on household food security in two villages in Chingale, Malawi

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ABSTRACT

This case study investigated the impact of irrigation on household food security at Ibu and Kalizinje villages in Chingale, Malawi. The aim of the study was to investigate whether irrigation improved household food security. The study was qualitative in nature. Fifty-eight farmers and three World Vision field staff participated in the study. Group discussions with participatory techniques and in-depth interviews were used to collect data. Data were analysed qualitatively using matrix/logical analysis.

Irrigation improved irrigating farmers' household food security through an increase in production and income levels. Irrigating farmers were better off in terms of crop production and income levels than non-irrigating farmers. Irrigating farmers planted irrigated maize two to three times a year, while non-irrigating farmers planted rain-fed maize only once a year. In terms of income levels, irrigating farmers produced more food than households required, and sold surpluses. Most irrigating farmers began cash cropping after the introduction of irrigation and also earned higher incomes, as irrigation enabled production of crops during lean periods and enabled them to sell surpluses at higher prices.

Irrigation did not improve crop diversification. Non-irrigating farmers diversified crops more than irrigating farmers by planting groundnuts and sweet potatoes. Income from irrigating farmers did not increase dietary diversity and the acquisition of assets for irrigating farmers. Few farmers consumed a variety of foods and few acquired assets with the income derived from irrigation. Nevertheless, irrigation has the potential to smooth production cycles and provide food and income during seasons when food and income would be low.

In addition, the study revealed the following as problems faced by farmers: constraining size of small diesel pumps, pump breakdown at Kalizinje, floods, pests and diseases, storage problems, lack of market places and poor roads, small land sizes, and expensive farm inputs.

The above findings indicate the need for encouraging irrigating farmers to diversify crops; accommodate more people in the irrigation projects; and form groups to work together in

achieving goals. World Vision Malawi should also provide pesticide loans and train farmers in technical and managerial skills; water and land management; financial management; nutrition skills and food storage. Provision of irrigation equipment and input loans or training farmers in alternative techniques for example organic farming that requires no or low inputs; introduction of subsidy programmes on inputs so as to enable farmers to buy inputs at affordable prices; construction of market places and good roads by government and concerned stakeholders are also necessary.

DECLARATION

I, Edna Kalima, declare that:

- The work presented here, except where otherwise indicated, is my original work.
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- This work does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from those persons.
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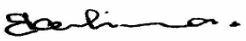
Signed:  Date: December, 2008

As Research Supervisor, I agree to submission of this dissertation for examination.

Signed: …… Date ……..

Professor S L Hendriks

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CHAPTER 1 THE PROBLEM AND ITS SETTING

1.1 Introduction

Food security is defined as the state when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life (United States Agency for International Development (USAID) 1992). According to Sahley *et al.* (2005), the definition of food security comprises three components namely: food availability, food access and food utilisation. Ali-Dinar (2006) explained that to be food secure means food is available, affordable and well utilised.

Food insecurity on the other hand, is simply the lack of food security which, in the extreme, is experienced as hunger (Hendriks 2005). It is evident that hunger continues to loom in some parts of the world today (McClain–Nhlapo 2005). The Food and Agricultural Organisation (FAO) (2002a) estimates that in the developing world, 840 million people are undernourished and food insecure. Yonge Nawe Environmental Action Group (2002) have stated that, between 1998 and 2001, 13 million people in southern Africa alone required food aid to stave off hunger brought about by dry weather and erratic rainfall. In 2005, around 12 million people across southern Africa alone are reported to have faced severe food shortages, mostly as a result of poor rains (Oxfam Great Britain 2006). Although the food security conditions are reported to have been stable since the 2008 harvests (April – June) in southern Africa with exception of Zimbabwe, projections indicated 8 million people would be at risk of food insecurity during the April 2008–March 2009 consumption period, and would require some kind of food assistance (Famine Early Warning System Network (FEWS NET) 2008).

The case of Malawi is no exception. Sahley *et al.* (2005) reported that Malawi is becoming increasingly food insecure, and has become dependent on food donations to fulfil national food needs. Reports indicate that throughout the 1990s, agricultural production was characterised by marked changes in production, mainly from drought (FAO and World Food Programme (WFP) 2004). In 2002, Malawi faced serious food shortages and hunger due to a combination of political and environmental causes (Ferguson *et al.* undated). In the 2003/2004 and 2004/2005 growing seasons, crop yields were negatively affected by drought (Oxfam Great Britain 2006). The

Southern African Development Community (SADC) (2006) stated that in 2005, the food security situation in Malawi continued to deteriorate due to crop failure experienced during the 2004/2005 growing season.

However, the Department for International Development (DFID) (2007) reported that the 2005/2006 production year showed good harvests while the 2006/2007 production year showed bumper harvests due to good rains and subsidised fertilisers. Malawi produced 34% increase from 2.58 million metric tons in 2005/2006 growing season to 3.44 million metric tons in 2006/2007 growing season (FEWS NET 2007). This is above Malawi's food need of approximated 2 million metric tons per year (Southern Africa Regional Poverty Network (SARPN) 2006).

Malawi's economy is highly dependent on the agricultural sector (Action by Churches Together (ACT) 2003). A joint report by the African and European Unions (2003) explained that 80% of the Malawian population is dependent on rural incomes, yet there is very little or no investment by the government and other organisations in rural areas. The National Statistical Office (NSO) (1998) reported that 65.3 percent of Malawians are poor. The poverty line adjusted to September 2000 shows the poverty lines in Malawian Kwacha (MK) of three administrative regions and the urban area of the country as follows: the southern rural area: MK15.33; the central rural area: MK 18.50; the northern rural area: MK22.04; and the urban area: MK50.15 per person per day (NSO 1998).

Since Malawi's food security situation seemed to have improved in 2006 and 2007, the challenge for Malawi now is to build on the successes of these past two years (DFID 2007). Again, the poverty situation in Malawi indicates that most households in Malawi, for most years, are unable to acquire the minimum basket of food items through their own food production, or by market purchases (Sahley *et al.* 2005). Therefore, there is still need for sustainable solutions to deal with the causes of food insecurity while ensuring improved agricultural production and reduction of poverty.

The African and European Unions (2003) pointed out that with recurrent droughts and the need to produce crops during the winter months, especially in the dry season, irrigation is the surest way of ensuring food security and reducing poverty in Malawi. By the year 2003**,** around 62,000 hectares of irrigation were developed in Malawi. In addition, the government of Malawi has been prompted by Malawi's persistent food shortages to align policies towards rapid irrigation development (African and European Unions 2003). It is against this backdrop that this study investigated whether irrigation as an intervention improved household food security. The study investigated the impact of irrigation on household food security in two villages in Chingale, Malawi.

1.2 Importance of study

Irrigation in Malawi is often assumed to be the surest way of ensuring food security and reducing poverty. As an intervention, irrigation is greatly needed to reduce the serious food shortages and hunger that Malawi has been facing for a long time (African and European Unions 2003). However, the question of whether irrigation improves food security or not needs to be answered, and this is the core of this study. Studying the impact of irrigation on household food security is important for a number of reasons discussed below.

Firstly, the study can help stakeholders like the Ministry of Agriculture and Food Security, the Department of Irrigation, the Agricultural Development Divisions (ADDs), Rural Development Projects (RDPs), the private sector and donors in Malawi understand the contribution of irrigation in ensuring household food security. The findings of this study would encourage government and stakeholders to contribute more effectively to the design and implementation of irrigation programmes, and to invest in irrigation systems in order to ensure food security at both national and household levels in Malawi.

Secondly, the findings could assist in identifying and understanding the problems brought about by irrigation. This would enable government and other stakeholders to introduce measures to deal with these problems and to search for alternative strategies to dealing with the problems with a view to improving food security. Policy makers and project owners (in the case of this study;

World Vision Malawi) could use the findings to make improvements in policies and operations in irrigation projects.

Knowledge of both the positive and the negative impacts brought about by irrigation could broaden farmers' understanding of irrigation systems, and encourage them to be responsible in managing and operating available irrigation systems.

1.2.1 Problem statement

This case study seeks to investigate whether irrigation improved household food security in two villages in Chingale, Malawi.

The following sub-problems were investigated:

Sub-problem 1: Are irrigating farmers better off in terms of crop production levels than non-irrigating farmers?

Sub-problem 2: Are irrigating farmers better off in terms of income levels than non-irrigating farmers?

Sub-problem 3: Is there an increase in diversification of crops for irrigating farmers than for non-irrigating farmers?

Sub-problem 4: Does income from irrigation increase dietary diversity and asset acquisition of farmers?

1.3 Study limits

In investigating the impact of irrigation on household food security, this case study does not include gender-related issues. Therefore, the case study does not investigate whether male or female-headed households had similar or different experiences with respect to the impact of irrigation on household food security. Furthermore, with respect to economic feasibility, the case study did not investigate whether this irrigation project was economically viable or worth pursuing. Instead, aspects that were directly related to food security at household level such as crop production levels, income levels, crop diversification and the role of income from irrigation in increasing dietary diversity and acquisition of assets, were investigated. Available resources, crop production before and after irrigation and the benefits and problems experienced by irrigating and non-irrigating farmers were also investigated.

The study only focused on the two components of food security (food availability and accessibility) because of the simplicity in monitoring and measuring the food security situation of the targeted individuals. Focusing on the third component of utilisation would also have required a lot of resources in terms of money, time and equipment. Although dietary diversity (that can be used as a measure of utilisation) was measured, the focus by this study was not utilisation that could bring about nutrition security but on the use of income generated from irrigation to access food.

Under normal circumstances, irrigation is used during dry seasons. The study therefore required information on irrigation for the full growing season. Although the study was conducted in 2007, only information from 2000 to 2006, years when irrigation was introduced and practiced, was investigated because irrigating farmers were more likely to have this information than the current 2007 information.

1.4 Assumptions

The case study assumed that participants would honestly disclose all information required for the study. Another assumption was that literacy levels would have no effect on the way participants responded to the questions. The case study also assumed that production levels were not affected by seasonality or other production factors.

1.5 Structure of the dissertation

This case study explored the impact of irrigation on household food security in two villages in Chingale. The chapter that follows (chapter 2) reviews the literature on food security issues and irrigation development globally and in Africa and Malawi. Chapter three deals with the context of the study, describing the characteristics of the study area and the sample. Chapter four discusses the research methodology specific to this study. Results and discussions are discussed in chapter five. Finally, chapter six presents the conclusions and recommendations.

CHAPTER 2 LITERATURE REVIEW

2.1 Conceptualising food security

The FAO (2006b) explained that food security as a concept emerged in the mid 1970s when the World Food Conference in 1974 defined food security in terms of food supply assuring the availability and price stability of basic foodstuffs at the international and national levels. The occurrence of several famines in the 1970s against the technical successes of the Asian Green Revolution led observers to broaden the definition to include issues of access (Juhola undated), as researchers and development practitioners realised that food insecurity occurred in situations where food was available but not accessible because of an erosion of people's entitlement to food (Borton and Shoham 1991).

Entitlement is not related to a normative right as such, but rather on the actual ability of an individual or household to mobilise the various assets at their command, including the power vested in them by the society they live in, whether formal or informal (Khanya- African Institute for Community-Driven Development (Khanya-AICDD) 2006). Frankenberger and McCaston (1998) indicated that food entitlements of households derive from their own production, income, gathering of wild foods, community support (claims), assets, migration and many more. Sen (1982) introduced an entitlement approach to food. The approach had a considerable influence in the change of thinking, representing a paradigm shift in the way that famines were conceptualised. The concept of entitlement (the means or the ability to access food) rather than aggregate food supplies, has since then been critical to the food security debate (Gayi 2006).

Over the years most of the definitions of food security have converged towards a number of key words including satisfaction, access, risk and sustainability (FAO undated a). During the 1990s the scope of the definition widened further spanning the global to the individual level (Juhola undated). The FAO (undated a) indicated that there is no one single universal concept of food security. More than thirty definitions were found between 1975 and 1991 (Maxwell & Frankenberger, 1995), showing the many different approaches that exist to the food security issue.

In terms of food insecurity, Devereux (2006) distinguished chronic food insecurity that is long term and persistent and transitory food insecurity that is short term and temporary. However, chronic and transitory situations are linked and overlapping (Devereux 2006). For instance, many people that are food insecure temporarily are affected by small shocks and can become chronically food insecure. Conversely, chronic food insecurity is often the result of repeated shocks such as recurrent droughts (Devereux 2006). The Committee on World Food Security (2005) elaborated that chronic hunger is a consequence of structural deficiencies while transitory hunger is mainly a result of shocks to food security. The distinction between chronic and transitory food security is crucial as it often determines the type, timing and targeting of the responses to the food insecurity situation (Juhola undated).

The definition of food security by USAID (1992) explains that food security is the state where all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life. This study is focused on two of the three (food availability, food access and food utilisation) components of food security, namely, food availability and accessibility because of their simplicity in measuring and monitoring the food security situation of the targeted individuals. Investigating food availability and accessibility is crucial in revealing the food security situation of individuals or households but not individual's and household's nutrition security.

Food availability is enhanced by increasing domestic food production and productivity (FAO undated b). Food is also available from commercial imports and donors (USAID 1992). However, Ali-Dinar (2006) pointed out that availability of food can be affected either temporarily or for long periods by a range of factors: climate, disasters, wars, civil unrest, population size and growth, inappropriate agricultural practices, environment, social status and trade. Another determinant to food unavailability is inappropriate economic policies in terms of pricing, marketing, lack of foreign exchange, tax and tariffs. Additional factors that affect the availability of food and result in food insecurity are inadequate agricultural inputs; the non-existence of an effective private sector; marketing and transportation systems that inhibit movement of food from source to need; and the inability to predict, assess and cope with emergency situations that interrupt food supplies (USAID 1992).

Food access refers to the situation where individuals have adequate incomes or other resources to purchase or barter, in order to obtain adequate levels of food to maintain the consumption of an adequate diet or adequate nutrition levels (USAID 1992). The FAO (undated a) commented that food availability is necessary for accessibility to food although, according to Sahley *et al.* (2005) availability of food at regional and national levels does not assure every household access to food. Constraints to food access include inadequate economic growth, leading to lack of job opportunities; the negative impacts of national economic policies; inadequate training and job skills; and lack of credit or other means of assets or income exchange (USAID 1992).

2.2 Food insecurity in southern Africa

Food insecurity is simply the lack of food security that, in the extreme, is experienced as hunger (Hendriks 2005). Millions of people in southern Africa are chronically food insecure according to Oxfam Great Britain (2006). Oxfam Great Britain (2006) reported that the number of vulnerable people as a result of food insecurity has been rising because of a number of factors such as economic stagnation; decreases in formal employment opportunities; poor agricultural policies; adverse climatic factors; environmental degradation; and the devastating impacts of HIV/AIDS. Food security remains challenging for most African countries given the low agricultural growth, rapid population growth, weak foreign exchange earnings and high transaction costs in linking domestic and international markets (World Bank 2008).

An unstable food security situation in the SADC region has been reported as food security indicators in the SADC region portray a decline in the average per capita dietary energy supplies, (SADC undated). Food aid to most SADC countries has almost doubled over the last 15 years, a burden compounded by the increasing weight of debt servicing in SADC member states. Cereal demand in the region is estimated to reach more than double the current requirement by 2015 because of increased population growth. There is a high incidence of poverty. It is estimated that 40% of the region's population are living below the international poverty line of US$1.0 per day (SADC undated). The HIV/AIDS pandemic has frustrated the region's efforts to ensure food security because of loss of labour and loss of the inter-generational transfer of agricultural knowledge and skills (Committee on World Food Security 2003; SADC undated). There have

been repeated droughts and floods, which have left large numbers of people without food and in need of humanitarian assistance. The last food crisis in 2002/2003 affected close to 15.2 million people in the region (SADC undated).

Among the above causes of food insecurity in southern Africa, drought is one of the major causes of the food shortage crisis in southern Africa (Øygard 2005). Hussain *et al.* (2002) explained that, for centuries, the African continent has experienced a history of rainfall fluctuations and droughts, of varying lengths and intensities. According to USAID (2006), erratic rains from October to December 2004, and prolonged dry spells from January to March 2005, adversely affected much of Mozambique, Zimbabwe, southern and central Malawi, southern Zambia, and northern South Africa.

During the 2004/2005 agricultural season, poor and erratic rainfall across the central part of southern Africa resulted in reduced crop harvests throughout the region, and exacerbated vulnerability to hunger. As a result, around 12 million people across southern Africa (Oxfam Great Britain 2006) faced severe food shortages, mostly as a result of poor rains in 2005. This triggered large-scale humanitarian responses from governments, donor countries and aid agencies (Oxfam Great Britain 2006). By February 2006, the SADC region's food security situation was poor in most member states, with the number of households running out of food continuing to increase as the region entered its lean period before the main harvest of 2006 (SADC 2006).

2.2.1 Malawi's food insecurity situation

As for Malawi, the World Bank (2005) reported that agriculture is the single most important sector of Malawi's economy, contributing about 36% of value-added to Gross Domestic Product (GDP), employing 85% of the workforce, and contributing 90% of foreign exchange earnings in 2003. Apart from maize, which is the staple food crop, people in Malawi grow rice, sorghum, millet, cassava, sweet and Irish potatoes, groundnuts and other legumes (Mloza-Banda 2006). In terms of agricultural tradables, tobacco is Malawi's largest export (World Bank 2005) which accounts for 80% of Malawi's export income (Øygard 2005).

The World Bank (2005) reported that Malawi's agriculture has been characterised by low and stagnant yields, particularly in maize production systems. Average maize yields have remained below 1.0 metric ton/ha for the past decade, and below comparable potential (World Bank 2005). In 2002, Malawi faced serious food shortages and hunger due to a combination of political and environmental causes (Ferguson *et al.* undated). In the 2003/2004 and 2004/2005 growing seasons, crop yields were negatively affected by drought (Oxfam Great Britain 2006). Poor rainfall, combined with inadequate supplies of fertilisers, affected the staple food, maize as yields dropped considerably (USAID 2006). Øygard (2005) reported that in 2004/2005, maize yields were 30% below the already poor harvest of 2003/2004. Harvests of other crops such as rice, millet, sorghum, sweet potatoes and cassava were reduced by 10 - 30%, compared with 2003/2004. Harvests of the main cash and export crop tobacco, also dropped by 12% (Øygard 2005). During the 2004/2005 agricultural season, Malawi produced approximately 1.2 million metric tons of maize (USAID 2006). This is below Malawi's food need of approximated 2 million metric tons per year (SARPN 2006).

In April and May 2005, the Malawi Vulnerability Assessment Committee (MVAC) mission reported that Malawi was facing a cereal gap of between 400,000 and 450,000 metric tons (USAID 2006). Depending on maize price increases, it was predicted that in 2005, Malawi would require between 272,000 and 424,000 metric tons of food entitlements and international food aid (USAID 2006). The MVAC estimated that between 4.2 and 4.6 million of a total population of 12 million Malawians required food, agricultural inputs, cash or livelihood assistance through the next harvest in March 2006 (USAID 2006; United Nations 2005).

With regard to food insecurity, the case of Malawi shows that it is not only poor rainfall or drought that is responsible for severe food shortages, but a number of factors are responsible for these severe food shortages. Constraints to food security in Malawi are listed below (FAO 2006a; Sahley *et al.* 2005; Southern Africa Regional Poverty Network (SARPN) 2006); World Bank 2005).

- Production levels have not been keeping pace with population growth, which nearly doubled from six to 11.5 million between 1977 and 2000.

- National food supply is vulnerable to small climatic variations in rainfall, yet irrigation is only used to a limited extent.
- Productivity of local and hybrid maize has dropped as soils have become depleted; hence Malawi's soils are in annual need of nutrient replenishment.
- Tobacco has displaced maize in exports.
- The amount of land planted to maize has dropped from 70% to 55% because smallholders have turned to cash crop production after 1990.
- There has been a drain on agricultural labour in households affected by HIV/AIDS.
- The perception by many that maize is the only food, when other types of cereals more adapted to drought are available.
- Inappropriate and outdated agricultural technologies are being used.
- Low irrigation development.
- Poor water management.
- Weak extension services.
- Inadequate markets.
- Cutbacks in donor subsidies for farm inputs.
- Advice from the International Monetary Fund (IMF) to the Malawian government to sell grain reserves.
- Failure of the media to alert the government of the impending disaster in time for donor assistance.
- Privatisation of the Agricultural Development Marketing Corporation (ADMARC), Malawi's grain board.

Malawi had a good harvest in the 2005/2006 season with total maize production estimated at 2.6 million tons nationwide due to good rains and subsidised fertilisers (United Nations 2006). The 2006 MVAC report explained that the food security situation of some households in Malawi improved slightly, due to the harvesting of winter crops in some parts of the country (FEWS NET 2006). However, the United Nations (2006) reported that there were still localised 'hotspots' where the harvest failed due to dry spells and floods. The 2006 MVAC estimated that a total of 50,761 metric tons of maize would be required to meet the missing food entitlements in the

period September 2006 to March 2007 (United Nations 2006), as 833,000 people would have little or no food at some point. In addition, 147,800 people were at risk of not meeting their food entitlements if the household economy deteriorated further, for example, as a result of high maize prices (United Nations 2006).

The favourable rains, coupled with availability of fertiliser and hybrid maize seed resulted in bumper harvests of most crops in 2006/2007 (FEWS NET 2007). Fertiliser was sold at the subsidised price of MK950 per 50 kg bag instead of the market price of up to MK4, 000 per 50 kg bag, enabling many poor farmers to access fertiliser and afford improved seed varieties (DFID 2007; FEWS NET 2007).

According to the Ministry of Agriculture and Food Security, maize registered a 34% increase in production from 2.58 million metric tons in the 2005/2006 season to 3.44 million metric tons in the 2006/2007 season (FEWS NET 2007). This provided Malawi with an estimated food surplus of over one million metric tons of maize (FEWS NET 2007). Through the National Food Reserve Agency (NFRA), the government exported 400,000 metric tons of maize to Zimbabwe in 2007. In addition, the government donated 10,000 metric tons of maize to Swaziland and Lesotho. The Swaziland government also expressed interest in importing approximately 40,000 metric tons of maize from Malawi. The Malawi government planned to build maize stocks that could be used in case the country had a food shortfall in the coming seasons (FEWS NET 2007).

DFID (2007) explained that due to the 2006/2007 bumper harvests, the market demand for various foods, including maize, was generally lower than usual. This resulted in relatively low prices for commodities and a disincentive to traders. Increased maize production benefited some of the country's poorest people, improving household food security (DFID 2007).

In terms of food access, most families in Malawi access food by consuming what they produce or by purchasing food in the growing season with income earned from harvest time sales or off-farm income (Sahley *et al.* 2005). Sahley *et al.* (2005) reported that most households in Malawi are unable to acquire the minimum basket of food items through their own food production, or by market purchases in most years. Øygard (2005) explained that incomes in Malawi, for a large

share of the population, are insufficient for basic food security. The 1998/99 Integrated Household Survey found that 65% of household incomes fell below the income necessary to buy a minimum package of food and non-food items (Machinjili and Kachikopa 2004). About 52.4% of the population had incomes below the national poverty line of MK16,165 per person per year in 1988/99 (MK 44 per day or US$ 1 per day at purchasing-power parity) (NSO 2005). About 22.3% of the population were considered ultra-poor, with incomes below MK 10,029 per person per year in 1988/99 (MK 27 per day, or US$ 0.66 at purchasing-power parity) (NSO 2005).

From the above, it can be seen that the food security crisis in Malawi existed between 2002 and 2005. However, there were increases in maize production in 2006 and 2007 due to good rains and the fertiliser subsidy programme. Although increased maize production in 2006/2007 ensured food security for some of the country's poorest people, the poverty situation in Malawi shows that most incomes are too low to ensure access to basic food stuffs. Therefore, Malawi is faced with the challenge of ensuring sustainability of maize production and significant reduction of poverty. There is need for sustainable solutions to deal with the causes of food insecurity and ensure improved agricultural production and poverty reduction in Malawi.

2.3 Agricultural development: a sustainable solution to Africa's food insecurity

Three out of four poor people – 833 million people– in developing countries lived in rural areas in 2002 and most of these depended on agricultural livelihoods (World Bank 2008). The FAO (2005) pointed out that agriculture is the major source of livelihoods for 70% of the population and 80% of the poor in Africa. Agriculture is extremely important as an engine for overall economic development in Africa (Mpyisi 2007). According to the World Bank (2008), agriculture is uniquely powerful in sustaining economic growth and reducing mass poverty and food insecurity. Cross-country econometric evidence shows that GDP growth generated in agriculture has larger benefits for the poor and is at least twice more effective in reducing poverty than growth generated by other sectors (World Bank 2008). Agriculture will continue to play a central role in reducing food insecurity because agriculture can maintain and increase global food production and improve food availability and providing income for the poor. Through new and improved crop varieties, agriculture can improve dietary quality and diversity (World Bank 2008).

Africa's agriculture sector accounts for 60% employment, 20% of total exports and 17% GDP (Mpyisi 2007). There have been numerous failures to get agriculture moving especially in sub-Saharan Africa (when contrasted with the Asian Green Revolution) (World Bank 2008). For example: stagnation in domestic production in many African agriculture-based countries like Burundi, Ethiopia, Kenya, Madagascar, Nigeria, Sudan, Tanzania and Zambia brought problems of food availability at national level. All these countries experienced negative per capita annual growth rates in staple food of –1.0 to –1.7 percent from 1995 to 2004 (World Bank 2008).

However, Mpyisi (2007) explained that, despite the enormous challenges facing African agriculture, there are still reasons for optimism. The World Bank (2008) has documented examples of success stories of agriculture as an engine of growth and a major force for poverty reduction in Africa. For example, Ghana experienced economic growth and poverty reduction over the past 15 years. Agriculture outperformed the service sector, growing at 5.7% a year between 2001 and 2005 faster than the overall GDP at 5.2%. Ghana's agricultural growth had been mainly due to expansion of the area under cultivation with increased yields, at 1%. Cocoa production contributed 30% of agricultural growth, and horticulture, almost 9% of total exports in 2006. Increased agricultural business opportunities in countries like Kenya (high-value products for domestic markets); international markets for coffee in Rwanda; and horticulture in Senegal are some of the examples of success stories of agriculture in Africa.

In the light of the above, sustainable social and economic development in Africa, based on the agricultural sector is imperative (FAO 2005) to reduce hunger and poverty across Africa (Mpyisi 2007). The World Bank (2008) proposes that a more dynamic and inclusive agricultural sector could dramatically reduce rural poverty, helping to meet the Millennium Development Goal of reduction of poverty and hunger. This is in line with the principles of the Comprehensive African Agriculture Development Program (CAADP) as a framework for the restoration of agricultural growth, food security and rural development in Africa (Mpyisi 2007).

At the 2003 African Union (AU) Summit in Maputo, African Heads of State and Government adopted the CAADP under the leadership of the African Union and the New Partnership for Africa's Development (NEPAD) (NEPAD 2005). The primary goal of CAADP is agriculture-led

development that eliminates hunger, reduces poverty and food insecurity, opening a way for export expansion (NEPAD 2005). Mpyisi (2007) explained that unlike previous programmes and initiatives, CAADP is a comprehensive programme that recognises the role of public and private sectors and encourages Public Private Partnerships (PPPs).

CAADP has specific targets to be achieved by 2015 and four pillars and cross-cutting areas are addressed as part of the implementation agenda (NEPAD 2005). The first pillar of CAADP deals with extending the area under sustainable land management and reliable water control systems (NEPAD 2005). According to NEPAD (2005), reliable water control systems (as part of the first CAADP pillar), aims at improving management of water resources, while expanding access to both small- and large-scale irrigation. This will help to solve the problem of irregular and unreliable rainfall for agricultural production which is a major constraint to crop productivity in Africa (Mpyisi 2007). The FAO (2005) reported that within CAADP, investment in water programmes are identified as a priority and an annual investment of around US$2 billion is needed to boost agricultural production in Africa (FAO 2005). From the above, in the context of agricultural development, irrigation is one of the possible solutions that would ensure improved agricultural production and reduction of poverty in Africa.

2.4 Need for irrigation in Malawi

Oxfam Great Britain (2006) suggested that, because of the current global food security crisis, it is imperative to provide policy makers and practitioners with a wide range of tools with which to respond to the food crisis. These tools include: food aid, cash, small-scale agriculture, irrigation, livestock programmes and national safety net schemes. Although there are many causes of food insecurity and a range of tools with which to respond, irrigation, is clearly one necessary tool to enhance food security in Malawi.

The African and European Unions (2003) stated that, with recurrent droughts and the need to produce crops during the winter months; irrigation is the surest way to ensure food security and reduce poverty in Malawi. By 2003**,** around 62,000 hectares of irrigation had been developed in Malawi. Malawi's persistent food shortages prompted the government of Malawi to direct their policies towards rapid irrigation development (African and European Unions 2003). Currently,

the area under cultivation, and the number of households with access to irrigation, has expanded due to increased efforts by government and its cooperating partners (FEWS NET 2006).

The World Bank (2006) pointed out that, irrigation in Malawi could help raise agricultural productivity and net incomes of Malawians and improve the food security situation. Development of irrigation infrastructure would ensure increased cropping intensity through the involvement of the private sector and rural farmers and increase the transfer of agricultural technology required to raise smallholder productivity and crop diversification. Irrigation would also improve rural infrastructure and access to markets, provide post-harvest asset, and mobilise and build the capacity of grassroots farmers' organisations. Irrigation in Malawi could enable production of crops such as maize, vegetables and leguminous crops in winter (World Bank 2006).

Malawi has excellent soil and water for irrigated farming to offset perennial hunger (Chiyembekeza 2005). Malawi is considered rich in water resources from lakes, rivers and aquifers (FAO 2006a). Integrated Regional Information Networks (IRIN) (2006) reported that Malawi has a vast source of fresh water from Lake Malawi and is located in the Great Rift Valley basin. Large quantities of fresh water are available in Lake Malawi which is the eleventh largest lake in the world (FAO 2006a) and the third largest fresh water lake in Africa (Mulwafu *et al.* 2002). The FAO (2006a) explained that Lake Malawi has a surface area of about 28,760km^2 (including the part of the lake which belongs to Mozambique). The lake is 570km long, 16 to 80km wide and has a total water storage of 1000km^3. The maximum depth of Lake Malawi is 700 metres (FAO 2006a).

Other lakes in Malawi include Lake Chilwa, Lake Malombe and Lake Chiuta (Mulwafu *et al.* 2002). Lake Chilwa lies on the boarder between Malawi and Mozambique and has an average surface area of 683km^2. The lake is shallow with an average depth of two metres (FAO 2006a). Lake Malombe covers 303km^2, is 30km long and 15km wide, with an average depth of four metres (FAO 2006a). Lake Chiuta also lies on the border between Malawi and Mozambique and covers an area of 200km^2 with a depth of five metres (FAO 2006a).

There is also a network of river systems such as the Shire River, a tributary of Lake Malawi (which flows south and joins the Zambezi River and is also the largest river in Malawi); the Ruo; the South Rukuru; the Songwe and many more (Mulwafu *et al.* 2002). Available water resources in Malawi are potential sources of irrigation for cropping purposes and cover more than 20% of the country's territory (IRIN 2006; Mulwafu *et al.* 2002). However, Malawians have not yet fully utilised the water sources for irrigation (IRIN 2006).

2.5 Irrigation

Irrigation is the artificial application of water to plants (Koegelenburg 2006) and has been practised for millennia, with the aim of maximising food supply for humanity (Shiklomanov 1998). Bhattarai *et al*. (2002) highlighted the fact that irrigation is a critical component of world food production and has contributed significantly to maintaining world food supplies and reducing poverty. Irrigation expansion is imperative to the growth of the agricultural industry (Hart 2000).

The FAO (2002b) has stated that although irrigated agriculture has played a significant role in increasing food production globally, especially during the Asian Green Revolution, its absolute contribution to food production is still lower than that of rain-fed agriculture. A 1995 baseline analysis on the role of rain-fed agriculture in the future of global food production, showed that rain-fed agriculture will continue to play a very important role in cereal production, contributing one-half of the total projected increase of cereal production between 1995 and 2025 (Rosegrant *et al.* 2002). By the year 1997, of the 1500 million hectares of global cropland, only about 250 million hectares (17%) were irrigated (Schöengold and Zilberman 2004; FAO 1997b). In 1997, this 17% of global cropland provided about 40% of the world's food production (FAO 1997b). The remaining 60% of world's food production came from rain-fed agriculture, grown on 83% of the cultivated land (FAO 2002b).

The FAO (2002b) explained that rain-fed agriculture is used on more than 95% of cropland in Africa and will remain the dominant source of food for growing populations in Africa. Irrigated agriculture is a necessity where traditional rain-fed farming appears to be high-risk, since

irrigation can boost crop productivity and allow farmers to diversify crops (FAO 2005; Hillel 1997).

Two-thirds (1.8 billion) of the developing world's rural population lives in areas with favourable agroecological potential – that is, irrigated (42% of the rural population) or humid- and semi-humid rain-fed areas with reliable moisture (26% of the rural population). However, one-third (820 million people) of the world's population live in less favoured rain-fed regions characterised by frequent moisture stress that limits agricultural production (World Bank 2008). Many of the world's hungry, live in water scarce regions and where the prevalence of food insecurity is most acute (FAO 2002b). For instance, in Africa, irrigated land represents less than eight percent of the available land, with large differences in ratios of irrigated land between countries (Hussain *et al.* 2002). Barely four percent of sub-Saharan Africa is irrigated (FAO 2005), while the corresponding percentages for South Asia, East Asia and the Pacific, and South America are 39%, 29% and 10% respectively (World Bank2008; Mpyisi 2007).

Irrigated farming is not widely practised in sub-Saharan Africa (FAO 2002b). The FAO and Sub-Regional Office for East and Southern Africa (2000) have suggested that a number of constraints account for a relatively slow rate of irrigation development in many sub-Saharan countries. These constraints include relatively high costs of irrigation development; inadequate physical infrastructure and markets; poor investments in irrigation; lack of access to improved irrigation technologies, and lack of cheap and readily available water supplies. Investments in irrigation projects steadily declined in the 1980s, partly in response to the many failed irrigation investments and partly because of poor market opportunities and higher investment costs than the other regions (World Bank 2008).

The capacity of farmers to invest in and manage irrigation projects in sub-Saharan Africa is also affected by low household resources; the fragmented and small sizes of land holdings; unsecured or lack of land titles; high interest rates, and poor transportation and marketing facilities (FAO and Sub-Regional Office for East and Southern Africa 2000).

According to the World Bank (2008) demand for water for both agricultural and non-agricultural uses is rising and water scarcity is becoming acute in much of the developing world because of competition from rapidly growing industrial sectors and urban population. This limits the expansion possibilities for irrigation (World Bank 2008). The key challenges in irrigated areas are to use less water in the face of growing water scarcities; stop unsustainable mining of ground water; and prevent the degradation of irrigated land through water logging, salinisation and nutrient depletion (World Bank 2008).

Currently, agriculture represents 69% of all water withdrawal in the world, and exceeds 90% in some arid areas (FAO 2005). However, the World Bank (2008) reported that sub-Saharan Africa and Latin America have large untapped water resources that could be used for agriculture. There are now many opportunities for economically investing in irrigation in sub-Saharan Africa and the irrigated area in sub-Saharan Africa is projected to double by 2030 (World Bank 2008).

2.5.1 Irrigation development in Malawi

In Malawi, *dimba* (stream bank) cultivation and the use of *dambo* (seasonal flood plains or wetlands) have been used from the early pre-colonial period (Mandala 1990). Mloza-Banda (2006) pointed out that Malawi's agricultural development has for a long time relied heavily on rain-fed agriculture. Similarly, Nkhoma and Mulwafu (2003) explained that agricultural production has been promoted through rain-fed farming and some limited irrigation dating from the early pre-colonial period. Mloza-Banda (2006) concluded that rain-fed agriculture in Malawi is unreliable for sustainable food security, poverty alleviation, and the achievement of rural development.

The FAO (2006a) noted that irrigated agriculture started in Malawi in the 1940's with the development of the Limphasa Irrigation Scheme in the Nkhata Bay District, and in the 1950's with an irrigated crop research station in Makhanga. Nkhoma and Mulwafu (2003) explained that at independence, in 1964, the government of Malawi introduced formal irrigation involving settler estates and settlement schemes with a view to promoting community development.

The government's establishment of smallholder irrigation schemes as part of an agricultural development strategy to solve the problems of climatic changes, rapid population growth and scarcity of land in the 1960's, showed the growth in irrigated farming (Chirwa 2002; Kishindo 1996). Further irrigation development took place between 1968 and 1979 when 16 irrigation schemes, with a total irrigable area of around 3,600 hectares, were constructed by the government (FAO 2006a). The Sugar Corporation of Malawi (SUCOMA) for example, started the production of sugar cane under irrigation in 1965 (FAO 2006a).

Almost all irrigation in Malawi is from surface water, either pumped or diverted from rivers or increasingly, from shallow wells in wetlands where temporary or perched water tables are close to the surface (World Bank 2005). Mzembe (1994) pointed to three types of available irrigation in Malawi. These include surface irrigation, sprinkler irrigation and micro irrigation. The total area equipped for fully or partially controlled irrigation in 1992 was 28,000 hectares (Mzembe 1994). In 2000, the total area equipped for fully or partially controlled irrigation was 55,000 hectares, with almost 80% being under sprinkler irrigation (FAO 2006a). Table 2.1 below indicates the types of irrigation, and the total area equipped for irrigation in Malawi, in the years 1992 and 2000.

Table 2.1 System of irrigation and total area equipped in 1992 and 2000 in hectares, Malawi, (FAO 2006a; Mzembe 1994)

Irrigation system	**Area equipped in 1992 (ha)**	**Area equipped in 2000 (ha)**
Surface irrigation (furrow and basin)	15,700 ha	6,357 ha
Sprinkler irrigation	11,300 ha	43,193 ha
Micro irrigation (drip/trickle)	1,000 ha	5,450 ha
Fuller/partial control equipped area	**28,000 ha**	**55,000 ha**

The potential area for irrigated production in Malawi has been estimated at between 161,000 hectares and 207,300 hectares (World Bank 2005). The World Bank (2005) and Mzembe (1994) stated that the irrigated area is managed by different stakeholders including private estates, government-run smallholder schemes, self-help smallholder schemes and farmers or small groups of farmers.

Table 2.2 shows the management of irrigation with the area of irrigation managed, and estimated future irrigation development potential in 1994. Altogether, the total potential area of irrigation in Malawi is 161,900 hectares.

Table 2.2 Management of irrigation and the area managed in Malawi in 1994, (World Bank 2005; Mzembe 1994)

Irrigation management (full or partial control)	**Area (ha)**
Private estates	18,300 ha
Government-run smallholder schemes	3,200 ha
Self-help smallholder schemes	6,500 ha
Farmers or small groups of farmers using wetlands	61,900 ha
Future irrigation development potential	72,000 ha
Total irrigation potential	**161,900 ha**

2.5.2 Irrigation systems and technologies used by smallholders in Africa and common in Malawi

Smallholdings dominate African agriculture (Brabben and Pearce 1999). It therefore follows that improvement of agricultural production in the future will depend upon the contribution to agricultural production made by smallholders. Encouragement of smallholders to take up irrigation is widely considered to be an appropriate development option (Brabben and Pearce1999). Kay and Brabben (2000) highlighted the fact that small-scale irrigation is one of the success stories in many countries in Africa, at a time when large-scale developments have failed to meet expectations of improving crop production.

There are many irrigation systems and technologies that smallholder farmers in Africa use. Flood or surface irrigation, sprinkler irrigation, drip or trickle irrigation and underground irrigation are commonly used in Africa (FAO 2002b). In Malawi, apart from using surface, sprinkler and micro irrigation, other irrigation systems, namely conventional irrigation systems and water storage systems, for example, roof harvesting with above ground tank, wells, underground tank, earth dams, river impounding/weirs and underground water springs are also used (Mloza-Banda 2006). Table 2.3 shows the irrigation systems and technologies used, examples of suitable crop types and the advantages and disadvantages of the systems.

Table 2.3 Irrigation systems and technologies for smallholder farmers in Africa which are common in Malawi (Australia Department of Primary Industries 2004; FAO 2002b; FAO 1988; Hillel 1997; Koegelenburg 2006; Mloza Banda 2006; Mzembe 1994; Wilson and Bauer 2006)

Irrigation system	Example of technology used	Examples of suitable crop types	Advantages	Disadvantages
Flood/surface irrigation	Bed, basin and furrow.	Grain crops, grapes, pastures and fruit trees.	No sophisticated equipment, low capital costs.	High labour costs, water logging and salinisation
Sprinkler /overhead irrigation	Watering can, mobile gun systems (hose pull, drag-hose), spray lines.	Sugarcanes, vegetable crops, pastures and grass on lawns.	Except for watering can, less wasteful of water, uses less labour than surface irrigation.	Apart from watering can, requires on-farm support in terms of maintenance and supply of spare parts; loss of water through evaporation and high winds, difficult to water uniformly, water on leaves causes fungal and other diseases.
Micro irrigation, Drip/trickle	Plastic bottles with bottom removed and turned upside down, bucket drip irrigation and micro spray.	Vegetable crops, grapes and fruit trees	Saves water and time, increasing water use efficiency and reduces salinisation, decreases labour, increases effectiveness on uneven ground, Reduces leaching of water and nutrients below the root zone, Prevents disease by minimizing water contact with the leaves, stems, and fruit of plants and can be used to apply liquid fertiliser to gardens.	High investment costs, greater maintenance requirements, clogging of emitters, animals, rodents and insects may cause damage to some components.
Underground	Perforated clay jars, pots and pipes.	Fruit trees, vegetable crops and row crops.	Simple, flexible and inexpensive.	Labour intensive, difficult to control rate of water application, need careful observations and constant monitoring, careless trampling may crash jars and exposed openings of pots and jars attract animals that may damage crops.
Conventional irrigation	Treadle pumps, river diversion or canalisation, residual moisture cultivation.	Vegetable crops, legumes like beans and peas.	Increases yield and cheaper.	Labour intensive, greater maintenance requirements.
Water storage	Roof harvesting with above ground tank, wells, underground tank, earth dams, river impounding/ weirs and underground water springs.	Grain crops and vegetable crops.	Inexpensive and simple.	Labour intensive, careful maintenance.

From Table 2.3, micro irrigation, drip or trickle irrigation appears to be more advantageous than the other irrigation systems, even though investment and maintenance costs are high. One may argue that because of the many advantages that drip irrigation presents, the benefits thereof may override investment and maintenance costs. More over, the advantages of drip irrigation far outweigh the advantages that the other irrigation systems present, as drip irrigation reduces most problems that irrigating smallholder farmers in Africa face. Drip irrigation presents advantages like saving time and increasing water use efficiency; decreases in labour requirements; the reduction of diseases through moisture control; salinisation; and loss of nutrients and water. This is what every irrigating farmer is looking forward to.

2.6 The impact of irrigation on household food security

The question of whether irrigation is beneficial to food production is highly controversial. Bhattarai *et al.* (2002) stated that the actual contribution of irrigated agriculture to global food production, maintenance of food security, rural livelihoods and overall well-being of society, is debatable because both negative and positive impacts may be experienced where irrigation development is in place. The impact of irrigation on household food security is discussed in terms of the advantages and disadvantages that irrigation brings to society, and whether irrigation can improve household food security.

Hussain (2004) and Bhattarai *et al.* (2002) explained that the benefits of irrigation are realised through increased yields; diversification of crops; crop intensity; switching from low-value subsistence production to high-value market-oriented production; stabilisation of agricultural output; farm incomes; farm and non-farm employment or wages; consumption; lower food prices; and asset accumulation. Moreover, irrigation-induced benefits are not limited to farming households only, but also affect broader sectors of the economy by providing increased opportunities to grow rural service provision and other off-farm employment activities (Mellor 1966).

Improvement in production through increased yields is one of the advantages that irrigation brings. The FAO (2002b) explained that irrigation has the potential to provide higher yields than rain-fed agriculture. In irrigation projects, the doubling and tripling of yields is achievable, which

contribute significantly to food production and food security within three years of the first project interventions (Chiza 2005). Jimenez (1995) reported 58 studies from various countries and showed that a one percent increase in irrigation infrastructure generated a 1.62% improvement in agricultural productivity (Table 2.4).

Table 2.4 Effects of infrastructure on agriculture: cross-country evidence[#] (Jimenez 1995)

Due to 1% increase in	Increase of aggregate crop output (%)
Irrigation	1.62[*]
Paved roads	.26[*]
Rural road density	.12[*]
Adult literacy rate	.54

[*] **Statistically significant at 10%** [#] **Cross-country study - 58 countries**

A study in Tanzania, by Chiza (2005) on the role of irrigation in agriculture, food security and poverty reduction, concluded that rehabilitation of irrigation structures and factors including improved water management and access to inputs, under the implementation of the River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP) in the Pangani and Rufiji River Basins increased crop yields. Rice, maize, tomato and onion yields per hectare rose from 1.5 to 4.1 tons, 1.1 to 3.3 tons, 2.0 to 3.0 tons, and 2.5 to 3.5 tons respectively in the Rufiji basin, and 2.0 to 5.3 tons, 1.1 to 4.9 tons, 2.0 to 4.0 tons and 2.5 to 4.0 tons respectively in the Pangani basin (Chiza 2005). The FAO (1997a), in a general brief overview of the smallholder irrigation sub sector in Zimbabwe, also pointed out that smallholder irrigation increased crop yields.

High crop yield enhanced through irrigation explains the need for knowledge and skills in effective crop storage methods. According to Thamaga-Chitja *et al.* (2004), effective storage is crucial to improve agricultural incomes and food security for small scale farmers. Examples of improved storage techniques that are useful for rural settings whose livelihood depends on agriculture include; storage baskets which are raised from the ground; use of ash; calabashes, gourds and earthenware pots that are airtight and treated with varnish or dry oil externally; very large and immobile jars with outlets for easy removal of grain; and traditional solid wall bins (FAO 1994).

Irrigation enables farmers to increase the diversification of crops (Hussain 2004; Bhattarai *et al.* 2002). Mudima (1999) reported that one of the impacts of 180 operational schemes in Zimbabwe, of which 70% use surface irrigation and 30% use sprinkler irrigation, is the cultivation of crops that were not grown before. With drag-hose sprinkler irrigation, Chitora Farmers' Managed Irrigated Scheme of Zimbabwe grew many high-value horticultural crops like tomatoes, peas, green peppers, groundnuts, green maize, cucumbers and rape (FAO and Sub-Regional Office for East and Southern Africa 2000), allowing farmers to switch from low-value subsistence production to high-value market-oriented production (Hussain 2004).

Increased cropping intensity and the feasibility of year-round crop production are possible with irrigation (Bhattarai *et al.* 2002). Hillel (1997) commented that irrigation permits the growing of multiple crops – two to four times a year – where only a single crop could otherwise be grown. Mudima (1999) reported that most farmers in the Chitora Farmers' Managed Irrigation Scheme achieved an increased cropping intensity of over 300% between 1994 and 1998. Increased cropping intensity is possible because water can be stored in the rainy season for use in the dry season (Schöengold and Zilberman 2004). Availability of irrigation also encourages a shift from less to more water-responsive crops. Evidence from India indicates that farmers substitute rice for sorghum when irrigation is available (Pandey undated).

Irrigation reduces the risk of using expensive inputs from being wasted due to lack of water. Hillel (1997) argued that irrigation reduces production risks encouraging, additional inputs (pesticides, fertilisers, and improved seed varieties) to further intensify production. The World Bank (2008), for example, reported that promotion of input use in terms of seed and fertilisers with complementary investments in irrigation, rural roads, marketing infrastructure and financial services made seed and fertiliser use profitable and paved the way for dynamic commercial input markets in much of Asia and parts of Latin America.

Where irrigation is in place, there is smoothing of seasonal variability and supply (Schöengold and Zilberman 2004). Stability in crop yields and income, and reduced crop insurance costs are all possible with irrigation (Hart 2000). However, this is only possible where water and land resources are utilised efficiently and sustainably (Hillel 1997), since, in drought-prone areas,

limited access to water is often a major constraint to improving food production, irrigation, water harvesting and water development technologies (FAO 2002b). It is therefore necessary to improve water management to ensure stability, in terms of food supply, crop yields, income and reduced crop insurance costs (Hillel 1997).

Increased farm income is also seen as one of the advantages of irrigation (Bhattarai *et al.* 2002). Smallholder farmers who use irrigation, generally achieve higher incomes than their rain-fed counterparts (Hussain *et al.* 2002). A study from Zimbabwe, in the Hama Mavhaire Irrigation Scheme, showed that farm income rose from about US$ 280 to US$ 2800 per hectare per year (Chitsiko 1999). The World Bank (2008) reported that Nigeria's second National Fadama Development Project, which invested in irrigation equipment, farm assets, rural infrastructure, and advisory services, increased the income of participants by more than 50% on average, between 2004 and 2006. In the dry Savannah zone, where farmers invested in small-scale irrigation, average incomes increased by nearly 80% from 2004 to 2006 (World Bank 2008). In Gambia, a study of an irrigation scheme in the village of Chakunda reported increased income that translated into increased expenditure, investment, construction and trade (Webb 1991). The World Bank (2008) indicated that while irrigation projects in sub-Saharan Africa were often ineffective in the 1970s and 1980s, returns on projects now often reach the 15-20% range commonly obtained in the rest of the world. These economic returns can be realised only if a significant share of the area is sown with higher-value crops, reiterating the need for complementary investments in roads, extension services, and access to markets (World Bank 2008).

Irrigation development helps to provide local employment (MacLean and Voss 2006). Chiza (2005) suggested that irrigation development in rural areas may help to keep people in the rural areas, reducing migration from rural to urban areas. A reduction in migration is a saving for urban municipalities in terms of avoiding the costs of providing services like housing, water, sewerage, education and health to potential migrants (Mudima undated). Bhattarai *et al.* (2002) indicated that migration from rain-fed agro-environments to intensively irrigated environments is common in Asian countries. For instance the states of Haryana and Punjab, in the hub of the Asian Green Revolution belt in India, attracted hundreds of thousands of seasonal farm labourers

from more than 2000km away (Bhattarai *et al.* 2002). Hussain *et al*. (2002) reported a World Bank study in Vietnam, which showed that irrigation development enhanced farm employment opportunities both on-farm and off-farm, hence providing entitlements and purchasing power for the poor.

According to Bhattarai *et al.* (2002) irrigation development in the past, along with other factors like the introduction of fertilisers and high yielding varieties, were some of the reasons for the increase in the levels of food production that led to reduced food prices worldwide over the past 30 years. Bhattarai *et al.* (2002) noted that the real world price of rice dropped from US$1,050/metric tons in 1974/75 to US$200/metric tons in 1998. Similarly, the real price of wheat on the world market declined from US$500/metric tons in 1975 to US$175/metric tons in 1996. This was due to the expansion of food supplies (Bhattarai *et al.* 2002). The FAO (1998) explained that from 1960 to 1990, global cereal production expanded by more than 100%, whereas the global population expansion was around 70%.

In 2008, the FAO (2008a) has reported that in the first three months of 2008, food prices reached their highest level in real terms for thirty years. According to the FAO (2008b) and the FAO (2008c), global food prices rose by 9% in 2006, 23% in 2007 and then shot-up to 53% in the year leading up to the end of April 2008. In Africa, the prices of basic foodstuffs such as bread, rice, meat and milk have nearly doubled in three years and African governments and Regional Economic Committees (RECs) are raising fears about increases in malnutrition and hunger (Kanyegirire 2008). While the food insecure face the risk of being pushed deeper into poverty in the absence of protective measures, there is also an excellent opportunity to promote agriculture and rural development in response to the strong market signals from the higher food prices (FAO 2008a). This explains the need for irrigation as a medium/long-term measure aimed at addressing the soaring food prices.

Reduced food prices have been seen as a benefit of irrigation investment, leading to increased food supply and lower food prices, as irrigation development increases (Hussain 2004). Bhattarai *et al.* (2002) pointed out that lower food grain prices benefit the urban poor and rural landless communities by enabling them to purchase required food at affordable prices.

Hussain (2004) and Bhattarai *et al.* (2002) explained that investment in assets and increase in household consumption are some of the benefits from irrigation. Irrigation development also makes it possible for rural infrastructure development in areas that would otherwise have remained without roads, telephones, schools and clinics (FAO 1997a). In Hama Mavhaire, Zimbabwe, Chitsiko (1999) explained that farmers have experienced new prosperity since the inception of the scheme in 1992. About 29% of the plot holders were reported to have bought between one and four head of cattle from the proceeds of the scheme and 13 % had built a brick house with asbestos or corrugated iron sheets (Agricultural Technical and Extension Services (Agritex) 1999). At Wenimbi irrigation scheme in Zimbabwe, farmers bought a second-hand five ton truck to transport produce to the markets (FAO and Sub-Regional Office for East and Southern Africa 2000).

Webb (1991) reported that an irrigation scheme in Chakunda village in Gambia, led to an increase in material wealth in terms of trade and construction both at village and household level. At household level, this increased wealth was observed in the houses that were built and some with corrugated metal roofing. Traders were reportedly purchasing irrigated produce (rice), and in turn sold cloth, jewellery and other consumer items to farmers (Webb 1991).

In terms of consumption, the FAO (2003) indicated that farmers benefit directly from irrigation through a more varied diet. The FAO (1997a) reported that farmers of smallholder irrigation sub-sectors in Zimbabwe, who come from very low rainfall areas, enjoy the human dignity of producing and consuming their own food, instead of depending on handouts from the Department of Social Welfare. According to Chitsiko (undated), food handouts from government became a thing of the past in Hama Mavhaire Irrigation Scheme in Zimbabwe as farmers started producing enough food to eat and sell. The general appearance of farm families in Hama Mavhaire suggested they enjoyed good nutrition status (Chitsiko undated).

On the other hand, there are instances where irrigation generates negative outcomes, adversely affecting resources, opportunities and overall socio-economic outcomes (Hussain 2004). These negative outcomes include: water scarcity, water logging and salinisation; reduced yields;

reduced crop size and poor quality of crops; increased disease susceptibility to crops; high operational costs and reduced profits for the farmer; displacement of people from one area to another; and water conflicts (Hussain 2004; Schöengold and Zilberman 2004).

The World Bank (2008) explained that wasteful irrigation has contributed to the growing scarcity of water, unsustainable pumping out of groundwater, and the degradation of prime agricultural land. Hillel (1997) explained that yields from irrigated land can be negatively affected where there are inappropriate practices associated with irrigation, in terms of over- and under-irrigation. Where crops are over-irrigated, not all the water is used by the crops; instead water percolates through the ground and accumulates over time (Schöengold and Zilberman 2004). This is called water logging and eventually leads to the salinisation of soil and water. Water logging results in the increased disease susceptibility in crops and difficulties with cultivating the soil (Doughtery and Hall 2004). The Australian Department of Primary Industries (2004) explained that water logging also results in reduced yields and lower product quality.

Furthermore, excessive irrigation results in run-off, soil erosion and subsequent transportation of sediments (Stockle 2001). The Australian Department of Primary Industries (2004) further stated that run-off and soil erosion can reduce soil fertility, which negatively affects crop yields. Soil erosion may also cause silting, that is, clogging of drainage ditches and streams. In this regard, food security is negatively affected, as the fertility of the soil is crucial for the improvement of yields to improve food security. According to the World Bank (2008), improvement of degraded soil will require improved soil management and fertiliser use.

In terms of under-irrigation, Hillel (1997) explained that the application of too little water is wasteful as it fails to produce the desired benefits. This is common in areas where irrigation schemes have problems with water availability. Griffin Green House and Nursery Supplies (2006) indicated that when plants are under-watered, crops wilt, resulting in smaller leaves, shorter stem internodes (the length of the stem between leaves), and a hardened appearance of the plants. In some cases, leaves may begin to burn and spread inward; affecting whole leaves (Griffin Green House and Nursery supplies 2006). This results in reduced yields and poor crop quality.

Although increases in crop diversification and cropping intensity are benefits derived from irrigation, these benefits also mean an increased input requirement (improved seed varieties, fertilisers, pesticides) and higher labour costs. The World Bank (2008) reported that since the 1960s, rising cereal yields have been driven by widespread use and intensification of irrigation, improved crop varieties, and fertilisers. This is evident from the Sarda canal irrigation and the non-irrigating villages of India that showed that inputs per acre were 3.7% higher in the canal irrigating area than in non-irrigating areas, indicating more intensive farming under irrigation. Wages for labour, including casual and permanent farm assistants, were 21% higher in the Sarda canal irrigation area than in the non-irrigating areas (FAO and Sub-Regional Office for East and Southern Africa 2000).

The Australian Department of Primary Industries (2004) explained that irrigation brings about increased operational costs in terms of labour, pumping, water costs and reduction of yields. Furthermore, Chiza (2005) pointed out that, when examined purely in investment terms, it seems that irrigation development requires high investment that benefits relatively few people. This is especially so, when the substantial spin off effects of irrigation to the surrounding community are not considered (Chiza 2005). Schöengold and Zilberman (2004) explained that, in practice, revenue from water projects often fail to cover operational and management costs. The Australian Department of Primary Industries (2004) showed that, in irrigation projects, there are higher operational costs, hence reduced profit for the producer.

In the light of these issues, the economic viability of smallholder irrigation schemes in Zimbabwe was questioned by Mupawose (1984) as some smallholder schemes had failed or were underutilised. Failure of the schemes was reportedly due to poor management, lack of inputs, and lack of farmer experience (FAO and Sub-Regional Office for East and Southern Africa 2000). The Southern African Development Community (SADC 1992) reported that most new smallholder irrigation schemes in southern Africa do not cover the cost of development and operation, and are therefore not feasible. The report further suggested that these schemes have a negligible impact on national and household food security (SADC 1992).

One could argue that the migration of people to places where irrigation development takes place, be it rural or urban, results in the displacement of people from their native areas. Harris Consulting and Brown Consulting (2005) reported some negative social changes that usually take place where irrigation is developed. These changes were expected to be experienced in the Mackenzie Basin in New Zealand, where assessment was done on the impacts of allocating irrigation water. The report indicated that selling of land by older farmers was one of the social changes that would lead to the inflow of new comers to purchase properties and work on the farms.

Salinisation of soil and water is another disadvantage of irrigation development. Eilers *et al.* (undated) defined salinisation as the process by which salts accumulate in the soil or water. This hinders the growth of crops by limiting the ability of crops to take up water. Stockle (2001) highlighted that salinisation is a worldwide problem, particularly in semi-arid areas that use large amounts of irrigation water but have poor drainage systems. Salinisation has been associated with irrigated agriculture, because irrigation always exacerbates the effects of salinity (Stockle 2001). Similarly, Schöengold and Zilberman (2004) commented that the development of irrigation systems can increase the salinity levels of existing rivers and lakes because salinisation often happens when water, which formerly ran into a fresh water lake, is diverted, or if withdrawals from the rivers or lakes are substantial.

The problem of salinisation remains costly for farmers (Hillel 1997), because irrigation becomes unsustainable due to the high costs related to the rehabilitation of land. Postel (1999), indicated that farmers lose about US$11 billion in production every year to salinisation of the soil. By the year 2002, about 20 to 30 million hectares of land were seriously damaged by the build-up of salts. Every year 0.25 to 0.5 million hectares are estimated to be lost from production as a result of salt build-up (FAO 2002b).

Irrigation development also leads to both local and international conflict. Harris Consulting and Brown Consulting (2005) in their report of the Mackenzie Basin Project assessed the allocation of irrigation water, reported that there was an expectation of conflict between dry land farmers and dairy farmers because of lifestyle and work routine differences. Conflict was also reported

between urban residents and farming communities over the environmental impacts of intensive farming systems (Harris Consulting and Brown Consulting 2005). Maganga *et al.* (undated) reported that on the Usangu Plains in Tanzania, water scarcity has resulted in conflict between farmers and pastoralists, especially during dry seasons. At the same time, the expansion of areas under irrigation by farmers has reduced the available land for grazing. Pastoralists, in turn, drive their cattle onto cultivated fields to access water during dry seasons, causing damage to crops and cultivated fields (Maganga *et al.* undated).

The above discussion shows that irrigation development brings with it both advantages and disadvantages. However, the advantages of irrigation play an important role in improving food security, especially where there are increased yields; diversification of crops; switching from low-value subsistence production to high-value market-oriented production; crop intensification; smoothing food supply; increased farm incomes; farm and non-farm employment; increased dietary diversity; lower food prices; and increased investment in assets. It is worth noting that well functioning irrigation systems has far greater benefits in terms of local economic development. Due to the much needed advantages of irrigation in poor areas, there is need for improving management of irrigation schemes and finding ways of reducing costs.

2.7 Successful and failed irrigation projects in the world

When evaluated in terms of impact, irrigation projects around the world show varying results. Some perform well while others perform poorly. A few irrigation projects that performed well with positive results (rated successful) and those that performed poorly with negative results (rated unsuccessful) were identified from literature and compared in this study. Success and unsuccessful ratings were determined by evaluators on the performance of the projects[1]. Criteria used involved what the projects were able to deliver to beneficiaries in terms of agricultural production, income, farmer's institutional development, infrastructure, food security, water use

[1] Successful projects were determined by the positive outcomes that the projects were able to deliver while irrigation projects that delivered negative outcomes were rated unsuccessful (table 2.5).

Table 2.5 Irrigation projects in various parts of the world that succeeded or failed (Community Ground Water Irrigation Sector Project 2005; FAO and Sub-Regional Office for East and Southern Africa 2000; International Rivers Network 2003; Nazzal and Vidal 2000; Vidal *et al*. 2001)

Project name and place,	**Project size (hectares)**	**Irrigation technology**	**Sample size and techniques for data collection**	**Assessment criteria and achievement**	**Reasons for success/failure**	**Ways of Sustainability**
Successful projects						
Community Ground Water Irrigation Sector Project (CGISP) in Nepal	15,000	Shallow tube wells (STW)	369 sample size	*Income* increased by 27% *Agricultural production* Increased yields - 27%, 80%, over 60% increase in rice, wheat and maize respectively. 225% increased cropping intensity. *Beneficiary coverage* 18,000 poor households, services to wide range of ethnic groups. *Farmer institutional development* 125 WUAs, 2 district level federations. *Farm to market roads improvement* 42km in improvement progress, 87.2km constructed.	Water user groups (WUGs), water user associations (WUAs), NGOs and consulting services, credits, farm to market roads improvements, implementation assistance and institutional strengthening, staff training, procured service vehicles and equipment.	Coordination of stakeholders, environmental monitoring, demand responsive approach, and capacity development strategy.
International Programme for Technology and Research in Irrigation and Drainage (IPTRID) Jordan Valley in Jordan	Two farms	Drip irrigation	Experiments Evaluation forms completed by local consultants	*Water savings* 20%-50% water savings. *Crop yield increase* 15%-20% increase of cucumber and tomatoes. *Water use efficiency* 44%-140% increase.	Use of tensiometres with drip irrigation.	Training for farmers.
IPTRID in middle Egypt		Modernised lined mesqua	Evaluated forms completed by	*Crop yield* 10% increase in cereals and	Farmers were organised before modernisation	Irrigation management

		(tertiary canals)	local consultants Experiments	cotton. *Water use efficiency* 10% increase		transfer involving WUAs and adequate technology transfer.
Chitora irrigation scheme in Zimbabwe	Nine	Drag-hose sprinkler	18 male and 18 female Participatory Rural Approval Descriptive statistics, Primary and secondary data	*Agricultural performance* 300% cropping intensity High crop yields e.g. 35,000 cobs of green maize in one season. *Income* High annual income per farmer Z$ 60,000. 90% Economic internal rate of return (EIRR) for the project. *Labour* More employment created because of horticultural crops. *Food security* Farmers never run out of food and do not get drought relief from govt. *Assets* Brick walled houses, farm implements and cattle. Entrepreneurial skills.	Use of high levels of inputs, farmer participation in planning and implementing, Strong Irrigation Management Committee (IMC), security of tenure, group cohesion, irrigation is valued, training to farmers.	IMC, training of farmers and security of tenure.
Unsuccessful projects						
IPTRID Jordan Valley in Jordan	One farm	Micro-spray irrigation with tensiometres	Experiments Evaluation forms completed by local consultants	*Observation* Citrus trees stressed.	Citrus trees over 40 years old had an extensive root system and parts of the root zone received less water due to pressure losses in the pipe network.	Not sustainable
Ngezi Mamina irrigation scheme in Zimbabwe)	216	Sprinkler	134 male, 30 female Participatory Rural Approval	*Agricultural performance* 200% cropping intensity but concentrated on low value crops, low crop yields e.g. 20,000 cobs	Poor relations between farmers and govt. institutions, poor water management, poor	In need of cooperation between farmers and govt.

			Descriptive statistics, Primary and secondary data	of green maize. *Income* Annual average income per farmer of Z$ 3000. Economic internal rate of return (EIRR) for the project was not computed because cash flows were negative. *Labour* Provided low employment opportunities as dominated by low value crops	operations and maintenance (O & M), no group cohesion, poor cropping patterns dominated by low value crops, poor marketing strategies, irrigation is not valued, lack of inputs and draught power .	institutions, improvements in O & M and proper cropping patterns.
Chasma Right Bank irrigation project iii in Pakistan	135	Canal	Surveys	*Transparency* Lack of transparency. No community participation. *Traditional irrigation system* Destruction of traditional irrigation system. *Socio impacts* Displacement of people forced to move from their homes and lands. Inadequate compensation of affected people. *Environmental impacts* Deforestation, loss of biodiversity, water logging and salinisation, extensive flooding, land degradation and soil erosion.	Exclusion of the community from decision making process and exclusion of affected areas from environmental impact assessments, both social and environmental.	In need of inspections and revisiting the planning and implementation process.

efficiencies, creation of employment and assets, socio and environmental impacts and transparency. Table 2.5 shows the projects and their locations, project size, irrigation technology used and sample and techniques for data collection. The reasons for their performances and ways of sustainability are recorded and are briefly explained. The table shows successful projects followed by unsuccessful projects.

The formation of water user associations and committees, and the development of group cohesion, community participation and capacity building are common reasons mentioned as contributing factors to successful irrigation projects, while lack of these things are common among the unsuccessful projects. The formation of such groups and the building of capacity by training farmers are imperative to the sustainability of successful irrigation projects. Unsuccessful irrigation projects require a revisiting of the design and implementation processes, the formation of groups, the training of farmers, cooperation, and improvements in operation and maintenance of the projects for sustainability.

From the above information, it can be seen that irrigation projects need to benefit communities by improving their food security situation. The section that follows presents current agricultural, food security and nutrition projects which have a component of irrigation development, recognised by the Ministry of Agriculture and Food Security in Malawi. Time frame, objectives and targeted beneficiaries of the projects are also presented.

2.8 Current agricultural, food security and nutrition projects in Malawi with the component of irrigation development

Many irrigation projects exist in Malawi and are initiated and operated by stakeholders, including government, NGO's, civil society, the private sector and church groups. These projects are recognised by the Ministry of Agriculture and Food Security for their importance in improving food production and enhancing food security. Table 2.6 presents some of the agricultural projects that have been initiated and operated in Malawi and have a component of irrigation development.

Table 2.6 Projects in the Ministry of Agriculture and Food Security with an irrigation component, Malawi (Ministry of Agriculture and Food Security 2006)

Project	Time frame	Objectives	Component specific to irrigation	Targets
A Community Based Management of Chia Wetland Lagoon in Nkhotakota District	01-Oct-04 to 30-Sep-07	Improve livelihoods of the rural communities through an integrated community-based approach that involves sustained economic use of the watershed's natural resources of land, water, flora and fauna.	Winter cropping and irrigation.	55000 individuals
Agriculture and Food Security Programme in Chitipa, Kasungu, and Mzimba Districts	01-Jan-04 to 31-Dec-07	Promote soil and water conservation technologies, use of organic manure, crop diversification, equip farmers with skills and knowledge in proper storage, processing and utilization of food crops and reduce dependency on rain fed crop production.	Awareness meetings in soil and water conservation, nutrition, irrigation farming.	7380 h/h
Agricultural Productivity Investment Programme (APIP) in Lilongwe, Dedza, Blantyre, Zomba, Mzuzu and Dowa Districts	01-Jun-97 to 30-Jun-06	Mitigate adverse social impact of the liberalisation process, give small holder farmers easier access to credit and contribute to income generation and employment generation for rural households.	Employment creation in micro and small enterprises e.g. small-scale irrigation.	70000h/h
Chingale Area Development Programme in Zomba	01-Oct-96 to 30-Sep-11	Improve crop and livestock production in Chingale area by 2010 to ensure household food security.	Small-scale irrigation	6000 h/h
Ching'anda Area Development Programme in Mangochi District	01-Oct-99 to 30-Sep-09	Improve household food security and household income for Ching'anda Community.	Small-scale irrigation	3000 h/h 3600 individuals
Dedza Food Security Improvement Project in Dedza District	01-Sep-02 to 01-Aug-07	Increased agricultural productivity, income and nutritional status.	Small-scale irrigation	8000 h/h
Development of Small-Scale Irrigation in Kasungu District	28-Jan-06 to 27-Jan-07	Increase productive capacity and income of the rural household poor through irrigated agriculture.	Development of small-scale irrigation.	670 h/h
Disaster Mitigation and Food Security in Nsanje District	01-Nov-05 to 31-Jul-10	Have communities with effective risk management plans and sustainable natural disaster risk reduction. Increase priority to mainstreaming disaster risk reduction into policies of government and aid agencies.	Irrigation	3000 h/h
Emmanuel International I-LIFE Program in Mangochi District	01-Oct-04 to 30-Sep-09	Increasing livelihoods through improved food security.	Irrigation schemes	5000 h/h
Enhancing Food and Nutrition Security for the most vulnerable communities in Malawi through agricultural livelihood diversification – Country-wide	02-Jan-06 to 31-Jul-06	Establish and support small-scale irrigation schemes, promote and institutionalize cookery demonstrations and nutritional education, promote agricultural knowledge and life skills of the vulnerable pupils through support	Small-scale irrigation	14500 h/h 72500 individuals

Project	Time frame	Objectives	Component specific to irrigation	Targets
		to extra curricular training.		
Food Security Investment Programme in Dowa District	01-Apr-03 to 30-Nov-06	Improve household food security levels through food production, club to club training and sustainable farming methodologies.	Small-scale irrigation farming	2000 h/h 8000 individuals
HIV/AIDS and Irrigation Programme in Kasungu District	01-Mar-05 to 28-Feb-07	Increase agricultural production and knowledge of HIV/AIDS.	Irrigation	1000 h/h 5000 individuals
Horticulture and Food Crops Development Project in Mzuzu, Kasungu, Lilongwe, Salima and Nkhotakota Districts	01-Jan-00 to 31-Dec-06	Increase agricultural productivity and farm incomes.	Small-scale irrigation schemes and rehabilitation of small earth dams.	6000 h/h
Income Generating Public Works Programme (IGPWP) in Blantyre, Chikwawa Dedza, Lilongwe, Dowa, Mchinji, Ntcheu, Kasungu, Nkhotakota, Machinga, Mangochi, Mzimba, Mulanje, Thyolo and Zomba Districts	01-Aug-05 to 31-Dec-11	Contribute to the Government's objective of poverty reduction in line with the Malawi Poverty Reduction Strategy (MPRS).	Irrigation	79000 individuals
Integrated Food Security Programme in Balaka, Mangochi, Dedza and Nkhotakota Districts	01-Oct-04 to 01-Sep-07	Improved access to both inorganic and organic agricultural inputs, access to agricultural produce markets, crop diversification and strengthened extension services and community capacity to respond to the needs of disadvantaged community members.	Promotion of Small-scale irrigation scheme.	3000 h/h
Malawi Food Security Project in Chiradzulu District	25-Sep-02 to 24-Sep-07	Improve food security and health of rural inhabitants in identified vulnerable areas in southern Malawi.	Small-scale irrigation development.	31331 individuals
Michemba/Naminjale Area Development Programme in Neno District	01-Oct-05 to 30-Sep-18	Increased food crop production among 1000 in Midzemba/Naminjale by the year 2018.	Irrigation	5000 h/h
Mobilizing for Life Malawi Agriculture and Food Security Programme in Salima, Nkhotakota, Ntchisi, Mzimba and Chitipa Districts	01-Sep-04 to Not stated	Mobilize local churches to build the capacity of over 10,000 vulnerable rural households for sustainable food security status.	Irrigation and wetland cultivation	6000 h/h
Mphuka Area Development Programme in Thyolo District	01-Oct-98 to 30-Sep-12	To improve household food security and household income for Mphuka area.	Small-scale irrigation	3000 h/h 15000 individuals
Mutendere Area Development Programme in Mzimba District	01-Oct-95 to 10-Sep-31	Improve food security and incomes of rural poor.	Small-scale irrigation	3000 h/h
Namachete Area Development Programme in Zomba District	01-Oct-99 to 30-Sep-14	Increased food availability by all households.	Small-scale irrigation	8220 h/h 42388 individuals
Namatumbi/Kanyenjere Area Development Programme in Chitipa District	01-Jun-96 to 30-Sep-11	Ensure food security.	Small-scale irrigation	22148 individuals
Ngodzi-Matowe Area Development Programme in Salima District	01-Oct-02 to 30-Sep-18	Increased food crop diversification among farmers of Ngodzi-Matowe by 2018.	Small-scale irrigation	6000 h/h
Nthondo Area Development Programme in Ntchisi District	01-Oct-95 to 30-Sep-10	Improved quality of life for Nthondo Community by 2010.	Small-scale irrigation	200 h/h 1000 individuals

Project	Time frame	Objectives	Component specific to irrigation	Targets
Promotion of Small-Scale Irrigation and Crop Diversification in Machinga, Kasungu and Lilongwe Districts	01-Mar-06 to 28-Feb-07	Support small-scale irrigation during dry spells and winter period as well as crop diversification.	Small-scale irrigation	5000 h/h 25000 individuals
Protracted Recovery and Relief Operations (PRRO) in Kasungu District	01-Jan-05 to 01-Jun-07	Support vulnerable groups with basic agricultural skills.	Small-scale irrigation	1330 h/h
Rural Income Enhancement Project in Rumphi, Nkhatabay, Ntcheu, Dedza, Thyolo, Nsanje, Mulanje, Mzuzu, and Lilongwe Districts	01-Feb-00 to 31-Dec-06	Increase income of rural smallholders and improve well-being of Malawians through poverty alleviation.	Agricultural development (training and extension, seed multiplication, crop diversification, soil and water conservation, agro-forestry, small-scale irrigation).	63000 h/h
Sasakawa Global 2000 in Blantyre, Machinga, Lilongwe, Salima, Kasungu, and Karonga Districts	01-Jun-98 to 30-Jul-06	Increase and accelerate adoption of enhanced agricultural technologies that could lead to reduced poverty, enhanced food security and preservation of natural resource base.	Small-scale irrigation	20000 h/h
Smallholder Flood Plains Development Programme in Karonga, Nkhotakota, Balaka and, Machinga Districts	01-Jul-99 to 31-Dec-06	Improve household food security, nutritional and health status, provide critical health and drinking water services, strengthen long-term capacity of public and non-governmental institutions and create capability at the grass-roots level of community.	Irrigation Development	6000 h/h
Smallholder Irrigation Project in Mwanza, Shire Highlands, Nsanje, Neno, Chikwawa, Chikwawa, Thyolo, and Chiradzulu Districts	02-Jan-00 to 31-Jul-08	Improve well-being of Malawians through poverty alleviation, increase irrigated land by 4600 ha and increase agricultural productivity.	Small-scale irrigation (distribution of treadle pumps, construction canals, setting out micro-sprinkler plots).	10000 h/h
Small-Scale Irrigation in Nsanje District	01-Jul-05 to 30-Nov-06	Increase food security, food production, capacity and knowledge to implement irrigation intervention and participation of vulnerable communities in winter cropping.	Crop production through irrigation.	2071 h/h 10988 individuals
Sustainable Livelihood Security in Zomba, Chikwawa, and Blantyre Districts	01-Mar-99 to 31-Dec-10	Achieve a sustainable end to hunger and poverty through participatory exploration of long term strategies together with partner communities.	Small-scale irrigation	0

The projects in table 2.6 above have been in Malawi, some from as early as 1995. The projects have been presented to show how the government of Malawi and other stakeholders have dedicated themselves to ensuring food security through irrigation. Progress on the projects has not been highlighted as this is not the focus of the study.

The literature review above, explored issues surrounding agriculture and food security with respect to irrigation globally, Africa and Malawi. Irrigation was discussed as one of the tools used to respond to food security crises. In a continued search to investigate the impact of irrigation on household food security, the chapter that follows discusses the context of the study.

CHAPTER 3 STUDY CONTEXT

3.1 Malawi demographics

Malawi is a land-locked country, lying in southern Africa between latitudes 9°, 22'S and 17°, 03'S and longitudes 33° 40'E and 35° 55'E (FAO 2006a). The country is bordered by Tanzania to the north and northeast; Mozambique to the east, south and southwest; and Zambia to the west (FAO 2006a). Malawi is divided into the northern, central and southern regions with 27 districts (Open Society Initiative for Southern Africa (OSISA) undated).

Malawi is the most densely populated country in the SADC region, with a population density of 104 inhabitants/km^2 (FAO 2006a). According to IndexMundi (2007), Malawi's population was 13,603,181 with the median age of 16.7 years in July 2007. Population growth rate was 2.383% while the birth rate was 42.09 births/1,000 populations and the death rate was 18.25 deaths/1,000 populations in 2007. Infant total mortality rate fell at 92.1 deaths/1,000 live births and total fertility rate was 5.74 children born/woman. Life expectancy at birth for the total population was 42.98 years. The average literacy rate of Malawians was 62.7% (IndexMundi 2007). Malawi is one of the poorest countries in the world (FAO 2006a). In 2000, its Human Development Index (HDI) was 0.464 that ranked the country 163rd out of the 174 countries of the world.

The IndexMundi (2007) 2003 estimates showed that Malawi had a HIV/AIDS adult infection rate of 14.2%. The FAO (2006a) explained that high prevalence of HIV/AIDS has resulted in increased infant mortality and death rates and changes in the distribution pattern of the population in terms of age and gender. Despite the increase in death rates, there is rapid increase in the population that has resulted in pressure on land, leading to severe deforestation, soil erosion and general degradation of the natural resource base (mostly in southern Malawi – as compared to the central and northern Malawi) (FAO 2006a). In 2007, major diseases affecting people were malaria, bacterial and protozoal diarrhoea, hepatitis A, typhoid fever, and schistosomiasis (IndexMundi 2007).

3.2 Background and location of the study

The case study was carried out in the Chingale area, Zomba District, in southern Malawi. According to Konyani (1996) the year that World Vision Malawi unveiled a plan to initiate an Area Development Programme (ADP) in Zomba District was not documented but initiation of the programme started in 1995 with support from the United States World Vision Support Office. The overall goal of initiating the programme was to improve the standards of living of people in the Zomba District.

The Zomba District Development Committee (DDC) reported to World Vision Malawi that the entire Zomba West area was neglected in terms of community development efforts by government and other development agents. Zomba West, where Chingale area is located, is isolated from the main trading centres and commercial towns because of poor road infrastructure and the inaccessibility because of the Zomba Mountain in the east. Consequently, people have difficulties in accessing Zomba West during both the rainy and dry seasons. Many development agents also shun the Zomba West community and concentrate their development efforts on the eastern and northern parts of Zomba District because of poor accessibility. Zomba West is one of the poorest communities in the Zomba District (Konyani 1996). Figure 3.1 presents a map showing the location of Chingale, in Traditional Authority Mlumbe's area, located in the west of Zomba District.

In Chingale area, the average land holding size is 0.8 hectares (ACT 2003). Chingale's total population is 189,000 with a rapid population growth of over 4% per annum (ACT 2003), which has resulted in the destruction of natural resources, causing environmental degradation. The hills are bare, as trees have been harvested for charcoal production. People have resorted to cultivating along the river banks and on marginal land and along and on top of the hills because of shortage of land. Most rivers become dry immediately after the rains (ACT 2003). Konyani (1996) commented that since Chingale is cut off from the main trading centres and commercial towns; there are very few income-generating activities, and most men leave the community to the cities in search of employment opportunities. According to Konyani (1996), the national figures indicated that there are more females (52%) than males (48%) in Chingale ADP.

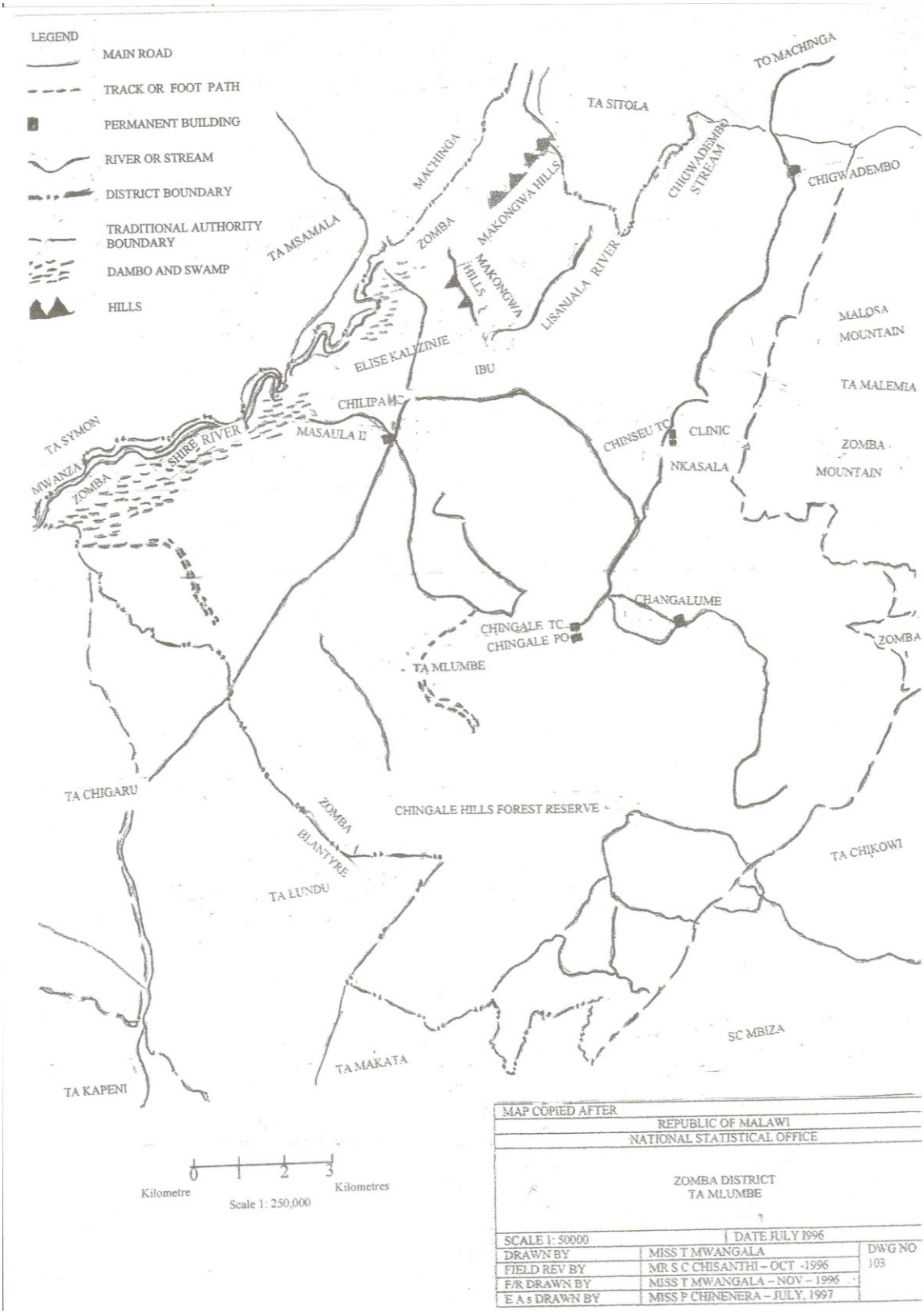

Figure 3.1: Map showing the location of Chingale in Zomba District (National Statistical Office 1996).

Konyani (1996) reported that the 1997 Population Housing Census showed a total population of 99435 in the whole Traditional Authority Mlumbe's area covering 678km^2 of land. The average density of the population in Traditional Authority Mlumbe's area was 147 people per km^2. Twelve group village Headmen do form Mlumbe's Traditional Authority. Only four of the 12 Headmen in Traditional Authority Mlumbe's area, are part of Chingale ADP.

Chingale ADP is situated between the Shire River and the Zomba Mountain and has 144 villages with an estimated population of 30,000 people. On the northern side, the ADP community is bordered by the Machinga District and the Chigwadembo stream (figure 3.1).

3.3 Findings from baseline survey in Chingale ADP

A baseline survey conducted by Konyani in 1996 included a sample of 463 people in Chingale ADP, but the report did not explain how the sample was selected**.** Three data collection techniques were used namely: observation, review of secondary data, and face to face interviews through the use of a guided questionnaire.

The survey showed that farming was the main source of income for 61.5% of the surveyed households. Of the food crops grown, maize was the main food crop grown by 91.9% of the surveyed households. Only 15.8% of the surveyed households grew cassava. Maize was the main cash crop grown by 48.6% of the surveyed households, while tobacco was the lowest cash crop grown by 5.2% of the surveyed households. Peaches, the most common fruit trees available, were grown by 96.1% of the surveyed households.

At least 22% of the surveyed households were engaged in business ventures like selling agricultural products, beer brewing, fishing, tailoring and baking**.** Seven percent of the surveyed households were employed while 9.3% of the surveyed households were engaged in unspecified activities. Transportation of farm produce beyond the community for sale was hampered by poor road networks in the community. The majority of community members expressed interest in income generation ventures, but also expressed lack of capital (funds) as their major bottleneck to venture into business.

Livestock was kept on a very small-scale, mainly as a source of income and food. At least 40% of the sampled households kept free range chickens, while 39.9% of the sampled households kept goats. Only 2.5% of the sample kept other livestock like doves, sheep, rabbits and cattle. The low numbers of cattle kept in the community was attributed to lack of grazing land and poor climatic conditions that are unfavourable for dairy farming. A fish farming programme (Malawi-Germany Fisheries and Aquaculture Development Programme (MAGFAD) was launched in Chingale in 1988 with funding from the Germany Technical Corporation (GTZ). The programme encouraged fish farming among community members to enable them acquire protein and income. A total of 165 community members were trained in fish farming. However, persistent drought and lack of fingerling stock affected progress.

Secondary data from agricultural extension staff showed that the Chingale area had been heavily deforested because of the demand for farm land as the population increased. To remedy the problem of deforestation, the Department of Forestry introduced clubs and afforrestation programmes. A demonstration garden was also established for training farmers in techniques of agroforestry in the area.

Konyani's (1996) survey results also indicated that 58% of the sampled households drew water for drinking and other domestic purposes from open sources such as rivers, wells and dams; 28.1% of the sampled households drew water from gravity-fed water taps; 11% of the sampled households drew water from boreholes; and 2.4% of the sample drew water from springs. Despite the availability of taps, almost 85% of the taps were only functional for three to six months on average per year. On average, few boreholes had water for nine months per year. These situations forced people to resort to using open water sources for drinking and other domestic use. The reasons attributed to the problems of water flow were blockages and plugging at intakes, especially during the rainy season; low water tables during dry seasons; and pipes that had too small a diameter and could not cope up with the high water demand. Only 28% of the sampled households boiled drinking water. The reasons indicated for not boiling drinking water were lack of interest and time; people had been drinking water from the same open sources and were not getting sick; and lack of firewood.

At least 52% of the sampled households used the post office at Chingale Trading Centre, while 34.1% of the sample used the postal agency at Masaula Trading Centre which is frequently affected by telephone breakdowns and attacks by armed robberies. Postal service failures in the community were related to poor road network infrastructure which is worse during the rainy season due to poor or lack of bridges.

In terms of health, 91.6% and 84% of the households interviewed indicated diarrhoea and malaria as common diseases in the area respectively. The results explained that the high cases of diarrhoea and malaria were due to lack of potable water in the community and the presence of marshes along the Shire and Linthipe rivers respectively. Chingale ADP has four Health Centres that assist in treating minor diseases; conduct growth and monitoring exercises; immunisation of children under-five; and educating and communicating health related aspects. The ADP only had ten Health Surveillance Assistants serving the population of the ADP.

Interaction with agricultural extension workers showed that extension workers had a heavy workload and failed to reach out to the wider community. Some villagers also explained that they had never been visited by agricultural extension staff. However, villagers close to agricultural extension offices indicated frequent interaction with field staff. The problems of extension workers were compounded by lack of bicycles and motorcycles to facilitate mobility within the community.

On average, 82.1% of school-aged children were in school. This was mainly attributed to the free primary school education system introduced by the government. It was noted that primary school enrolment especially in infant classes soared in the first term and dropped as the academic year progressed. The reasons for not going to school were lack of interest by children and/or parents; poverty (inability to provide presentable clothes for children to wear to school); distances travelled to school; early pregnancies; and illness.

As for literacy levels, illiteracy rate was high among women (53.4%). The illiteracy rate of the whole Chingale ADP community was 38%, which was lower than the rate of Zomba district and the country which were at 42.6 and 64% respectively as per 1987 Population and Housing Census

(Konyani 1996). Functional literacy classes were introduced to help adults learn how to read and write. Only few females attended the functional literacy classes while no men attended. The reasons that were given for not attending the classes were lack of classes nearby; lack of interest; old age; laziness; a combination of men and women in the same class made people uncomfortable; and irrelevance of the teaching material.

3.4 Chingale ADP and its operations

World Vision Malawi demarcated the ADP into 11 Management Centres for easy management and coordination of activities (Konyani 1996). Makhunje (2006) reported that Chingale ADP offered a number of projects in the agriculture, education, health, HIV/AIDS (child hope), leadership development and programme management, Christian commitment programme, and support in terms of food, cash, school fees and seed.

The Agriculture and Food Security component of the ADP began in 1997 to address the food insecurity and poverty of many smallholder farmers in the Chingale area (Chimutu 2001). Agricultural interventions included irrigation, farm input loans, agroforestry and afforestration, fish farming, soil and water conservation, seed multiplication, poultry protection, cash crop production, horticulture and vegetable production, compost making, and farmer field schools (Chimutu 2001).

Since farm inputs are crucial to the production of crops, the ADP has, since 1988, provided farmers (beneficiaries) with credit for maize production with an aim to improve food security. Table 3.1 shows farm input loans for maize production in terms of seed and fertiliser. Loan quantity, value and the number of farmers benefiting from the input loans and recovery of the loans are also presented.

Irrigation as one of the interventions, started with the introduction of irrigation projects which were introduced in the year 2000. Three irrigation sites were successfully initiated at Kalizinje, Mlooka 1 and Mlooka 2. Each of the irrigation sites had an area of four hectares. In 2001, a total of 94 farmers (including 43 women) were involved in the projects.

Table 3.1: Farm input loans for maize production, the number of beneficiaries and recovery of loans in Chingale from October 1998 to July 2001 (Chimutu 2001)

Year	Loan beneficiaries			Loan	Quantity (kgs)	Loan value	Recovery of loans
	Men	Women	Total	Seed	Fertiliser	MKwacha	MKwacha
1998	66	30	96	910	6250	5690	56960 (100% recovered)
1999	232	93	325	2830	11300	383514	383514 (100% recovered)
2000	289	160	449	2000	27000	471424	471424 (100% recovered)
2001	268	200	468	2872	24550	811594	573819 (71% recovered)
Total	**855**	**483**	**1338**	**8612**	**69100**	**1672222**	
%			**100%**				
% increase	**306%**	**567%**	**387%**	**215%**			

The projects restricted the number of participants because of limitations in equipment and land, although the demand from farmers to participate in the projects was very high. Crops grown in the irrigation sites were maize, beans, rice and vegetables (Chimutu 2001). Currently, other irrigation sites that are opened include: Ibu, Luwezi, Mitumbili, Mdoka and Mjambe.

The Chingale Irrigation Programme is active during the dry season. Communal land that farmers have the right to use is rented out after harvesting rain-fed yields to the individual farmers who are part of the World Vision Malawi Irrigation Project. These farmers can then grow and irrigate crops during the dry season. Therefore, irrigating farmers are able to produce crops during both the rainy and dry seasons.

CHAPTER 4 RESEARCH METHODOLOGY

4.1 Introduction

This case study investigated the impact of irrigation on household food security among the people of Chingale ADP in the Zomba district of Malawi. Methodological approaches applied in the study are presented in this chapter.

Initial meetings were held on 23rd August 2006 with Blantyre Programme Manager of the World Vision Malawi, Mr Hastings Banda who referred the researcher to Mr Peter Makhunje (Zomba Programme Manager, responsible for the Chingale ADP). The manager gave permission for the researcher to collect data from Chingale ADP.

4.2 Sampling

The activities of the irrigation project in Chingale are in operation mostly during the dry season. Farmers relied on both irrigation and rain-fed farming (irrigators) and rain-fed farming only (non-irrigators). A meeting was organised with the assistance from Chingale ADP office of World Vision Malawi to meet and invite irrigating and non-irrigating farmers to participate in the study. Farmers who were willing to participate in the study responded to the call by World Vision Malawi and came to the meeting. Therefore, self selection technique was used to select the sample.

Participants indicated whether they were irrigators or non-irrigators and joined the group they belonged to. Initially, it was planned that eight people were required per group but the groups ended up having more than eight people. From each village, two group discussions with irrigating and non-irrigating farmers were conducted. Twenty-four participants, 10 irrigating farmers and 14 non-irrigating farmers from Ibu and 34 participants, 12 irrigating farmers and 22 non-irrigating farmers from Kalizinje participated in the study. Altogether, fifty-eight farmers from two irrigation sites of Ibu and Kalizinje villages participated in four group discussions. Three World Vision staff were also interviewed the following day.

4.3 Data collection

The researcher and three research assistants who were oriented on the methods of data collection of the study collected data from the two villages. Consent was sought through a consent form given to the participants of the study to ensure their acceptability as being part of the study. After reading and understanding the consent form participants signed the consent form to confirm their participation in the study. Consent to record data through the tape recorder and note taking was also sought from the participants. Furthermore, the researcher explained to the participants what their rights to participating in the study were in terms of anonymity and confidentiality.

The fields, crops and source of irrigation were observed when visiting farmers in their gardens. Photos were taken as evidence of the experiences to see the visible impact of irrigation on household food security (Appendix A). Data collection at Kalizinje ended late in the evening and the researcher was unable to visit the fields in Kalizinje. Appendix B shows the questionnaire used for collecting demographic characteristics of participants.

4.3.1 Data methods and techniques

Saunders *et al.* (2003) recommended that analytical aids are very useful as they help one to recall the context of the interviews. In collecting data, the researcher used researcher's diary for summaries and key points that emerged from the group discussions and the interviews.

Group discussions and in-depth interviews were used to collect data. Participatory techniques were used in group discussions that were conducted with farmers and in-depth interviews were conducted with World Vision field staff. Participatory techniques that were used included: resource maps, historical time lines, brainstorming and ranking, matrices, and observation. SWOT analysis was used during in-depth interviews with World Vision field staff.

A resource map was drawn by the farmers, indicating resources before and after irrigation. A resource map is a tool that helps one to learn about a community and its resource base, and shows geographical locations, topographical or conceptual relationships between resources like households, infrastructure, wildlife, grazing land, water sources, trees, arable land, residential

areas, meeting places and important sites (example: Appendix A, picture 5). Appendix C shows the procedure and the key/probing questions that were used in resource mapping.

Information on a historical time line was entered by groups in group discussions to understand the background to the project and explore changes that occurred after irrigation. The procedure and probing questions used with the historical time line are presented in Appendix D. Brainstorming assisted in collecting information, while simultaneously using a historical time line and resource map to collect information. Brainstorming and ranking were used to explore the benefits and problems the farmers experienced with regard to rain-fed farming and irrigation (Appendix E). Matrices were also used to explore information on consumption, assets, income, crop yields, cash cropping, purchases and social services. Procedures and probing questions for using the matrices are shown in Appendix F.

In-depth interviews were administered to World Vision field staff in search of information on the project itself. Questions on progress of the irrigation project and the impact of irrigation on household food security were asked. Administering in-depth interviews allowed a flexible environment where World Vision field staff were free to express their views on the impact of irrigation on household food security and what irrigation had brought to the people of Chingale ADP.

In-depth interviews also helped to answer the four sub-problems of this study. SWOT analysis was used during in-depth interviews with World Vision field staff to discuss the strengths, weaknesses (challenges), opportunities and threats of Chingale Irrigation Project in terms of production levels; income levels; diversification of crops; the role of income from irrigation on dietary diversity and asset acquisition. This approach enabled field staff to consider the opportunities and strengths of the irrigation project to make suggestions for irrigation and identify strategies to improve food security. Questions for in-depth interviews and SWOT analysis document are presented in Appendix G.

4.4 Data analysis

Table 4.1 below, presents a summary of sub-problems, indicators, themes, questions, tools and analysis that were used as a basis for collecting and analysing data for this study. The indicators were identified from the sub-problems and were used as measures to investigate the sub-problems. Themes were identified from the indicators on what was necessary to be investigated. Questions were derived from the themes and this gave the researcher ideas of the tools that were relevant in accessing the information needed.

Data were analysed qualitatively. Themes, trends, patterns, and relationships were identified through matrix or logical analysis. The use of matrices from the data collection tools (Appendices B to E) helped to generate an outline that was based on the organisation of data. This enabled comparisons to be made between responses from irrigating farmers before and after the introduction of irrigation and between farmers after introduction of irrigation and non-irrigating farmers.

After the findings were drawn, a validation exercise was conducted. The findings of the study were presented to the participants of the study on 25th June 2008 and participants gave their comments; clarified some issues and confirmed that the results were a true reflection of the impact of irrigation at Ibu and Kalizinje villages (Appendix H).

Table 4.1: Sub-problems, indicators, themes, main questions, tools and analysis used for data collection

Sub-problem no	Sub-problems	Indicators	Themes from indicators	Main questions	Tools	Analysis
1	Are irrigating farmers better off in terms of crop production than non-irrigating farmers?	Crop production	Crops grown. Crop yield per hectare (more or less per hectare) Hectares before and after irrigation . Reasons for crop yield. Years of plenty and scarcity.	How many hectares used by non-irrigating farmers and farmers before and after the introduction of irrigation? Benefits of irrigation in terms of crop production.	Group discussions. Observe directly (See for oneself). Resource Map. Historical time line. In-depth interviews with project staff. SWOT analysis of project. Matrix.	Compared land sizes for irrigating farmers before and after introduction of irrigation and farmers after introduction of irrigation with non-irrigating farmers.
2	Are irrigating farmers better off in terms of income levels than non-irrigating farmers?	Income	Crops produced for cash cropping. What farmers were able to purchase after irrigation and were not able to purchase before. Income from other sources of income (More or less and high/low than farming income).	Were crops produced for cash cropping by non-irrigating farmers and farmers before and after the introduction of irrigation? What was purchased by non-irrigating farmers and farmers before and after the introduction of irrigation that which irrigating farmers were not able to purchase before introduction of irrigation? Benefits of irrigation in terms of income earned.	Group discussions. Observe directly (See for oneself). Resource Map. Historical time line. In-depth interviews with project staff. SWOT analysis of project. Matrix.	Compared crops produced for cash for irrigating farmers before and after introduction of irrigation and farmers after introduction of irrigation with non-irrigating farmers.
3	Is there an increase in diversification of crops for irrigating farmers than non- irrigating farmers?	Crop diversification	Crops grown. Crops grown before and after irrigation by irrigators. Reasons for growing additional crops.	What were the crops grown and the number of crop types grown by non-irrigating farmers and farmers before and after the introduction of irrigation? Benefits of irrigation in terms of crop diversification.	Group discussion. Observe directly (See for oneself). Resource Map. Historical time line. In-depth interviews with Project staff. SWOT analysis of project.	Compared number of crops grown for irrigating farmers before and after introduction of irrigation and farmers after introduction of irrigation with non-irrigating farmers.
4	Does income from irrigation increase dietary diversity and asset acquisition of farmers?	Dietary diversity Assets	Diets eaten by households before and after irrigation. Assets in working order owned by households before and after irrigation.	Dietary diversity What were the diets for non-irrigating farmers and farmers before and after introduction of irrigation? Assets What assets were owned by non-irrigating farmers and farmers before and after the introduction of irrigation?	Group discussions. Matrices. In-depth interviews with project staff. Resource map. Observe directly (See for oneself). SWOT analysis of project. Brainstorming and ranking.	Compared diets for irrigating farmers before and after introduction of irrigation and farmers after introduction of irrigation with non-irrigating farmers. Compared assets acquired by irrigating farmers before and after introduction of irrigation and farmers after introduction of irrigation with non-irrigating farmer.

CHAPTER 5 STUDY RESULTS AND DISCUSSIONS

5.1 Description of participants

Participants in this study were three World Vision Malawi field staff based at Chingale and 58 farmers from the villages of Ibu and Kalizinje in the Chingale area of Malawi (24 farmers from Ibu and 34 farmers from Kalizinje villages). Sixteen males and eight females participated from Ibu, while 15 males and 19 females participated from Kalizinje (Appendix A, pictures 1, 2, 3, 4, 5 and 6). Altogether, 31 males and 27 females participated in the study. The average age of the participants was 35 years and ages ranged from 20 to 71 years. Fifty-two participants were married, three were divorced and three were widowed. On average, participants had six years of formal schooling. Only two had 12 years of formal schooling (had completed school). Household sizes ranged from one to nine individuals, with the average size consisting of five people. Apart from farming, 19 participants were engaged in business and four participants were engaged in piece work. One participant was engaged in business and piece work.

5.2 Physical and natural resources

The villages of Ibu and Kalizinje were approximately 5km away from each other (Figure 3.1). Participants reported that their villages had many resources in common, including a main road (dirt), livestock, a church, a shared private mission hospital, primary schools, gardens, markets, graveyards, and rivers. The Makongwa Hill borders the Lisanjala River where the Ibu irrigating farmers have fields. Ibu residents used the Lisanjala River for both drinking and irrigation as there was no borehole at Ibu (Appendix A, picture 7). Kalizinje residents had a bore hole for drinking water, and irrigating farmers irrigated crops from the Shire River. Kalizinje residents also indicated the availability of forests and *dambo* (wetlands) where some farmers irrigated crops using simple and traditional methods of irrigation (for example, buckets and wells). There was also an Agricultural Development Marketing Corporation (ADMARC) market where maize grain is sold at the Masaula trading centre, 4km away from Kalizinje and 6km away from Ibu irrigation schemes.

5.2.1 How the irrigation projects worked

The irrigation projects from Ibu and Kalizinje used motorised diesel pumps for irrigation (Appendix A, picture 8). The pumps were installed at the point where water was sourced. Pipes

connected to the pump were directed into the irrigated fields to irrigate crops through furrow irrigation (flood/surface irrigation system). Land that was close to the pump intake point was ideal for irrigation because water was easily pumped onto that land. According to irrigating farmers, the pumps at Ibu and Kalizinje were too small to meet the needs (table 5.7). Farmers contributed money for the diesel used by the pumps and were allocated days and times to pump water onto their fields. Farmers irrigated once per fortnight in both irrigation schemes and worked for a day in teams of four individuals. Four plots were irrigated in one day and the teams assisted each other. At Ibu, non-irrigating farmers who had land adjacent to the irrigation project rented land to irrigating farmers after harvest for irrigated production. Payment of the land was in the form of money and there were no other payment arrangements made because money was what was accepted by the farmers. Later in the year, the land was returned to non-irrigating farmers for rain-fed production. At Kalizinje, the land for the irrigation scheme was communal. The land was demarcated into plots and was fully managed by irrigating farmers.

Farmers did not apply to be part of the scheme. Farmers who had interest in joining and accepting the conditions that applied to the management of the project became part of the project. Other reasons for not being part of the project were the costs involved (membership fee and fuel costs) and the unwillingness to take risks.

5.3 Crop production before and after irrigation between 2001 and 2007

Table 5.1 shows the crop production that occurred through rain-fed farming and irrigation at Ibu and Kalizinje, between 2001 and 2007, as reported by the participants of the study. The irrigation project at Ibu started with 47 farmers in 2005. In 2007, there were 27 farmers involved in the project. The reduction in farmers was explained by the distance they lived (7-10km) from the irrigation scheme. In 2006/2007, these farmers who stayed far away did not turn up for irrigation during their allocated days due to long distance. Consequently, the crops wilted, and crop production was lower than expected. However, irrigating farmers at Ibu reportedly harvested plenty of food in the 2006/2007 production year. Farmers confirmed that the fertiliser subsidy programme assisted all farmers that planted that year to produce enough yield.

Table 5.1: Crop production before and after irrigation between 2001 and 2007, Ibu and Kalizinje, 2007

Year	Ibu			Kalizinje		
	Irrigators		**Non-irrigators**	**Irrigators**		**Non-irrigators**
	Before irrigation	***After irrigation***		***Before irrigation***	***After irrigation***	
2001	Drought.	Not applicable.	Drought, hunger**,** no job opportunities, received food from government.	Drought.	Started irrigation with 32 farmers using motorised (diesel) pump.	Drought, hunger, people died of hunger.
2002	Drought and cholera.	Not applicable.	Not enough rains, expensive fertilizers and low yields.	Drought and hunger.	Enough food, theft by others.	Hunger, drought, and people eating maize husks.
2003	Drought, pests (army worms) destroyed crops and low yields.	Not applicable.	Not enough rains, low yields and hunger.	Drought and hunger.	Happy year, enough maize, planted thrice.	Hunger.
2004	Low yields.	Not applicable.	Not enough rains, low yields and hunger.	Drought, low yields and hunger.	Happy year, a lot of maize, planted thrice.	Drought and hunger.
2005	Drought, low yield and hunger.	Started irrigation with 47 farmers using motorised (diesel) pump, planted twice a year, no hunger, theft in fields by others increased, income available after selling crops.	Low yields.	Hunger, maize swept a way by floods from shire river.	Enough food.	Rains stopped earlier, hunger.
2006	Enough rains and plenty of food.	Happy year, planted maize twice a year with irrigation, plenty of maize, income available from selling crops, no theft.	Enough rains, cheap fertilizer due to government subsidy, more yield, enough food.	Maize swept away by floods from shire river.	32 farmers involved and enough food.	Enough rains, plenty of food but lack of money.
2007	Plenty of food from 2006.	27 farmers involved. Plenty of food from previous year.	Plenty of food from previous year.	Enough food from previous year.	No irrigation because of pump breakdown but enough food stored from 2006.	Plenty of food from previous year.

At Kalizinje, the initial number of farmers in the project was 32 and remained constant between 2001 and 2007. Farmers at Kalizinje attributed the lack of growth in numbers of farmers involved in the project to the constraining size of the small diesel pump and small size of land that could not accommodate more members. The land was demarcated into 32 plots that was just enough for the 32 people – one plot per farmer. These farmers did not apply to be part of the scheme. They were farmers who showed interest in joining and accepting the conditions that applied to the management of the project for example, payment of membership fee and fuel costs. However, as time went and the benefits of the project were observed, many people were willing to be part of the project.

The findings above, explain that there is need for strategies to accommodate more farmers at both Ibu and Kalizinje. These strategies could include: adding to the irrigation equipment already in use, for example, more pumps and increasing irrigated land and encouraging farmers who are near the irrigation schemes to join the irrigation projects so that the project is fully utilised. Opening other irrigation schemes where there is potential for irrigation would help accommodate more farmers, resulting in wider, improved household food security.

Common crops planted by irrigating and non-irrigating farmers from both villages included maize, pigeon peas and beans (table 5.4 and Appendix A, pictures 9 and 10). Farmers at both Ibu and Kalizinje mostly grew maize because it is the main staple food. In addition, Kalizinje farmers grew groundnuts, and vegetables like rape and leaf mustard. Participants confirmed that the environment and climate accommodated the growth and maturity of crops grown. The growing of other crops by Kalizinje farmers indicates that additional crops could be planted at both Ibu and Kalizinje villages. Ibu farmers did not grow rape and turnips because of choice and groundnuts were not planted in irrigation sites because soils were poor. Trying new crops, especially with irrigation, would give farmers an added advantage in offering more varied diets and more income opportunities.

Crops that were commonly sold locally were green maize, cotton and pigeon peas. Green maize, which farmers took to Limbe to sell, was said to be more profitable than dry maize grain. Selling fresh maize would encourage irrigating farmers to plant more for profit. However, selling all the

maize green would be counter-productive because dry maize grain is an important staple food in Malawi. Storage of dry maize also has to be considered so that farmers do not lose stock to pests and diseases. Food that is preserved for the future or sold while in good condition would benefit farmers – both nutritionally and economically.

Some participating farmers at Ibu and Kalizinje experienced hunger because of the drought between 2001 and 2005. In 2001, before irrigation was introduced, farmers from Ibu received food aid from the government of Malawi. Farmers reported that some people had died of hunger in 2001 at Ibu. Participants reported that in 2002, people at Kalizinje ate *nsima* (the traditional staple food) made from *madeya* (maize husks) instead of maize grain because of the lack of grain. However, at both Ibu and Kalizinje, irrigating farmers were better off than non-irrigating farmers in terms of crop production and had enough food – from 2001 in Kalizinje, and from 2005 in Ibu, the years irrigation was implemented.

The 2006/2007 growing season brought with it enough rain and food for all farming households. All farmers at Ibu explained that cheap fertilisers from the government subsidy programme contributed to the availability of food. These findings indicate that, much as good rains contribute to enough food for all, fertiliser is also essential for farmers to produce enough food and rain is essential for fertiliser use. The result confirms the report by FEWS NET (2007) in that favourable rains, coupled with availability of fertilisers, resulted in bumper harvests of most crops in Malawi in 2006/2007. During 2006/2007, there was no theft of crops in the fields, compared with the previous years of drought. This was reportedly because all farmers had enough food in 2006/2007 production year because of the good rains and accessibility of fertilisers.

The availability of food for irrigating farmers households' tallies with the findings reported in literature (Chiza 2005), in that within the first three years of irrigation project interventions, yields can contribute significantly to food production and food security. These findings indicate that irrigation helped farmers produce enough food to protect them from the devastating effects of hunger experienced by non-irrigating farmers between 2001 and 2005 at both, Ibu and Kalizinje. In this regard, irrigating farmers could assist in making food available to non-irrigating farmers, provided they had surpluses for sale to the community.

Irrigating farmers at Kalizinje reported that their fields were close to the Shire River and that the flooding of the Shire River in 2005/2006 washed crops away. Although the floods affected irrigating farmers at Kalizinje, they still had enough food and did not experience hunger, possibly because irrigating farmers at Kalizinje planted three maize crops a year.

The breakdown of the pump at Kalizinje in 2007 had had negative effects on the production of irrigating farmers. Lack of expertise, tools, equipment and money for repairs brought the whole irrigation project to a halt and forced irrigating farmers to return to rain-fed farming. As a result, food insecurity threatened irrigating farmers at Kalizinje. There is a need for training farmers in operating and maintaining the pump in order to enhance the pump's lifespan so that irrigation can continue. This is in line with literature (Community Ground Water Irrigation Sector Project 2005; FAO and Sub-Regional Office for East and Southern Africa 2000; International Rivers Network 2003; Nazzal and Vidal 2000; Vidal *et al*. 2001), in that the building of capacity by training farmers are imperative to the sustainability of successful irrigation projects

In 2005 and 2006, irrigating farmers at Ibu reported that they had derived income from selling irrigated crops, while Kalizinje non-irrigating farmers had not. This was possible because irrigating farmers had surpluses to sell, having already produced enough food for consumption. Their income was generated by selling their produce within and beyond the community. Income was ranked by Ibu and Kalizinje irrigating farmers on positions two and three respectively, relative to other gains in irrigation farming like food, houses with iron roofs, livestock, clothes and sending children to school (table 5.7). The finding may mean that income was among the highest benefits enjoyed by irrigating farmers. In this regard, irrigating farmers reported to have bought some of the things required in the home and repay input loans from World Vision Malawi with the income they earned from selling farm produce. In terms of food security, irrigating farmers would be more food secure because they would have access to food they did not produce by using income to buy food.

An outbreak of army worms reportedly destroyed crops at Ibu in 2003. Grasshoppers and maize streak virus were also reported as recurring problems by one field staff member (Table 5.11).

While pests and diseases can be controlled by pesticides and fungicides, farmers complained of the associated costs. Since irrigating farmers have income from the sales of farm produce, they could more likely buy pesticides. On the other hand, farmers could use non-chemical ways of controlling pests and diseases that include: sanitation, physical control methods like hand removal of insects, crop rotation, use plant varieties that are resistant to pests and diseases.

5.3.1 Potential of rain-fed farming and irrigation to improve food security

All the World Vision field staff who were interviewed were of the opinion that irrigation had potential to improve food security over rain-fed farming (Table 5.2). As irrigating and non-irrigating farmers grew similar crops, except for groundnuts and sweet potatoes (grown by non-irrigating farmers), and tomatoes (grown by irrigating farmers) (Table 5.4), field staff were able to compare rain-fed farming with irrigated farming. Irrigation was reported to have potential to improve the food security of irrigating farmers in both villages because of the following reasons:

- Control of irrigation water prevents leaching of fertiliser;
- Increased cropping of different crops is possible;
- Cash cropping is possible;
- Fewer pests occur with irrigation;
- Irrigation enables reliable water application.

Although irrigation was hailed to have potential to improve food security, field staff explained that availability of land, inputs and water were necessary to realise this potential. The field workers' views concurred with literature (Bhattarai *et al*. 2002) in that irrigation, fertilisers and high yielding varieties have increased food production worldwide. Irrigation alone will not ensure food security, but requires availability of inputs, such as fertilisers, available land and adequate supply of water (Bhattarai *et al*. 2002). The Chingale Irrigation Project needs greater availability and accessibility of agricultural inputs like seeds, fertilisers, pesticides and fungicides; land and knowledge in the operation and maintenance of pumps to improve food production.

Table 5.2: Reasons given by three World Vision field staff as to why irrigation has the potential to improve food security, Ibu and Kalizinje, 2007

Field staff 1
Irrigation water is more easily controlled by irrigating the required amount of water to crops than rain water. In this way, fertiliser applied to crops is not washed away through leaching, as is the case with rain water.
Farmers plant two to three times a year. As a result, farmers do not experience hunger due to increased production.
When irrigating, pests are not as plentiful as they are during the rainy season because control of irrigation water discourages weed growth and the presence of too much moisture; conditions that are necessary for the survival of pests and diseases.
Field staff 2
With irrigation, water and moisture are more easily controlled than rain water because farmers know how much water and moisture is needed by the plants.
With irrigation, it is easy to grow cash crops.
Irrigating farmers plant three times within one year.
Field staff 3
Irrigation is more reliable than rain-fed farming as rain can stop at any time, whereas irrigation can be controlled.
If farmers have land, inputs and water, then irrigation has the potential to improve food security.

5.4 Crop production levels

Crop production levels were measured according to the number of hectares planted. An increase in the number of hectares used in 2005/2006 was discussed. Table 5.3 shows the number of hectares planted before and after the introduction of irrigation. After irrigation was introduced, the number of hectares under production increased by 20% and 8% respectively for Ibu and Kalizinje villages. On average, the number of hectares under production for non-irrigating farmers at Ibu dropped. This finding explains the fact that non-irrigating farmers at Ibu had rented out their land to irrigating farmers. Irrigating farmers at Ibu confirmed that since they had no plots that were demarcated as in Kalizinje; they were not limited to the size of land they could rent. At Kalizinje, non-irrigating farmers farmed more land than irrigating farmers and farmers reported that in reality, non-irrigating farmers have larger fields than irrigating farmers. This

finding is evidenced by the fact that the 32 irrigating farmers at Kalizinje continued to use the same plots demarcated for them from 2001 to 2007 and had not increased hectarage.

Table 5.3: Number of hectares (ha) under cultivation, Ibu and Kalizinje, 2007

	Ibu			**Kalizinje**		
	Irrigators (n=10)		**Non-irrigators** (n=14)	**Irrigators** (n=12)		**Non-irrigators** (n=22)
	Before irrigation	***After irrigation***		***Before irrigation***	***After irrigation***	
Total land used in 2005/2006 growing season	13.5 ha	16.25 ha	15.5 ha	9.5 ha	10.25 ha	23 ha
Average land used per person	1.35 ha	1.62 ha	1.11 ha	0.79 ha	0.85 ha	1.04 ha

Having less land may not necessarily result in lower production levels, because farmers could grow crops on the same piece of land two to three times a year with irrigation realising overall large yields per annum. Farmers at Ibu planted two times a year while at Kalizinje farmers planted three times a year with irrigation. This concurred with the literature (Hillel 1997) that irrigation permits multiple growing of crops, two to four times a year, where only a single crop could be grown with rain-fed agriculture. In this regard farmers need to be introduced to soil and water management techniques for sustainable production systems.

5.5 Diversification of crops

Diversification of crops was investigated by asking irrigating farmers if they had added to the number of crops grown after the introduction of irrigation. The results from Table 5.4 show that after the introduction of irrigation, only Ibu irrigating farmers diversified production into tomatoes and cabbages. Irrigating farmers at Kalizinje did not diversify into other crops for fear of crop failure and lack of knowledge in handling other crops in terms of production, food preparation and cultural restrictions (where people are used to eating only what they know). One field staff member indicated that:

"Farmers have not done much on diversification of crops as they are not sure of the survival of the other crops. There is need to experiment on whether these other crops will fit into the climate of this area."

Table 5.4 Diversification of crops for farmers before and after the introduction of irrigation and non-irrigating farmers, Ibu and Kalizinje, 2007

	Ibu			**Kalizinje**		
	Irrigators (n=10)		**Non-irrigators (n=14)**	**Irrigators (n=12)**		**Non-irrigators (n=22)**
	Before irrigation	***After irrigation***		***Before irrigation***	***After irrigation***	
Crops grown	Maize Beans Pigeon peas Cotton	Maize Beans Pigeon peas Cotton *****Tomato *****Cabbage	Maize Beans Pigeon peas Cabbage Sweet potatoes	Maize Beans Pigeon peas Tomato Leaf mustard Rape	Maize Beans Pigeon peas Tomato Leaf mustard Rape *****Increased the frequency of growing maize and bean crops per year	Maize Beans Pigeon peas Cabbage Groundnuts Cotton Sweet potatoes

***Crops that irrigating farmers diversified into and increase in frequency of crop planting.**

Non-irrigating farmers from Ibu and Kalizinje grew similar crops with the exception of groundnuts and cotton, which were grown by Kalizinje non-irrigating farmers only. All the crops grown by non-irrigating farmers were also grown by irrigating farmers, except for tomatoes, which were grown by irrigating farmers at Ibu and ground nuts at Kalizinje and sweet potatoes at both Ibu and Kalizinje, which were grown by non-irrigating farmers. The results may mean that non-irrigating farmers diversified more than irrigating farmers by planting groundnuts and sweet potatoes. As reported by the community, irrigating farmers did not plant groundnuts and sweet potatoes because the irrigation sites have clay soils which are poor for groundnuts and sweet potatoes.

However, the findings above indicate that although Ibu irrigating farmers diversified into tomatoes and cabbages, not all irrigating farmers are taking advantage of the irrigation project to

increase crop diversification, which could be beneficial to them in terms of varied diets, sales for income and is crucial for crop rotation. These findings are contrary to literature (Hussain 2004; Bhattarai *et al.* 2002) in that irrigation typically enables farmers to increase crop diversification. Therefore, irrigating farmers need to be encouraged to take advantage of the irrigation project and diversify into other crops. Ibu farmers suggested that they could diversify crops such as Irish potatoes, ginger, onions and cabbage while at Kalizinje crops to be diversified could include Irish potatoes, onions and peas.

Rented land could affect crop diversification by preventing the growth of late maturing crops. As one field staff member explained, irrigating farmers avoid planting crops that mature late, because the owners of the land may require their land back before the irrigating farmers have harvested the crop (Table 5.11). The nature of land rentals were informal with farmers who wanted land for irrigation agreed on the rentals with the farmers who had land. The price was dependent on the size of land; the bigger the size of land the more one paid for it. If irrigating farmers, especially at Ibu where farmers rent land for irrigation purposes, are to plant late maturing crops, negotiations under the agreement are needed to avoid quarrels.

Farmers also have to ensure that rented land is efficiently used. High yields are expected by farmers from the land before it is given back to the owners. Poor yields will mean that a renting farmer's income is lost. Farmers would not want to risk trying new crops for fear of losing produce, especially if the new crops do not do well. In the light of this, field trials on new crops with extension support needs to be introduced in order to minimise the risk or fear of crop failure. This would also encourage farmers to diversify crops.

Land for field trials (experiments) may be acquired through the following ways: World Vision Malawi can encourage farmers to rent some land or contribute money to buy a big garden specifically for experimenting with new crops. Alternatively, irrigating farmers may demarcate a portion of land from their own gardens for experimenting. Plots should be demarcated in the gardens to try several crops. It is imperative that farmers work together in groups to share the work and ideas. The groups should report on how they faired and share observations with others in order to encourage peer learning. Decisions may then be made by the farmers on whether the

crops can be planted, ignored, or tried again. This will promote crop diversification because farmers will be encouraged to plant crops that performed well from the experiments, without fear of crop failure.

Although there is a possibility that, through irrigation, the amount of land belonging to non-irrigating farmers will be reduced, irrigation by irrigating farmers is only temporary as land is given back to non-irrigating farmers for rain-fed production. Irrigation equipment that the farmers were using was temporary and simple. Since farmers worked in groups, they converted irrigated land to non-irrigated land by removing the equipment from the fields. The equipment was kept at the chief's or treasurer's house until the time farmers needed it.

World Vision Malawi also needs to promote responsible land and water management practices, and alert irrigating farmers to the dangers associated with over- and under-irrigation and soil mismanagement. At the same time, non-irrigating farmers deserve to be informed in advance of the dangers associated with over- and under-irrigation, so that they can make well-informed decisions before leasing out their land for irrigated production. There is a potential problem with sustainability of production unless soil health and nutrition is ensured. The current practices render farmers dependent on fertilisers as farmers mine nutrients through intensified cropping and irrigation leaches nutrients. In this regard, farmers should be introduced to ways of conserving and building soil quality.

5.6 Income levels

Table 5.5 shows the numbers and percentages of farmers growing cash crops. The percentages of both Ibu and Kalizinje farmers who grew cash crops before the introduction of irrigation was lower than after the introduction of irrigation. Fewer non-irrigating farmers grew cash crops. Therefore, more irrigating farmers cash-cropped than non-irrigating farmers, and more even cash-cropped after the introduction of irrigation. Irrigation seems to have encouraged farmers to grow cash crops. It seems likely, therefore, that more farmers would continue with cash cropping because the income allows them to buy necessities for their homes and for agricultural production. There is need to introduce market places (Tables 5.7 and 5.11) and good roads for easy transportation of produce (Table 5.7) so that farmers can sell their produce easily.

Table 5.5: Numbers and percentages of farmers who produced cash crops, Ibu and Kalizinje, 2007

	Ibu			**Kalizinje**		
	Irrigators (n=10)		**Non-irrigators** (n=14)	**Irrigators** (n=12)		**Non-irrigators** (n=22)
	Before irrigation	***After irrigation***		***Before irrigation***	***After irrigation***	
Number of farmers	0	9	4	8	11	6
% of farmers	0%	90%	29%	67%	92%	27%

Irrigation enabled irrigating farmers to improve income levels. Field staff, irrigating farmers, and non-irrigating farmers commented on income levels from selling maize by both irrigating and non-irrigating farmers. Table 5.6 highlights some comments made by field staff and farmers in terms of income earned from selling maize.

Table 5.6: Comments by field staff, irrigating and non-irrigating farmers, on income earned from selling farm produce, Ibu and Kalizinje, 2007

Field staff 1

Irrigating farmers were better off in terms of income levels because irrigating farmers had crops to sell and get income. Sometimes farmers took their maize to Limbe town for sale. Sometimes farmers also sold seed to get income which farmers used to buy what they could not produce.

Field staff 2

Irrigating farmers were economically empowered since they sold their produce.

Irrigating farmers (n=22)

We gained income from selling maize, pigeon peas and cotton. Fresh maize was more profitable than dry maize, so we preferred selling fresh maize to dry maize grains.

Non-irrigating farmers (n=36)

We sold some of our produce to find money for other expenses although our food was not enough for the whole year.

As indicated in Table 5.6, irrigating farmers sold their produce willingly and intentionally because they produced more food than required. The comments by non-irrigating farmers and field staff showed that these farmers sold produce to get what was needed for the home, as money was needed to buy necessities. Non-irrigating farmers at Kalizinje explained that they sold produce during harvest time when food was plentiful, but expressed concern that during these times, prices of food are low (Table 5.7). Although non-irrigating farmers know that they do not have enough food for the whole year, and that income earned during periods of plenty is low, they still sell crops because money is needed. Consequently, they continue to go without food during lean periods and resort to using coping strategies, like piece work, to find money for food. Non-irrigating farmers from both villages expressed the desire to start irrigating because they wanted to increase their harvests and have food throughout the year, just like irrigating farmers (Table 5.8). By wanting to start irrigation, non-irrigating farmers acknowledged that irrigation helped irrigating farmers.

The findings above assert that after the introduction of irrigation, irrigating farmers were better off in terms of income levels than non-irrigating farmers, and than before farmers started irrigation**.** These findings concur with literature (Bhattarai *et al.* 2002), which says that farm incomes increase with irrigation. Again, smallholder farmers who irrigate, generally achieve higher incomes than rain-fed counterparts (Hussain *et al.* 2002). That non-irrigating farmers at Ibu and Kalizinje earned lower incomes, is evidenced by the fact that these farmers only sold food during times of plenty when food was cheap, and therefore earned lower incomes that could hardly help to improve the standards of living. While irrigating farmers may also have sold food during the same periods of plenty and also earned lower incomes, they were advantaged because they planted two or three times a year, covering the lean periods when food was scarce, when they could sell at higher prices.

However, these results did not agree with literature (Hussain 2004) that states that irrigation can influence a switch from low-value subsistence production to high-value market-oriented production because farmers simply intensified production of cash crops. Unless there is improved marketing infrastructure like roads, markets and market places, farmers would not be encouraged to embark on high-value market-oriented production.

5.7 Benefits and problems experienced by irrigating and non-irrigating farmers

Table 5.7 shows the benefits and problems experienced by farmers before and after the introduction of irrigation, and by non-irrigating farmers. Farmers at Ibu listed food and income as gains before the introduction of irrigation, but more food and higher incomes after the introduction of irrigation. Irrigation increased food availability and income for Ibu irrigating farmers, and ensured their food security.

At Kalizinje, irrigation had many beneficial effects including increases in food, number of bicycles, incomes, number of livestock and clothing. Farmers were also able to send their children to school and invest in houses with iron roofs. The results show that irrigating farmers at Kalizinje had higher gains in terms of assets than irrigating farmers at Ibu. This may be because the Kalizinje Irrigation Project started four years earlier than the Ibu Irrigation Project. Ibu and Kalizinje irrigating farmers ranked enough food as the highest gain from irrigation. The finding implied that irrigating farmers were certain that their food security situation had improved. Farmers therefore wanted to continue with irrigation, as evidenced by their responses in Table 5.8.

Problems were experienced by non-irrigating farmers and by irrigating farmers before and after the introduction of irrigation. Before irrigation was introduced, both Ibu and Kalizinje farmers indicated common problems of hunger and lack of income, which they ranked at positions one and two respectively in terms of food security. The results indicate that hunger and lack of income were persistent problems for the farmers before irrigation started, because they were not able to produce enough food to have surpluses for sale. Therefore, if irrigation had not started, farmers would have continued to experience food insecurity.

Non-irrigating farmers at Ibu also ranked lack of food as the greatest problem they encountered. That all irrigating farmers before the introduction of irrigation and Ibu non-irrigating farmers, ranked lack of food as the top problem for their households, indicates the seriousness of food insecurity. Lack of fertiliser was a common problem for both Ibu and Kalizinje non-irrigating farmers.

Table 5.7: Benefits (gains) and problems associated with both rain-fed farming and irrigation, Ibu and Kalizinje, 2007

Ibu				**Kalizinje**			
Benefits (gains)				**Benefits (gains)**			
Irrigators (10)		**Non-irrigators (14)**	**Benefits 1=high**	**Irrigators (12)**		**Non-irrigators (22)**	**Benefits 1=high**
Before irrigation	***After irrigation***			***Before irrigation***	***After irrigation***		
Little food.	Enough food.	Little food but not enough.	1	No benefits from rain-fed farming.	Enough food.	No benefits from rain-fed farming.	1
Little income.	More income.		2		Houses with iron roofs.		2
	Training.		3		Income.		3
					Livestock.		4
					Clothes.		5
					Send children to school.		6
					Bicycles.		7
Problems				**Problems**			
Irrigators (10)		**Non-irrigators (14)**	**Problems 1=high**	**Irrigators (12)**		**Non-irrigators (22)**	**Problems 1=high**
Before irrigation	***After irrigation***			***Before irrigation***	***After irrigation***		
Hunger.	Pump is small.	Lack of food.	1	Insufficient food.	No markets.	Lack of fertiliser.	1
Little income.	No capital.	Lack of agricultural equipment.	2	No income.	Hard labour.	Hippopotamus destroy crops.	2
	No markets.	Lack of fertiliser.	3	Lack of decent houses.	Small pump and expensive diesel.	Lack of pesticides.	3
	Poor roads.		4	No livestock.	Lack of agricultural tools.	Drought.	4
	Pests (army worms) and diseases.		5	Children not going to school.	Infertile soils.	Selling price is too low.	5
	Few extension officers.		6	No clothes.	.		6
	Theft.		7				

This may be because non-irrigating farmers had no income to buy agricultural inputs like fertilisers or repay fertiliser loans from World Vision Malawi, unlike irrigating farmers, who had income from crop sales and were able to buy fertiliser and repay fertiliser loans to World Vision Malawi. The findings show, therefore, that food insecurity was prevalent among non-irrigating farmers. As a result, if nothing is done about the non-irrigating farmers' food security situation, food insecurity will continue.

Table 5.8: Responses of farmers on the desire to start or continue with irrigation, Ibu and Kalizinje, 2007

Ibu irrigating farmers (n=10)
We want to continue with irrigation so that we can continue to be food secure.
Kalizinje irrigating farmers (n=12)
We want to continue with irrigation because irrigation is very effective and enables us to plant crops three times a year.
Ibu Non-irrigating farmers (n=14)
We desire to start irrigating our crops because irrigating farmers have food throughout the year.
Kalizinje non-irrigating farmers (n=22)
The desire to start irrigation is there because we want to increase our harvests.

After the introduction of irrigation, irrigating farmers at Ibu and Kalizinje reported problems of lack of market places and small sized pumps that could not pump water to fields that were at a distance from the water source. Bigger pumps that are capable of pumping more water to as many gardens as possible, regardless of distance, were considered to be more useful, while market places were seen to be crucial for irrigating farmers to sell surpluses.

5.8 The role of income from irrigation in increasing dietary diversity of farmers

The question of whether income from irrigation improved dietary diversity and asset acquisition of farmers was investigated. The demographic characteristics of this study showed irrigation and business to be the major sources of income for the farmers. Table 5.9 shows the approximated income earned by irrigating farmers in terms of irrigation and business per person per annum.

Income earned from irrigation was higher than income earned from business at both Ibu and Kalizinje.

Table 5.9: Approximated income earned by irrigating farmers in terms of irrigation and business per person per annum, Ibu and Kalizinje 2007

Ibu		**Kalizinje**	
Income earned		**Income earned**	
Irrigation	*Business*	*Irrigation*	*Business*
K85,000.00 ($1195.15)	K27,000.00 ($379.64)	K30,000.00 ($421.82)	K8,000.00 ($112.49)

***Exchange rate USD/MWK of 140.6063 as of 16/03/2009)**

The role that income from irrigation played in increasing dietary diversity (the number of different foods consumed over a given period of time) was investigated by asking farmers to identify the food types consumed over the past six months from a list of foods provided by the researcher. Figures 5.1 and 5.2 indicate the food items consumed before and after the introduction of irrigation. Although irrigating farmers increased production and earned more income from cash cropping, most non-irrigating farmers' households ate a wider variety of foods than irrigating farmers.

This finding may mean that although income from irrigation was used to buy food that farmers did not produce (Table 5.11), farmers also used income from irrigation for other purposes, for example, school fees, buying clothes and livestock. According to irrigating farmers, repayment of input loans was crucial because failure to repay loans would prohibit the farmer from obtaining an input loan for the next growing season. The results show that irrigating farmers could not specifically tell whether income from irrigation played an important role in increasing their dietary diversity because the income was used for various purposes. As was observed through SWOT analysis, farmers indicated that some foods were expensive and they could not afford to buy them. Farmers would therefore, avoid such expensive foods and go for what they produced or what they could afford.

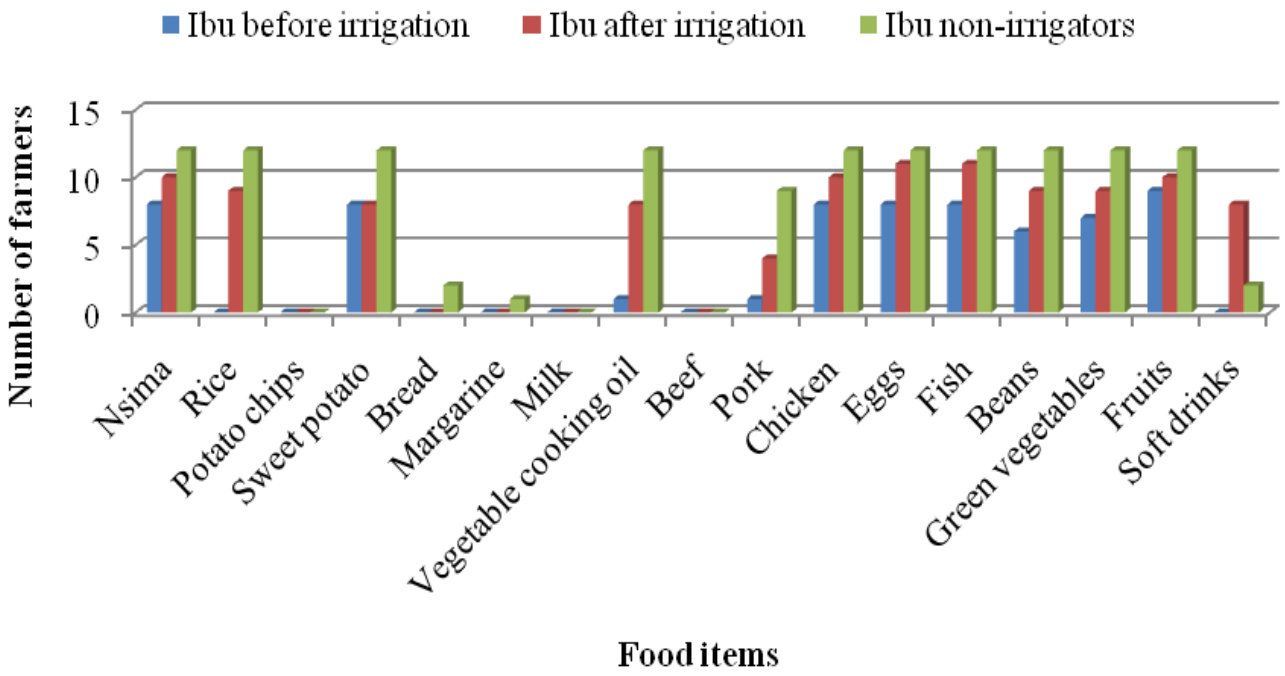

Figure 5.1: **Graph showing food items, and the number of irrigating farmers who could eat the food items before and after the introduction of irrigation, and non-irrigating farmers at Ibu in the past six months (January to June 2007).**

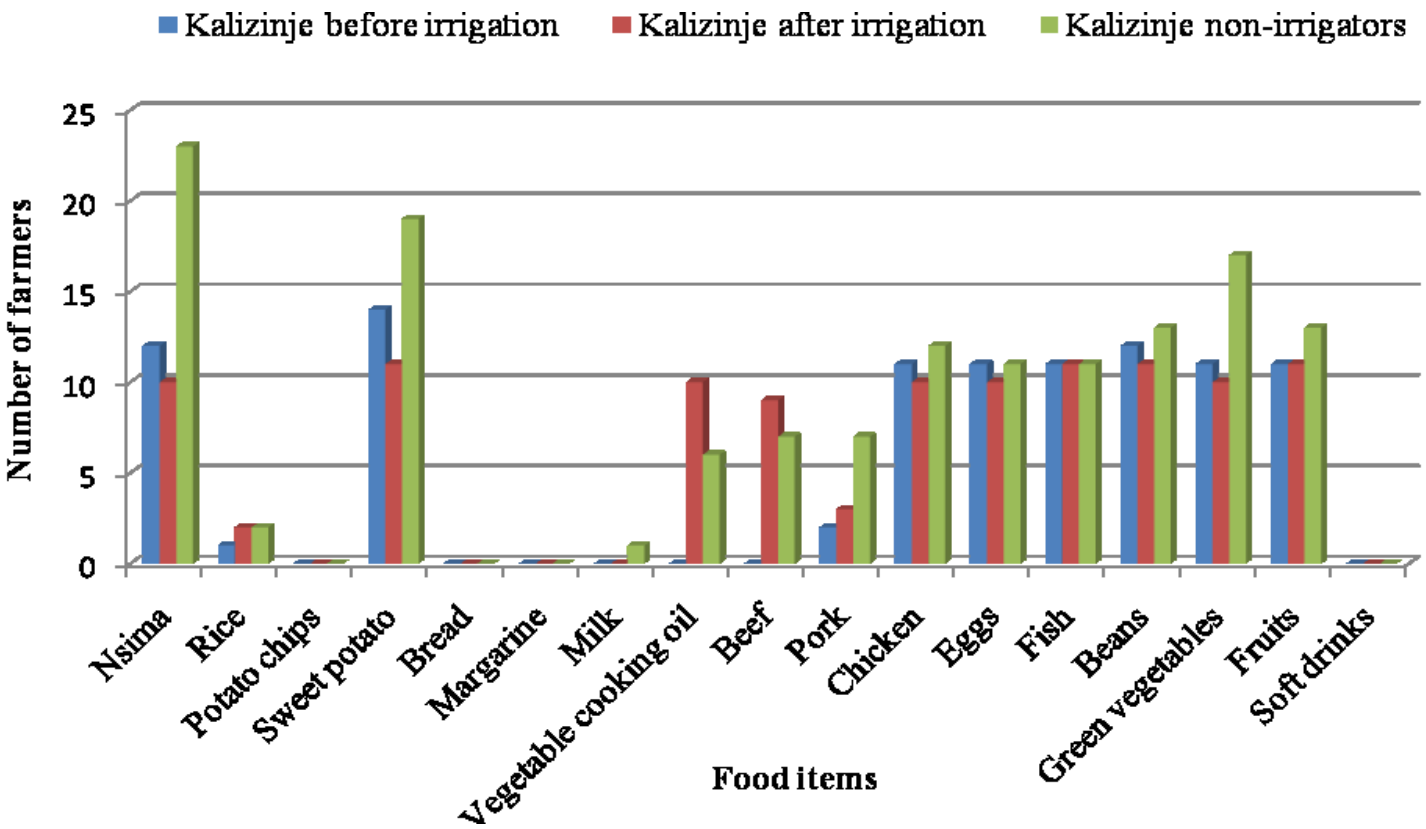

Figure 5.2: **Graph showing food items, and the number of irrigating farmers who could eat the food items before and after the introduction of irrigation, and non-irrigating farmers at Kalizinje in the past six months (January to June 2007).**

As noted in (Table 5.3) for Kalizinje; (Table 5.4) and through the validation exercise, it was confirmed that increased dietary diversity by non-irrigating farmers was possible because non-irrigating farmers had larger fields that they used to plant a variety of crops and diversify crops unlike irrigating farmers. Since non-irrigating farmers diversified their crops, they were able to eat a variety of foods. This shows the possibility of non-irrigating farmers diversifying crops as a risk-aversive measure.

Reduced dietary diversity by irrigating farmers also confirms the fact that irrigating farmers were cash cropping and that cash cropping itself tends to be mono cropping. In this regard, there was a possibility that irrigating farmers were more concerned with producing the maize crop that was profitable to them in terms of cash and food. This is in line with the literature (FAO 2006a; Sahley *et al*. 2005; SARPN 2006; World Bank 2005), that indicates that in Malawi there is a perception by many that maize is the only food yet other cereals are available. However, this does not mean that irrigating farmers were eating maize only, a few other crops that irrigating farmers produced served as food as well.

One field staff member reported that farmers were trained in nutrition, food processing and utilisation by World Vision Malawi (Table 5.10) and it was confirmed through the validation exercise that all farmers who were beneficiaries of World Vision projects were trained to make *tapado* (a mixture of meat, banana and vegetables). Training of farmers in nutrition, food processing and utilisation meant that farmers only increased their knowledge of the importance of varying and balancing diets and not necessarily that farmers increased their dietary diversity. The findings above show that income from irrigation did not increase dietary diversity of irrigating farmers. The results do not agree with literature (FAO 2003) that explains that farmers benefit directly from irrigation through a more varied diet. There is need to encourage farmers to diversify their crops and use the income earned from irrigation to buy food they do not produce so as to promote dietary diversity.

5.9 The role of income from irrigation in increasing acquisition of assets of farmers

Assets and the approximated costs associated with each asset are shown in Table 5.10. Farmers were asked what they were able to purchase after the introduction of irrigation that they were not

able to purchase before the introduction of irrigation. Some irrigating farmers from both Ibu and Kalizinje, reported buying radios, bicycles, televisions, livestock and clothes, and building houses and brick walls with income from irrigation and income from businesses such as carpentry, brick making, weaving baskets, and brewing beer.

Table 5.10 Assets and approximate costs on each asset, Ibu and Kalizinje 2007

Asset	Amount in Malawian Kwacha (K)	Amount in USD* ($)
House furniture	4850.00	68.19
Bicycles	15000.00	210.91
Radios	75000.00	1054.55
Television	10000.00	140.61
Cellphones	7000.00	98.42
Livestock (goats)	3500.00	49.21
Brick house with iron roof	150000.00	2109.09

***Exchange rate USD/MWK of 140.6063 as of 16/03/2009)**

At Kalizinje, more irrigating farmers acquired assets than irrigating farmers at Ibu. Irrigating farmers at Kalizinje reported gaining iron-roofed houses; livestock and bicycles (Table 5.7). Irrigating farmers at Ibu explained that they did not make enough income to buy assets. However, Table 5.9 shows that it is the Ibu irrigating farmers who earned more income from irrigation than Kalizinje irrigating farmers. The finding illustrates that Kalizinje irrigating farmers were able to buy assets with time because the Kalizinje Irrigation Project started earlier than the Ibu Irrigation Project.

Although Table 5.9 above showed that income earned from irrigation was more than income earned from business, figures 5.3 and 5.4 below show that fewer irrigating farmers at Ibu and Kalizinje acquired assets than non-irrigating farmers and than before the introduction of irrigation. One would expect irrigating farmers to have more assets than non-irrigating farmers because they made more income than their counterparts. Farmers confirmed that irrigating farmers used income earned from cash cropping for other needs like school fees, clothes, and repaying agricultural loans rather than investing in assets. Also, farmers may not have been

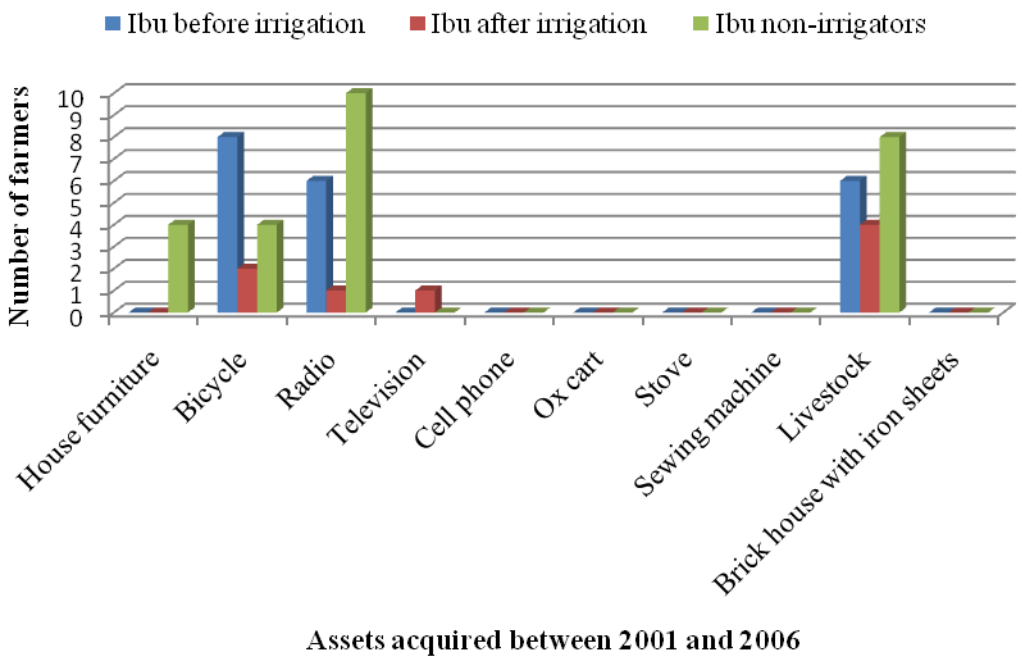

Figure 5.3: Graph showing assets and the number of farmers before irrigation, irrigating and non-irrigating farmers who acquired assets, Ibu, 2007.

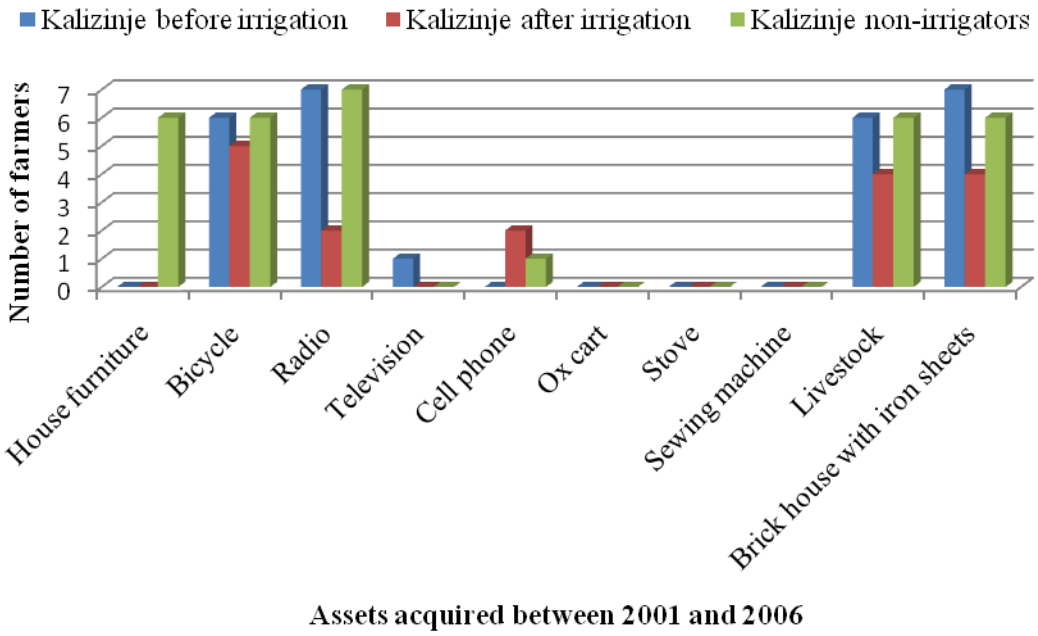

Figure 5.4: Graph showing assets and the number of farmers before irrigation, irrigating and non-irrigating farmers who acquired assets, Ibu, 2007.

willing to buy assets. According to one field staff member, they could not afford to buy assets because assets were too expensive; thieves stole the assets; and also because farmers were accustomed to the kind of lifestyle they lived (Tables 5.10 and 5.11). From the above, it is clear that irrigating farmers would not invest in assets because of inadequate income, thieves, expensive assets and prioritising other needs.

The finding that fewer irrigating farmers acquired assets than non-irrigating farmers is contrary to the literature (Hussain 2004 and Bhattarai *et al*. 2002), in that improvement of assets is one of the documented benefits from irrigation. In this regard, the need for training in business management skills is crucial, as farmers would then know how to save and better use the income earned from cash cropping to buy assets. In as much as the income from cash-cropping was used for other important needs, with training, farmers would be able to prioritise what assets to buy, so that they could improve their standard of living while still maintaining their food security position. Field staff need to make it part of their role to encourage farmers to buy productive assets which are necessary for their livelihood such as livestock, farm equipment, bicycle for transportation just to mention a few. Such assets may also be used as a means of coping strategies that will assist farmers to maintain food security in times of food insecurity. Farmers could sell assets like livestock or rent out equipment like farm cart and earn income that would be used to buy food for the home and agricultural inputs for the field.

5.10 SWOT analysis for Chingale Irrigation Project

A SWOT analysis of the Chingale Irrigation Project was conducted with World Vision field staff to determine strategies for improving irrigation. Table 5.11 shows the SWOT analysis that was conducted in terms of production levels, income levels, crop diversification and whether income from irrigation increased the dietary diversity and acquisition of assets. Table 5.11 shows that the production levels of farmers increased with irrigation.

However, there were many weaknesses (challenges) hampering production levels, such as poor food storage facilities, lack of skills and inputs, floods, pests and diseases. There is a need to ensure that farmers are empowered with skills and knowledge in food storage; operations and

Table 5.11: SWOT analysis for irrigation project, Ibu and Kalizinje, 2007

Aspect	Strengths	Weaknesses (challenges)	Opportunities	Threats
Production levels	Enough food throughout the year.	Storage problems, Lack of skill in using irrigation equipment.	Access to food, availability of water and use of drip irrigation for dry areas.	No access to inputs when World Vision does not get inputs since farmers access these inputs through loans. Floods. Diseases e.g. maize streak. Pests e.g. grasshoppers
Income levels	Increased income enabled farmers to buy assets, pay school fees, and get capital for business.	Unnecessary loans from others that attract interest.	Increase in income through sales of fresh maize in Limbe.	No reliable market places Delays in receiving income through cheques after selling produce as a club (group).
Crop diversification	Planting of beans that were only grown by farmers close to Shire River.	Not sure of the survival of other crops.	Farmers encouraged to try other crops. Promotion of seed multiplication through World Vision Malawi connecting farmers with researchers from the Ministry of Agriculture. Researchers inspect seed in all stages until certification, so that food is sold to NGOs.	Small land sizes. Owners of land require their land back therefore difficult to diversify into crops that mature late. Pests and diseases.
Role of income on consumption	Able to buy food not produced by farmers.	Farmers are used to the kind of life lived, therefore not willing to buy other foods.	Training in nutrition, food processing and utilisation e.g. training in making *tapado* (a mixture of meat, banana and vegetables).	Some foods are expensive and farmers cannot afford them.
Role of income on assets	Able to buy assets e.g bicycles and radios.	Farmers are used to the kind of life lived, therefore not willing to buy other assets.	Encouraging farmers to prioritise important and required assets.	Some assets are expensive and farmers cannot afford them. Theft.

Management of irrigation equipment, soil and water management and pest and disease control. Access to inputs is also important so that production levels continue to increase.

There was also an increase in farmers' income levels through sales of fresh maize. As a result, they had greater opportunity to food access, acquisition of assets and agricultural inputs leading to improved food security. Nevertheless, farmers needed reliable market places at which to sell their produce, and quick payments after selling produce to enhance income levels.

Although farmers had the opportunity to diversify crops, they were not sure of the survival chances of other crops. Therefore, crop diversification was very low. Farmers needed enough land and assistance in controlling pests and diseases to improve on crop diversification. Farmers had the opportunity to practise seed multiplication and to produce seeds. World Vision Malawi connected farmers to researchers from the Ministry of Agriculture who inspected the seeds from planting to maturity and certified the seeds. The seeds are sold to some non-governmental organisations.

It was observed that farmers were able to buy some foods they did not produce, and some assets. However, some foods and assets were very expensive and farmers could not afford to buy them. As noted, farmers had the opportunity of being trained in nutrition, food processing and utilisation, and received encouragement in prioritising purchases of important assets. Continued and extensive training in nutrition to enable farmers to acquire more knowledge in nutrition, and financial management skills to enable farmers save and buy assets, are necessary so that income from irrigation benefits the farmers accordingly.

From the above, the strengths and opportunities of the irrigation project enabled field staff to develop strategies for the project's improvement. From Table 5.12, capacity building training of farmers in different skills appears to be a common strategy by field staff for improving irrigation.

Table 5.12: Strategies reported by field staff to improve irrigation, Ibu and Kalizinje, 2007

Field staff 1
Establishment of irrigation schemes in more areas.
Field staff 2
Need for market research in terms of: potential buyers before crops are produced so that farmers have better choices depending on the prices which buyers can offer; information systems that can assist in updating farmers on prices of crops and marketing channels; sales of the crops in groups so as to increase bargaining power; bulk purchases of inputs so that farmers benefit in terms of discounts.
Training for capacity building of farmers in financial management and technical skills.
Improve crop diversification.
Continued commitment from farmers to work hand in hand through contributions of diesel for the pumps.
Field staff 3
Training for capacity building of farmers in terms of management skills.

It therefore seems that there is a great need to train the farmers of Chingale in many skills, for example financial skills, so that they know how to handle income from irrigation; technical skills for handling the pump; and managerial skills to know how to handle the project itself. Such skills would give farmers the impetus to continue with irrigation while improving their farming practice. Again, such skills would improve the irrigation project, as farmers would develop a sense of belonging and increased ownership of the project.

5.10.1 Suggestions for sustainability of Chingale Irrigation Project

Suggestions were made by World Vision field staff and irrigating farmers from both villages regarding the sustainability of the irrigation project (Table 5.13). Results from Table 5.13 indicate that training in the operation and maintenance of irrigation equipment, for example the motorised pump, and the formation of associations, are crucial to the sustainability of the Chingale Irrigation Project. Such training is crucial because failure of the pump to perform properly would bring the whole irrigation project to a halt, as was observed at Kalizinje in the year 2007 (Table 5.1).

Table 5.13: Suggestions for sustainability of irrigation project, Ibu and Kalizinje, 2007

Field staff 1
Training farmers in operating, repairing and maintaining irrigation equipment (motorised pump engine).
Field staff 2
Formation of association for easy access of inputs from organisations.
Training in capacity building of farmers.
Field staff 3
Training in operating, repairing and maintaining irrigation equipment (motorised pump engine).
Contributions of diesel for the pump to promote ownership.
Advice from agricultural extension officers on rules and procedures for agricultural practices.
Formation of associations, in terms of clubs, to empower farmers with skills, and promote the understanding of the goals and objectives of the project.
Irrigating farmers at Ibu (n=10)
Availability of big pumps, markets, capital, improved roads, agricultural extension officers, loans and agricultural tools, will help sustain this project.
Irrigating farmers at Kalizinje (n=12)
We want World Vision to help us when our pump breaks down, because the money we contribute on our own is not enough, and we cannot afford to maintain the pump because this is very expensive.]

In addition, if farmers were not trained in operating and maintaining the equipment, it would mean that someone would have to be hired to repair or maintain the equipment, even in the case of minor problems, and this might prove to be an expensive option for the farmers. Just as Kalizinje irrigating farmers expressed interest in getting help from World Vision Malawi when the pump broke down, training in operation and maintenance of the pump is one way in which World Vision Malawi could help the farmers, so that they preserve the pump while sustaining the project.

The formation of associations, in terms of clubs/groups within the project sites, is also crucial to the sustainability of the Chingale Irrigation Project because, within the clubs/groups, farmers would be able to gain new knowledge and useful information on the activities that take place within their irrigation environment. The formation of associations concurs with what is suggested by literature on the subject (Community Ground Water Irrigation Sector Project 2005; FAO & SARF 2000; International Rivers Network 2003; Nazzal & Vidal 2000; Vidal *et al*. 2001), in that the formation of water user associations, committees, group cohesion within these groups, community participation and capacity building, are common reasons given for the success of

irrigation projects, while lack of these features is common where irrigation projects proved to be failures.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

The case study investigated whether irrigation improved household food security at Ibu and Kalizinje villages in Chingale, Zomba district, Malawi. The four sub-problems of this study were: are irrigating farmers better off in terms of crop production levels than non-irrigating farmers? Is there an increase in diversification of crops for irrigating farmers than for non-irrigating farmers? Are irrigating farmers better off in terms of income levels than non-irrigating farmers? Does income from irrigation increase dietary diversity and acquisition of assets of farmers?

The impact of irrigation was investigated through discussion with the farmers about available resources, crop production between 2001 and 2007, crop production levels, diversification of crops, income levels, benefits and problems experienced by farmers, and whether income from irrigation increased the dietary diversity and acquisition of assets of farmers. A SWOT analysis was conducted with World Vision field staff to develop strategies for the improvement of the project. Suggestions on the sustainability of Chingale Irrigation Project were given by the participants. In addition, validation exercise was conducted to ensure validity of the results.

The study showed that irrigating farmers at both Ibu and Kalizinje were better off in terms of crop production levels than non-irrigating farmers, as irrigation had increased the production levels of irrigating farmers at both villages. From the time irrigation was started - 2001 at Kalizinje and 2005 at Ibu - irrigating farmers had had enough food in their households and sold surpluses and cash crops that increased their income levels.

The same crops were grown by irrigating and non-irrigating farmers. However, non-irrigating farmers diversified more than irrigating farmers by planting groundnuts and sweet potatoes. Therefore, irrigating farmers were not taking advantage of the irrigation projects to diversify into other crops, which could have been beneficial to them in terms of varied diets and potential income from sales.

The study found that income from irrigation did not increase dietary diversity of farmers at Ibu and Kalizinje. Most non-irrigating farmers consumed a variety of food items and this was possible because non-irrigating farmers had larger fields that they used to plant a variety of crops

and diversify crops. Much as irrigating farmers earned income from cash cropping and used the income to buy food they could not produce, income from irrigation was also used to meet different household needs of farmers including repayment of agricultural input loans.

Although after the introduction of irrigation, irrigating farmers reported gains in terms of food, income, bicycles, livestock, clothes, sending children to school and investment in houses with iron roofing, most non-irrigating farmers acquired assets than irrigating farmers at both Ibu and Kalizinje. Irrigating farmers did not invest in assets because of inadequate income, expensive assets, thieves and prioritising other needs like school fees, clothes, and repaying agricultural loans.

A SWOT analysis of the Chingale Irrigation Project showed that production and income levels for irrigating farmers increased. Farmers sold fresh maize, practised seed multiplication and sold seeds. Irrigating farmers had income from irrigation to buy some necessities, but still found certain foods and assets too expensive.

6.1 Conclusions

Household food security at Ibu and Kalizinje in Chingale, Malawi, was improved by irrigation. Irrigation increased crop production levels and incomes of the farmers and irrigation enhanced availability and accessibility of food. Although irrigation did not improve household food security through crop diversification, and income from irrigation did not improve dietary diversity and acquisition of assets, irrigating farmers were better off as they had more food than non-irrigating farmers. Irrigation could increase crop diversification and crop plantings with increased availability of land, and encouragement of irrigating farmers to diversify crops.

The results are an encouragement to irrigating farmers to continue with irrigation; non-irrigating farmers to desire irrigation; policy makers and project owners (in the case of this study; World Vision Malawi) to continue lending support; and the government of Malawi and other stakeholders to contribute more effectively to the investment in, and design and implementation of irrigation programmes, in order to ensure household food security, which would also enhance national food security. Inclusion and partnership of other NGO’s with government in irrigation is

crucial to reduce the risk of relying on one NGO to develop the sector. Maintenance of the irrigation schemes should be given more focus to develop skills within farmer groups.

6.2 Recommendations

The study indicates a need to expand irrigation in Malawi. It is recommended that farmers who are not irrigating, but have available resources in terms of water and land, be considered for irrigation programmes by the government and other stakeholders who invest in irrigation programmes. Irrigation equipment, the formation of groups to encourage farmers to work together in achieving set goals, and manage irrigation projects and various skills such as technical and management skills, are needed by such farmers.

World Vision Malawi should encourage irrigating farmers at Ibu and Kalizinje to take advantage of irrigation projects and ensure project sustainability by investing in capacity building of various skills of farmers. Managerial skills are needed in the forming and maintaining of strong group relationships, which are imperative to the progress and achievement of set goals. The formation of clubs/groups would also make it easier for farmers to get resources they would not have as individuals, for instance, larger loans for group enterprises, larger agricultural equipment and more access to advice from experts. It is also imperative that farmers avoid conflict as it is a potential barrier to projects' success by putting in place measures such as dialogue that necessitates conflict resolution.

The study recommends the promotion of irrigation, water and land management skills. Land tenure policies need to be clear in terms of distribution and acquisition so that chiefs and farmers follow proper procedures to avoid conflict. The introduction of enforceable contracts for non-irrigating farmers who lease out their land for irrigation is also recommended. In the case of the Chingale Irrigation Project, World Vision Malawi needs to explore ways of acquiring land, where experiments can be carried out to encourage crop diversification. These farmers need to be taught the dangers associated with irrigation such as over- and under-irrigation, so that care is taken when they irrigate the land, and soil fertility is maintained.

The study recommends that farmers be trained in financial management skills because these skills are imperative for the proper use of income earned. Farmers need to know how to handle income from cash cropping in order to improve their standards of living and invest in future production. Continued and extensive training in nutrition is necessary to broaden their knowledge of nutritional issues, and enable them to use locally available foods to vary and balance their diets. Knowledge of food storage techniques is also important as this promotes preservation of food for future consumption and sales, enabling farmers to benefit both nutritionally and economically.

While the promotion of irrigation is recommended, the study also recommends that irrigation be accompanied by farmers' continued accessibility of required inputs, through loans. It is recommended that World Vision Malawi make pesticides loans available to farmers, as was done with seed and fertilisers, so that farmers are able to purchase the pesticides and fungicides to reduce the pests and diseases that affect their crops. The government of Malawi and other organisations could also assist farmers, where there are outbreaks of pests, by subsidising pesticides or negotiating bulk discounts. The Government of Malawi's policy in 2006 and 2007 to subsidise fertilisers for the purpose of improving crop production is highly commended. It is therefore recommended that, although the subsidy is expensive, government should try as far as possible to partner with other players in assisting farmers in irrigation projects to improve household food security through input subsidies.

On the other hand, training farmers in alternative farming techniques, for example, organic farming that requires no or little inputs is essential to reduce the risk of lack of inputs such as fertiliser. Encouraging non-chemical ways of controlling pests and diseases such as sanitation, physical control methods like hand removal of insects, crop rotation, use of plant varieties that are resistant to pests and diseases is also necessary to minimise dependence on expensive pesticide and fungicides.

Since promotion of irrigation is needed, the construction of good roads and market places by the government is also recommended, because marketing and transportation systems will enhance movement of food from source to need. In addition, farmers would be encouraged to produce

cash crops. Consequently, irrigating farmers' income levels would be increased through selling farm produce, while food security for all farmers, through food access, would be enhanced.

Farmers should diversify into crops that have not been grown before with the advantage of offering varied diets and more income after selling such crops. In addition, more farmers need to be accommodated in the World Vision irrigation projects or in new projects. This can be done by encouraging farmers to join the projects, opening other irrigation schemes, and expanding irrigated land. Adding on the irrigation equipment already in use like, pumps will also help to accommodate more farmers. However, larger pumps that have the capacity of pumping a lot of water covering more land are recommended. Farmers in irrigation projects also need technical skills in order to operate and maintain the irrigation equipment and protect its life span.

6.2.1 Recommendations to improve the study

This study used a self selection technique in the sample selection. Self selection sampling might have been biased in that the researcher might have missed other people with relevant information who were not part of the study. This would have affected the differences in conclusions. Nevertheless, the validation exercise that was undertaken confirmed the findings and the conclusions to be a true reflection of what was happening in the two villages of Ibu and Kalizinje.

A random sample would have been ideal but in practice it was not possible due to money constraints. In this regard, a random sample would have minimised the bias that would come in with the self selection sample. A random sample would also improve the representation of the characteristics of the population with a possibility of a large sample that was necessary for this representation. In this regard, several other villages ought to have been included. This would also help to generalise the findings of the study for the whole Chingale population.

The study points to the need for a combination of qualitative and quantitative research designs. Qualitative and quantitative methods would complement each other in terms of the advantages that each of the research design presents. Quantitative methods and analysis would increase the validity of the results by confirming or disconfirming any significant data that emerged from the study and would allow statistical testing of the relationships that existed while qualitative design

would assist in understanding the underlying explanations. Quantitative methods and analysis would also complement qualitative analysis by adding numbers to the words while qualitative methods and analysis would add words to the numbers.

6.2.2 Recommendations for further research

Further research to the impact of irrigation on household food security should include the economic feasibility of the irrigation project. This would help different stakeholders like researchers, governments, non-governmental organisations, the private sector and donors of irrigation projects to know whether the irrigation project is worth pursuing or not. Further investigation on the impact of irrigation on household food security should include the comparison of different irrigation equipment that is used by smallholders to identify better equipment that is more advantageous in improving food security.

Capacity building was recommended as one of the necessities for the success of irrigation projects. Therefore, research on the contribution of capacity-building training of farmers on irrigation projects to food security is recommended.

The subsidy input programme was reported to have assisted farmers to harvest high quantities of maize in 2006 and 2007 in Malawi. There is need to further research on the contribution of the subsidies to the household and national food security situation in Malawi. In this regard, case studies for specific areas and a national study in Malawi are necessary so that there is recognition of the impact of the subsidy programme in the country.

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APPENDIX A: Pictures taken during data collection exercise

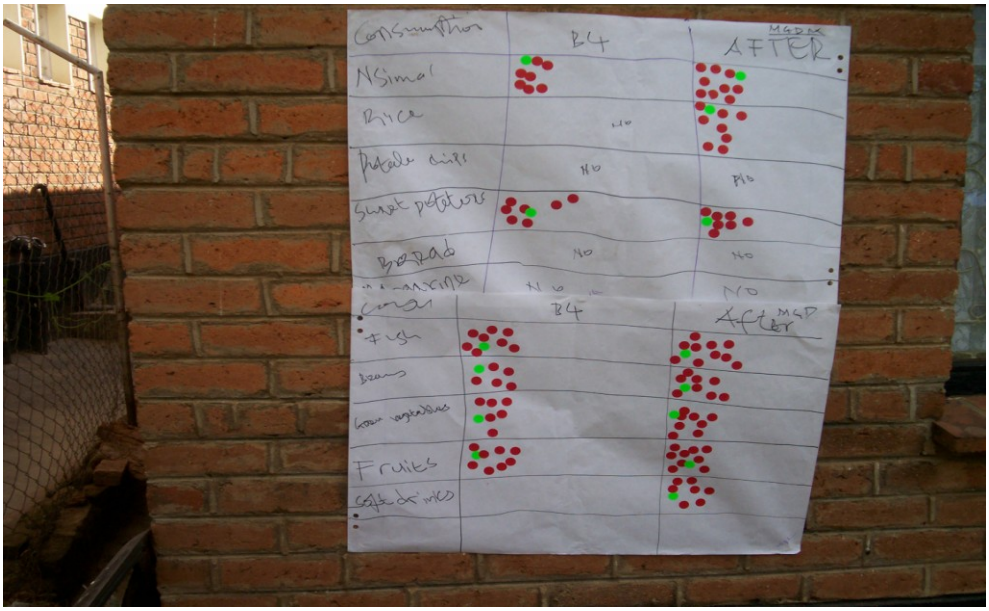
Picture 1: Group discussions with irrigating farmers at Ibu village.

Picture 2: Group discussions with non-irrigating farmers at Ibu village.

Picture 3: Group discussions with irrigating farmers at Kalizinje village.

Picture 4: Group discussion with non-irrigating farmers at Kalizinje village.

Picture 5: Example of resource map drawn by non-irrigating farmers at Kalizinje village.



Picture 6: Example of matrix filled in with stickers by irrigating farmers at Ibu village.

Picture 7: Lisanjala River and pump intake point at Ibu village.

Picture 8: Motorised pump – Ibu village.

Pictures 9 and 10: Two Ibu irrigating farmers and their bean fields.

APPENDIX B: Demographic characteristics of respondents

Case no	Age	Gender	Marital status	Years of formal schooling	Household size	Sources of income
1						
2						
3						
4						
5						
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44						

APPENDIX C: Steps and probing questions of resource mapping for farmers before and after irrigation

1. Mark things like boundaries, rivers, water sources, main roads, households, markets, land marks, fields, arable land, wildlife, grazing land, trees, residential areas, physical assets, meeting places and important sites before and after irrigation on a big sheet of paper
2. Put on significant qualitative information on irrigation before and after

   Where people collect water for irrigation, agriculture equipment used, size of plots (big or small), crops grown (highest and lowest), methods of irrigation, what crops sold, new crops added, income earned from crops sold (more/less), other sources of income and income earned from other sources (more/less) and what assets owned.
3. Put quantitative information on irrigation before and after irrigation

   Crop yields (how many 50 Kg bags per hectare), number of crop types grown, How much income on average earned from different crops sold (highest and lowest amount), how much income earned from other sources (highest and lowest amount)
4. Summarise key conclusions

   Any features people did not expect, findings of qualitative and quantitative information e.g. does irrigation increase income, number of crops grown, crop yields? Why new crops added, why the amount of yield harvested, why sell crops, which month people start buying maize, months of plenty and scarcity in a year.
5. Identify the main implications for the future

   What will happen if irrigation is increased? Will irrigation help or not? Do those who irrigate desire to continue irrigating and do those who do not irrigate desire to start irrigating?

Materials needed: drawing on a paper, use a big sheet of paper, pencils and markers.

APPENDIX D: Historical time line, procedure and probing questions for farmers before and after irrigation

Year	Before irrigation	After irrigation
2001		
2002		
2003		
2004		
2005		
2006		
2007		

1. Farmers in groups to give qualitative and quantitative information on what happened before and after introduction of irrigation
2. qualitative information

   Significant key events e.g when the project started, how the project started, main events associated with irrigation programme. what were some of the happiest times? Achievements e.g what people achieved with the projects and when crop yields (High or low), high/low income, crop diversification and crop intensity or what are some of the best things the community has done? Support received e.g. efforts from different stakeholders (churches, government) to support the project. Problems and shocks for example if there were any epidemics, floods, droughts, years of plenty and scarcity and other natural disasters
3. Quantitative information

   How many people were there when the project started? How many people are there today?
4. Find trends of events and ask how the community dealt with the situations that came their way, how the community mobilised itself, what communication methods were used to create awareness and action to deal with the problems.

Materials needed: Materials the people can use as symbols and feel comfortable with, Manila paper and marker.

APPENDIX E: Brainstorming and ranking the benefits and problems experienced by farmers (starting with one (1) as the major benefit/ problem)

Benefits	Rank benefits (1=high)	Problems	Rank problems (1=high)

APPENDIX F: Matrix used to explore information on consumption, assets, income from cash cropping, purchases, crop yields, and social services by farmers before and after irrigation

	Before irrigation	**After irrigation**
Consumption		
Nsima (Pulp)		
Rice		
Potato chips		
Sweet potatoes		
Bread		
Margarine		
Milk		
Vegetable cooking oil		
Beef		
Pork		
Chicken		
Eggs		
Fish		
Beans		
Green vegetables		
Fruits		
Soft drinks		
Assets		
House furniture		
Bicycle		
Radio		
Television		
Cell phone		
Oxcart		
Stove		

Sewing machine		
Livestock		
Brick house with iron sheets		
How many farmers produce for purposes of cash cropping		
What farmers were able to purchase after irrigation but were not able to purchase before		
Crop yields (Hactares before and after irrigation)		
Social services		
Water		
Electricity		
Telephone		
Health clinics/hospital		
Education		
Postal services		
Agriculture extension services		

Procedure of using matrix

1. Provide list of food consumed, assets, income from cash cropping, crop yields, and social services for the farmers in a matrix
2. Ask farmers to put a sticker on the row and column that matches the food eaten, assets acquired, if produced for cash cropping, crop yields (number of hectares) and social services before and after introduction of irrigation
3. The number of stickers will be compared before and after introduction of irrigation and between irrigators and non-irrigators

Materials needed: Large sheet of paper, stickers of various colours indicating the differences between irrigators and non irrigators, males or females.

APPENDIX G: Questions for in-depth interviews and SWOT analysis for World Vision field staff

1. Since when did you start working with the community in this irrigation scheme?
2. Brainstorm and rank the benefits beneficiaries experience
3. Brainstorm and rank the problems beneficiaries encounter?
4. In your opinion, between rain-fed farming and irrigation farming, which one has the potential to improve food security?
5. Give reasons for your answer in question
6. What do you think are the strengths, weaknesses, opportunities and threats (Challenges) for the project in terms of production levels, income levels, crop diversification, and role of income on consumption and assets of farmers? Use SWOT analysis document below
    - Brainstorm and fill spaces for the strengths, weaknesses, opportunities and threats
    - Use opportunities and strengths to consider alternative strategies to improve irrigation
7. Give suggestions for sustainability of the project

Strengths	**Weaknesses**	**Opportunities**	**Threats (challenges)**

APPENDIX H: Validation exercise (comments, clarifications and confirmation of the results)

1. ADMARC is located at Masaula trading centre some 4km away from Kalizinje irrigation scheme and 6km away from Ibu village.
2. Farmers irrigate once per fortnight in both irrigation schemes and farmers work in teams of four and four plots are irrigated in one day. The teams assist each other.
3. The information of frequency of crop production is true for both Ibu and Kalizinje schemes, that is, Ibu farmers plant two times a year and Kalizinje farmers plant three times a year with irrigation.
4. At Kalizinje, the land for irrigation is full time (farmers control their own plots) while at Ibu farmers do rent land from non-irrigators, so after producing two crops the land is surrendered back to the owners to prepare it for rain fed production.
5. Information at Ibu on the number of people who started irrigation was misquoted but here is what happened. Ibu farmers started with 47 farmers in 2005. In 2007 there were 27 farmers. The 20 farmer's difference came in because some farmers who joined in the schemes came from far away, a distance of between seven and 10km. During their allocated irrigation period these farmers were absent and eventually crops wilted and farmers harvested less than expected. The following year those farmers did not turn up for irrigated production.
6. At Kalizinje the number of farmers (32) who started irrigation remained constant up to 2007 because the plots were well demarcated and there were 32 farmers for each plot.
7. It is true that Ibu and Kalizinje villages share the same climate. However, Ibu irrigating farmers do not plant rape and turnips because it was not their choice and they mostly grew maize because it is the main staple food. Kalizinje irrigating farmers do not grow ground nuts because their soils were very poor for the crop.
8. Irrigating farmers do not plant sweet potatoes and ground nuts because in both irrigation sites there is clay soil which is not ideal for both sweet potatoes and ground nuts.
9. Crops which can be grown by irrigating farmers if they have to diversify include: Irish potatoes, onions and peas for Kalizinje and Irish potatoes, ginger, onions and cabbage for Ibu.

10. In general, non irrigating farmers have more land compared to irrigating farmers. However, hectarage by irrigating farmers does increase if they rent some land as is the case with Ibu farmers.
11. Loans from World Vision in terms of seed and fertiliser are accessed by both irrigating and non irrigating farmers. Irrigating farmers have more ability to repay these loans because of the income they earn from selling surplus.
12. Farmers get more income from irrigation than in business. This is illustrated below. Ibu K27,000 in business while K85,000 with irrigation per person per annum. Kalizinje: K8,000 in business while K30,000 with irrigation per person per annum.
13. There are pumps of different sizes and big pumps have the capacity to pump a lot of water and onto a larger piece of land than small pumps.
14. More non irrigating farmers ate a variety of food than non irrigating farmers for the following reasons:(a) irrigating farmers plant one type of crop at a time while non-irrigating farmers plant a variety of crops knowing that that is the only time they plant crops. (b) Irrigating farmers have other pressing needs other than the issue of food alone so farmers use their money for pressing needs like, school fees and repayment of loans, clothes, and livestock. As long as farmers have the maize and other foods available in the home/gardens there is no reason to worry about variety of foods. Here the issue of priorities is at play.
15. In the same way as number 14 above, more non-irrigating farmers have assets than non irrigating farmers because the issue of priorities is at play; the expensiveness of assets and being accustomed to the life style farmers lived. Farmers will have to be encouraged to vary the food and also buy assets.
16. Approximate figures on how much farmers spend on assets

Asset	**Amount in Kwacha (K)**
House furniture	4850.00
Bicycles	15000.00
Radios	75000.00
Television	10000.00
Cellphones	7000.00
Livestock (goats)	3500.00
brick house with iron roof	150000.00