ECONOMICS OF IRRIGATED CROPS IN KINYOPE AND KITERE IRRIGATION SCHEMES IN LINDI AND MTWARA DISTRICTS

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2011

ABSTRACT

Governments in many developing countries including Tanzania are promoting irrigation as a response to food insecurity. A current initiative in Tanzania for instance, is to scale up annual paddy irrigation production to 2 million tones in 2018 from the present 8×10^5 tones. Studies conducted in Ruvuma and Mbeya regions by the World Bank (WB) and the International Fund for Agricultural Development (IFAD) shows improvement in irrigation efficiency and crop yield. The question whether these research findings hold true for Kinyope and Kitere irrigation schemes or profitability of these two schemes had also increased, is the motivation behind this study. The main objective is to investigate the economic performance of Kinyope and Kitere irrigation schemes found in Lindi and Mtwara districts. Farm Enterprise Budget analysis was employed to determine the profitability of major crops grown in the schemes. Residual Imputation Method has been used to evaluate economic value of irrigation water. To capture the effects of institutional and technical factors on paddy yields in the schemes, multiple regression model has been estimated. The results show that the average profitability realised is Tshs 1 044 207/ha. Moreover the results show that the average value of irrigated water found to be 14 Tshs/m^3 and that the estimated average water productivity for paddy is 0.04 kg/m^3. Regression analysis results revealed that at $P<0.05$ paddy yield is positively influenced by cultivated plot size, capital invested, irrigation water availability and credits accessibility to the farmers in the irrigation schemes. From these findings it is concluded that economic performance of Kitere and Kinyope irrigation schemes is good though relatively lower as found by WB and IFAD in Mbeya and Ruvuma. It is therefore recommended that stakeholders should jointly work together to ensure that irrigation water is available throughout the year and that farmers are provided with cheap credits for them to expand farm sizes, purchase inputs and hire labour at a proper time.

DECLARATION

I, Stanslaus Beatus, declare to the Senate of Sokoine University of Agriculture that a dissertation hereby submitted is the result of my original work and has neither been submitted nor concurrently being submitted for a higher degree in any other institution.

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The above declaration confirmed

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ACKNOWLEDGEMENT

My foremost thanks are due the Almighty God for keeping me healthy during my MSc. Studies at Sokoine University of Agriculture (SUA). Otherwise the study would not have been accomplished without a good health during the entire period of studies. Acknowledgements are here extended to the following individuals and organizations.

My sincere appreciations are due to Dr. D. Philip, my supervisor, for his encouragement, suggestions, valuable and tireless guidance which made this study successful. I feel privileged to have had the opportunity to work under him. The appreciation is also extended to academicians of the department of Agriculture Economics and Agribusiness of Sokoine University of Agriculture for their efforts during the entire course work period.

My field work could not have been possible without cooperation from the farmers, ward and village leaders from Milola, Kinyope and Kitere. My sincere thanks are therefore to the wards and village leaders, farmers and scheme leaders from Kinyope and Kitere irrigation schemes. The DALDOs’ office Lindi and Mtwara district councils, Engineer Chikoleka, V.J.P and Mr. Mlyuka E. from Mtwara Zonal irrigation office for their cooperation and support in giving proper and complete information needed to organize and accomplish this study.

I would like to extend concern to my wife Flora, my sons Benedict and Bonaventure for their love, care and encouragement. Thanks to all, indeed.

DEDICATION

To my parents, Mr. Beatus Joseph Mkatila and Rose Hussein Mpunga, who laid the foundation of my education. In addition, it is also dedicated to my wife Flora and my children Benedict and Bonaventure.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immuno Deficiency Syndrome
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
CIA	Central Intelligence Agency
DADP	District Agriculture Development Plan
DALDO	District Agriculture and Livestock Development Officer
DIDF	District Irrigation Development Fund
FAO	Food and Agriculture Organization
FC	Fixed Costs
FMIS	Farmer Managed Irrigation Schemes
GDP	Gross Domestic Product
GI	Gross Income
GMIS	Government Managed Irrigation Schemes
GoT	Government of Tanzania
GRRC	Great Ruaha River Catchment
ha	Hectare
HIV	Human Immunodeficiency Virus
IFAD	International Fund for Agricultural Development
IMR	Irrigation Management Reforms
IMT	Irrigation Management Transfer
JICA	Japan International Cooperation Agency
Kg	Kilogram
LGA	Local Government Authority
MDGs	Millennium Development Goals
NI	Net Income
NIA	National Irrigation Agency
NIDP	National Irrigation Development Plan
NIMP	National Irrigation Master Plan
NSGRP	National Strategy for Growth and Reduction of Poverty
NVIDF	National Village Irrigation Development Project
O&M	Operation and Maintenance
PRA	Participatory Rural Appraisal
R^2	Coefficient of determination
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
SSA	Sub Sahara African countries
SUA	Sokoine University of Agriculture
TARP II	Tanzania Agricultural Research Project II
TC	Total Costs
TFC	Total Fixed Costs
TNCID	Tanzania National Committee for Irrigation and Drainage
TVC	Total Variable Costs
URADEP	Upper Region Agricultural Development Project
URT	United Republic of Tanzania
VC	Variable Costs
WUA	Water Users Association

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

One of the major constraints to growth in agriculture is the continued reliance by small-scale farmers on rain-fed agricultural systems. The continued dependence on rainfall in agriculture has proved incapable of sustaining the population increase. Irrigation development therefore holds the potential for reducing drought risks and increasing intensive production and that it is important for improvement in farm incomes for the majority of the rural population in Tanzania.

Irrigation is defined as the human intervention to modify the spatial or temporal distribution of water occurring in natural channels, drainage ways, or aquifers, and to manipulate all or part of this water to improve crop growth (Byerlee, 2006). If introduced and managed properly, irrigation can increase yield of the most crops by 100% to 400% in the developing countries however, most needy farmers are still unable to water their land (Chiduza *et al*., 2010).

Ashimogo *et al.* (2007) in his study on understanding poverty through the eyes of the poor conducted in Usangu plains, suggested that additional increments of income from paddy and dry season irrigated crops will reduce the overall income inequality amongst the rural households and that, one of the possible avenues for targeting poverty alleviation interventions could be through the improvement of productivity water in irrigated agriculture. Rain fed agriculture remains susceptible to drought and the inadequate and erratic nature of rainfall make irrigated agriculture a viable option to ensure food security (Berkholt, 2004). Therefore, increased food production to feed the world's growing population could have been possible through an increase or intensification of the irrigated lands (Dorsan *et al.*, 2004). The sector has developed a strategy, which is a planning, and coordination framework called the National Irrigation Development Plan (NIDP). This is essentially a response to the pressing need for food security, economic growth and counter measures against the drought cycle resulted mostly from the climatic change which dominates agricultural production in Tanzania. More than 80% of the Tanzanians engage in agricultural activities that contribute about 26.6% of the Gross Domestic Product (CIA, 2010). Out of this labour force, it is obvious that most farmers operate small-scale farms that contribute significantly to the total employment.

In Sub-Saharan Africa, rainfall is highly variable and, in many places, plainly insufficient. Drought is common. Although irrigation has the potential to boost agricultural yields by at least 50 percent, food production in the region is almost entirely rain-fed (FAO, 2000). The irrigated area, extending over 6 million hectares, makes up just 5 percent of the total cultivated area of which two-thirds of that area is in three countries namely Madagascar, South Africa, and Sudan. The total area under irrigation in Africa is estimated to be about 10 million hectares (FAO, 2000). In Tanzania, irrigation potential is estimated at one million hectares, of which only about 150 000 hectares (15%) are under irrigation. Out of total area under irrigation, 80% is under traditional irrigation schemes with low level of water use efficiencies and the remaining 20% are centrally managed irrigation schemes owned by public and private institutions and individuals (Berkholt, 2004). Most of the irrigated areas are under surface irrigation, mostly used by smallholders and that water distribution is usually by lined and unlined canals where furrows and basins are widely used.

1.2 Problem Statement

One of the most widespread assumptions in development is that irrigation is reducing poverty (Smith, 2004), and it is also believed that irrigation helps solving other problems such as water shortages and food production. Current initiatives to scale up paddy irrigation, under which Tanzania targets to boost annual production from the present $8x10^5$ to 2 million tonnes by 2018, is behind schedule, two years since it was set (Daily News Reporter, 2010). Studies undertaken for the National Irrigation Master Plan in 2002 have shown that, the total irrigation potential of the country is about 29.4 million hectares with different suitability levels (Mwandosya, 2008). Out of this potential only 331 490 hectares are currently irrigated, and the government plan is to increase the area to 1 million hectares by 2025 (Habarileo Reporter, 2010).

A study undertaken jointly by the World Bank and the International Fund for Agricultural Development (IFAD) in selected projects in Mbeya and Ruvuma regions shows irrigation efficiency has been improved by an average of 30 to 40% from 15% thus, substantially raising yields for crops such as paddy from an average of 2 tones to 6 tones per hectare (Mwandosya, 2008). This possibility for the farmers to raise paddy yields and the fact that food prices are rising, is an incentive for many farmers to resort to irrigated agriculture, with a consequent increase in the demand for water resources. For development of 405 000 hectares to attain self sufficiency in paddy production, it is estimated that about 32 km^3 per annum of water will be required which is 35% of the total available renewable water resources in Tanzania.

Although as described above there are several studies on the performance of irrigation schemes in the country, it is not clear whether these findings hold true for other projects particularly small scale farmers' managed irrigation schemes such as Kitere and Kinyope. Thus the present study aims at finding how irrigation is helping small scale farmers in Kinyope and Kitere irrigation schemes.

1.3 Justification

Many developing countries including Tanzania are not food secure despite the observed achievements in irrigation (Mwandosya, 2008). In response to food insecurity, governments in developing countries, among other things, are promoting irrigation as it helps in achieving the following primary objectives (i) Satisfying subsistence requirements in many parts of the country - equals increased food security at household level. (ii) Generating local surpluses of main staples, particularly rice in order to achieve food security in the country. (iii) Ensuring the production of much dietary supplements as vegetable fruits and pulses. The government through District Agriculture Development Projects (DADPs) and Distrct Irrigation Development Fund (DIDF) support many irrigation schemes including Kinyope and Kitere. For instance, in the year 2010-11, the government spent 31 billion shillings for irrigated agriculture whereas in this year, 2011-12, a total of 40 billion shillings will be spent throughout the country (Latifa, 2011). But little is known about economic performance of these two schemes. Economic potential of other schemes like Mombo, Kivulini and Lekitatu have been studied and hence known, or that of large scale irrigation schemes as those in Usangu are also known since a study on the economics of irrigated paddy in Usangu basin was done by Kadigi *et al*. in 2004. Therefore the present study aims at undertaking an economic analysis of Kinyope and Kitere irrigation schemes.

1.4 Objectives of the Study

1.4.1 Overall objective

To investigate the economic performance of small scale farmers' managed irrigation schemes of Kitere and Kinyope found in Mtwara and Lindi districts so as to establish how such schemes could be used to improve the performance of the agriculture sector in the country.

1.4.2 Specific objectives

i. To examine economic performance of Kinyope and Kitere small scale farmers' managed irrigation schemes in terms of crops profitability.

ii. To assess economic value of irrigation water in Kinyope and Kitere small scale farmers' managed irrigation schemes.

iii. To identify technical and institutional factors influencing paddy yields in Kinyope and Kitere small scale farmers' managed irrigation schemes.

1.5 Research Questions

i. Does Kinyope and Kitere irrigation schemes perform better in terms of crop profitability?

ii. Is irrigation water has any economic value in Kinyope and Kitere irrigation schemes?

iii. Are technical and institutional factors significantly influence paddy yields in Kinyope and Kitere irrigation schemes?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 An Overview of the Global Irrigation Development

Irrigation development is an effective way to increase crop production and productivity that may result into poverty alleviation and food self-sufficiency in the country (Maganga and Sosovele, 2005). By 2003 total irrigated land in developing countries was 207 965 x 10^3 hectares against a total world area of 277 098 x 10^3 hectares, which is about 17% of the world land area but provides 40% of the global food (Mwandosya, 2008).

Literature shows that furrow irrigation have been practised widely in Africa since pre-colonial times (Chiduza *et al.*, 2010). However, irrigation has received special attention as a tool for economic and social change since the Second World War (Babel *et al.,* 2011). Despite of this special attention that irrigation projects have received, it has been experienced that the overall performance is not worthwhile. FAO, a major agent in irrigation development projects throughout sub-Saharan Africa not excluding Tanzania (Machibya *et al.*, 2005), expressed disappointment on the overall performance of many irrigation projects, which were found to be caused by poor scheme conception, inadequate construction and implementation or ineffective management (Adegbite *et al*., 2008).

Over the past three decades, governments in both developed and less developed countries have transferred public companies and other state enterprises to the private sector. Countries have embarked on a process of transferring the management of irrigation system from government agencies to water users' organizations through a process called irrigation management transfer (Perret, 2002a). Irrigation management transfer (IMT), includes state withdrawal, promotion of the participation of water users, development of local management institutions, transfer of ownership and management, and therefore reducing public budget demand and increasing irrigation performances (Perret, 2002c). IMT was necessary since experiences of irrigation in Africa show that most of public interventions in both small and large scale irrigation schemes have not produced intended results (Underhill, 1990; Adegbite *et al.*, 2008). A first reason for this failure has been the way national and international agencies tended to conceptualise irrigation development. Local irrigation schemes that had often been operating well changed for the worse when centralised government bureaucracies assumed control of management and operations (Moris, 1997).

The second reason for failure has been poor planning, which includes failure to contextualise irrigation technology in terms of its local environment, specifically the physical and social aspects. Key social and cultural issues such as gender tensions, labour constraints, cultural obstacles, agrarian institutional relations (especially land tenure) and awareness of what crops are considered as food by local people are nearly always missed (Kissawike, 2008). The third reason for failure is the tendency to design infrastructure according to 'engineering thinking', with low levels of cost recovery, poorly executed maintenance and subsequent poor operation of many irrigation schemes, resulting in low irrigation efficiencies, poor water management (Gutierrrez, 2005) and low economic performance. The fourth reason for problems with formal schemes has been the lack of institutional understanding over farmers' water rights and gender relations in irrigation management.

Irrigation has been centrally directed, or farmers have been made to adopt irrigation management reforms (IMR) in a bureaucratic interest, a situation which has been a main obstacle in the attempt to improve management performance of irrigation systems (Zawe, 2006). In developing countries, priority is on rehabilitation of the small scale irrigation schemes because this is where maximum impact will be felt with a minimum of investment. Their contribution towards achievement of the country's policy objective of obtaining food security is what makes them unique.

2.2 Current Status of Irrigation Development in Tanzania

Up to 2008 Tanzania had 290 000 million hectares under irrigation. Plan in the short to medium term is to increase irrigated area to 1 million hectares out of which the country requires 405 000 hectares to attain paddy self sufficiency (Mwandosya, 2008). This irrigated area has increased to 331 490 hectares in 2010 (Habarileo Reporter, 2010). The study by the Ministry of Agriculture and Food Security (2002) through the National Irrigation Master Plan identifies a total irrigation development potential of 29.4 million hectares. Of this total area, 2.3 million ha are classified as high potential, 4.8 million ha as medium potential and 22.3 million ha as low potential. These potential levels were derived in consideration of land potential, water potential and socio-economic scenarios. These factors were overlapped to come up with the irrigation potential. Ashimogo *et al.* (2007) in his study on Collective arrangements and social networks: Coping strategies for the poor households in the Great Ruaha Catchment, found that access to suitable agricultural land is one of the major determinants of household livelihood and that access to land and access to water are often inseparable: paddy cultivation requires both suitable soils, as well as sufficient access to water; irrigable land is only useful in combination with secure access to irrigation water.

For years the government's strategy on irrigation development has been stressed on attainment of national food security, increased productivity and income. It has been stated that priority is on rehabilitation of the traditional irrigation schemes because this is where maximum impact will be felt with a minimum of investment. Such schemes have been built and are managed by the local people and there have been no external interventions to modify the system. However, most of the existing traditional irrigation schemes have fallen into disuse and therefore need either rehabilitation and/or modernization to ensure maximum production (Maganga and Sosovele, 2005). Tanzania national committee for irrigation and drainage argue that, irrigation in the form of traditional irrigation schemes goes back hundreds of years in the country (URT, 2007) and that those schemes have however become inadequate due to increase in population, wear and tear, catchments degradation etc. Traditional irrigation is through surface irrigation supplied from direct river diversion with distribution of water by lined or unlined canals. It also includes water harvesting and flood recession water control methods. The furrows and basins are widely used in water harvesting (capturing floods from seasonal rivers via bunds, dams or flood diversion for gravity).

According to Mkojera (2008), irrigation development in Tanzania has gone through in three stages: First, there was an imposed smallholder irrigation practice. The second was large scale, Government-Managed Irrigation Schemes practices in which only the government was involved in irrigation development. The third stage is the farmer-managed irrigation system. In the first two stages there were no farmers' involvements in planning, designing and constructing schemes, also farmers' responsibility in operating and maintaining schemes were not clearly defined as such, to contain the situation, the Government of Tanzania decided to improve small holder farmers - managed schemes whenever possible. Since 2001, the Government of Tanzania (GoT) has been promoting the Agricultural Sector Development Program (ASDP) and the District Agricultural Development Plan (DADP) under the Agricultural Sector Development Strategy (ASDS). Under the ASDP/DADP framework, Development of irrigated agriculture, including irrigated rice farming is one of the pillars of the agricultural sector (Mkojera, 2008).

2.3 Types of Irrigation Existing in Tanzania

As in other developing countries, irrigation categories in Tanzania are large and small-scale irrigation schemes (FAO, 1997). As their names indicate, the difference between the two is the scale determined by the spatial coverage of the project and investment in terms of capital and technology. Small holder farmers practice small-scale irrigation as it requires simple and affordable technology. Over time and in different places other terms like traditional irrigation, indigenous irrigation and local irrigation have been used referring to small-scale irrigation systems FAO (1997) defined traditional irrigation as irrigation on small plots, owned and controlled by farmers and the level of technology used is simple, which farmers can effectively operate and maintain. Most farmers are not able to operate and maintain large scale irrigation schemes since are expensive.

Traditional irrigation is a dynamic process that varies geographically, and where irrigating communities are capable of assimilating and adapting outside knowledge and experiences to improve their own situation (Maganga and Sosovele, 2005). The common type of traditional irrigation practiced in the southern highland areas of Tanzania is called *vinyungu*. In simple terms, *vinyungu* means valley bottom farming particularly during the dry season. Due to climatic variations, the exploitation of *vinyungu* has increasingly become important due to residual moisture sustained during the dry season, high natural soil fertility or easiness to irrigate. Due to technological changes, the traditional *vinyungu* is being transformed in order to increase productivity. Apart from paddy as the main crop, other crops grown by smallholder farmers under irrigation include maize, legumes (e.g. peas, cow peas and common beans) and vegetables like onions, tomatoes okra and spinaches.

2.4 The National Irrigation Policy

According to the National Strategy for Growth and Reduction of Poverty (NSGRP) which is the national organizing framework focusing on economic growth and poverty reduction, the rate of growth expected to reach 10% by 2010 (URT, 2010). The NSGRP targets are in line with the aspiration of the Tanzania Development Vision 2025. Tanzania is also committed to the Millennium Development Goals (MDGs) as internationally agreed targets for reducing poverty, hunger, diseases, illiteracy, environmental degradation and discrimination against women by 2025. Therefore the development and proper utilization of irrigation infrastructure is one of the important inputs for achieving the Tanzanians' decision of implementing its prioritized development of the agricultural sector as a means to meet both NSGRP targets and MDGs. Irrigation development can address the challenges posed by the variability of rainfall, and limited amount of manmade storage dams and inadequate use of natural storage or interbasin water transfer from large lakes which are major constraints on crop productivity and rural livelihood. It is unlikely to achieve the millennium targets of reducing food insecurity and halving poverty by 2025 without setting and implementing appropriate strategies which include irrigation development to curb the situation.

The vision of the national irrigation policy as stated by URT in 2010 is therefore "A sustainable and dynamic irrigation sector that is a driving force in transforming agriculture into a stable, highly productive, modernized, commercial, competitive, and diversified sector which generates higher incomes; increases food security and stimulates economic growth". The main objective of the policy is to ensure sustainable availability of irrigation water and its efficient use for enhanced crop production, productivity and profitability that will contribute to food security and poverty reduction, whereas specifically aims on;

i. To accelerate investment in the irrigation sector by both public and private sector players.
ii. To ensure that Irrigation Development Funds are established with a legal status;
iii. To promote efficient water use in irrigation systems.
iv. To abide by the Integrated Water Resources Management approach in irrigation development.
v. To ensure that irrigation development is technically feasible, economically viable, socially desirable and environmentally sustainable.
vi. To ensure reliable water for irrigation so as to facilitate optimization, intensification and diversification of irrigated crop production including pasture and aquaculture.
vii. To ensure demand driven, productive and profitable irrigation development models that are responsive to market opportunities;
viii. To strengthen institutional capacity at all levels for the planning, implementation and management of irrigation development.
ix. To empower beneficiaries for effective participation at all levels in irrigation planning, implementation, operation and management.
x. To strengthen research undertakings, technical support services, development and dissemination of new practices, innovations and technologies on irrigation and drainage, and
xi. To mainstream cross cutting and cross sectoral issues such as gender, HIV/AIDS, environment, health, land and water in irrigation development.

As it was proposed by the Agricultural Sector Development Strategy (URT, 2001), the National Irrigation Policy is comprehensive and robust taking into consideration:

i. Different water users
ii. Competitive water demands
iii. Sustainability of irrigation development and management and
iv. Targeting the poor (pro-poor).

The policy also recognizes that water is an economic good as well as a social good (Langford, 1999). This principle is consistent with the 'Dublin Statement' of the International Conference on Water and the Environment of 1991 which was agreed to by over 100 countries.

2.5 Overall Performance of the Irrigation Sector in Tanzania

There is a general awareness that irrigation management has been weak in many African countries for both government and farmer-managed irrigation schemes (Speelman, 1990). Improvement of traditional irrigation schemes started during the pre-independence and was extended during the post independence period, but with a low pace of development. Performance of the irrigation sector in the country from 1960s to the 1980s in developmental and operational context is reported with inadequate achievement. The period of 1960s was characterised by unrealistic and weakly coordinated planning resulting in slow development of new irrigation schemes with the achievement of only 2600 ha by 1970 out of the targeted area of 10 000 ha spread over the entire country (URT, 2010). The development goals were revised between 1980 and 1985 emphasizing on the rehabilitation and upgrading of village irrigation schemes – National Village Irrigation Development Project (NVIDP) around the country and varying in size from 200 to 2000 ha and a target of 150 000 ha was set. Technical support units were established at six zonal irrigation units in 1981 for the purpose of complementing the capabilities in the implementation of irrigation development at the Regional Authorities. Implementation of the number of programmes was slow because of limited resources and few trained and experienced staff.

According to URT (2010), the rate of development of new irrigation schemes began to pick up from 1985 with the start of several irrigation schemes development projects through external support with the performance below expectations despite the increased activities, the reasons for this performance being;

i. Absence of irrigation policy
ii. Absence of vital irrigation data for planning purposes
iii. Inadequate resources in the part of the government e.g. funds and trained irrigation personnel
iv. Absence of the national irrigation investment criteria
v. Lack of a national coordination for irrigation developments
vi. Poor management on irrigation schemes with sophisticated infrastructure and
vii. Poor planning of irrigation projects, particularly smallholder traditional irrigation schemes.

A major irrigation development plan was launched by the government in 1994, one of the objectives being addressing effectively constraints to the development of the sector which included inta alia: sector policy review and monitoring and sectoral coordination, institutional capacity building, planning and management, information systems and research, beneficiaries' involvement, cost recovery and commercialisation. By the year 2002, the National Irrigation Master Plan (NIMP) was launched with the intention to align the irrigation sector to contribute more effectively to agricultural productivity and profitability. NIMP identifies 29.4 million hectares in the country as potential irrigation area varying in three levels namely high, medium and low potential levels. According to the URT, (2010) a period starting from 2001-02 to 2004-05 seventy five irrigation schemes of an area of 27 470 ha and six dams commanding 860 ha were implemented. The developed area reached 227 486 ha in 2003-04 whereas in 2004-05 it was expected to achieve a cumulative developed area of 254 610 ha but the achievement was only 14 396 ha. In the year 2006-07 the target was to develop 10 000 ha out of which the achievement was 9 557 ha whereas the set target during 2007-08 was 27 500 ha of which only 15 300 ha were developed making a cumulative developed area under irrigation up to June 2008 to be 289 245 ha (URT, 2010). The targets were not achieved due to inadequate resources.

2.5.1 Government managed irrigation schemes (GMIS)

Government Managed Irrigation Schemes are those schemes in which the principal management responsibility is exercised by government agencies with the farmers playing subsidiary roles (Mkojera, 2008). Such schemes include some existing commercial irrigation schemes including those established for the purpose of seed production which are operating (URT, 2010). However they are constrained with inadequate water supply, poor access roads and marketing facilities whereas other schemes face problems in accessing credit facilities for rehabilitation, remodelling or expansion. In some existing schemes, the inhabitants in the vicinity are not provided with the existing opportunity of the neighbourhood as out-growers to benefit from the available facilities for irrigation technologies and other related services from those irrigation farms. Moreover, irrigation agencies have largely been unable to raise sufficient revenues from collection of water charges to meet operational expenses.

The irrigation agencies have provided the stimulus for many governments to adopt programs to devolve responsibility of irrigation management to users groups (Johnson *et al*., 2002). Indeed, these efforts towards the improvement of irrigation management performance are consistent with current tendencies, mainly driven by structural adjustment policies, to reduce the size and cost of government by devolving responsibilities and activities to the local level (Shah *et al*., 2001; Knox and Meinzen-Dick, 1999). They are also motivated by growing optimism that communities or user groups may be able to effectively manage the resources to ensure efficiency, equity and sustainability (Knox and Meinzen-Dick, 1999). Failure of the GMIS caused by the way those schemes were established, that:

1. The establishment based on social not economic policy objectives. It is not surprising that the economic performance of the irrigation schemes developed under these social policies leaves a lot to be desired.
2. The establishment also based on supply not demand driven. The development of irrigation was driven from the supply side. Water supplies were secured before consideration was given to what irrigation enterprises would deliver the best economic return. Marketing, in the true sense of the word, to assess the potential markets and likely profitability of particular irrigation enterprises was a secondary consideration.
3. There was lack of commercial discipline in investment decisions. While the early promoters of private irrigation schemes had sought full cost recovery by charging sufficient for water to recover operations, maintenance, administration, depreciation and a return on capital, typically revenue from water deliveries did not even recover operating costs. Rate of return on the investment was not a significant factor. The strong political and technical forces driving irrigation development led to much greater scale of irrigation development than could be justified on economic grounds.
4. Commercial discipline in water allocation was also lacking. In order to encourage farmers to use new water allocations no capital charges were levied for access to the water. Farmers had to be encouraged to take up the over supply of water from the multitude of new irrigation schemes. It is not surprising that large volumes of water were allocated to enterprises with low profitability. Irrigation of pastures and rice for example use large volumes of water but generate much lower returns per unit volume.

Balirwa (1990), studied economic analysis of large scale irrigation schemes, a case of Dakawa rice farm , which were basically government managed scheme and revealed that, such schemes in Tanzania were characterized by low yields, high unit costs of production, liquidity problems and return to assets being far below opportunity costs of capital. Langford, (1999) identified the role of government that should be to facilitate the development of larger scale integrated water supply systems for irrigation and that it should commission the conceptual plans for potential irrigation schemes, and create the legal and institutional framework.

A study by Osman (2002) provides an experience on the operation of irrigation schemes in Ghana. This study on determinants of success of community-based irrigation management shows that, many small-scale irrigation schemes, which are government managed, based on earth dams and dugouts exist, and that many were funded under World Bank projects. The majority of these schemes have structures broken down over time due to poor maintenance and the resulting siltation problems.

2.5.2 The farmer managed irrigation schemes (FMIS)

Farmer Managed Irrigation Schemes are defined as those schemes in which most management activities are carried out and decisions made by the farmers themselves with the government providing technical and logistical support (Mkojera, 2008). Such schemes can be developed by the government but owned and managed by the farmers' Irrigation Management Committees, with minimal government interventions in terms of management. In Tanzania under the current devolution and decentralization exercise of smallholder irrigation management, it is important that farmers put in place proper monitoring and evaluation mechanism to ensure the efficient use of resources i.e. water and infrastructure.

2.6 Management of the Farmer Managed Irrigation Schemes

The need to use water much more efficiently and productively especially in irrigation is more pressing due to increasing challenge to produce more food to feed the growing world population in the face of dwindling water resources - erratic rainfall regimes, increasing competition for water (due to urbanization and industrialization), Gyasi (2002), further argue that, governments are giving increased responsibility to community-based organizations to manage irrigation schemes, but the policy efforts will result in the expected effect only when farmers respond by increasing their participation in the management of the system. The success of participation efforts in the irrigation sectors depends on how well the project mobilizes support and builds effective farmers' organizations (FAO, 2007). In this respect, water users were formally registered by the government either as an association or a co-operative as observed in the study on the use of sustainable irrigation for poverty alleviation in Tanzania carried by Mwakalila and Noe (2004). Mkojera (2008) listed nine property rights that farmers' organizations need to have for optimal allocation and efficient use of resources in the scheme being:

i. **Water right –** The association and individual members have a right to a share of the water supply (of a useable quality) at the point of extraction from the resource base and at the level of individual users.

ii. **Right to determine crop and method of cultivation –** Individual water users, sometimes constrained by group imperatives, have the right to select which crops they will plant and how they will cultivate them.

iii. **Right to protect against land conversion –** The association has the right to protect its irrigated land against conversion to non-agricultural or non-water use purposes, in the event that the majority of members oppose such conversion.

Irrigated land is the main revenue base to finance the association, recover investment costs, and ensure sustainable livelihood for members.

iv. **Infrastructure use right** – The association has the right to operate, repair, modify or eliminate structures. Without this right, the association is unable or unwilling to invest in long-term maintenance and repair and is likely to consider the infrastructure as the property of the government.

v. **Right to mobilize and manage finances and other resources** – The association has the power to impose service fees, establish sideline revenue activities, plan and implement budgets, require labour or other inputs from members, recruit and release staff and provide training.

vi. **Right of organizational self-determination** – The association has the right to determine its mission, scope of activities (whether single function or multiple functions, including businesses), basic by-laws, rules and sanctions and method for selecting and removing officers.

vii. **Right of membership in organization** – All water users who are eligible for membership according to association by-laws have the right to be members of the association and receive its privileges, services and benefits as long as they comply with its rules and obligations.

viii. **Right to select and supervise service provider** – Where members of the association are unable or unwilling to directly implement the O&M service by themselves, the association may appoint third parties (such as contractors) to implement required services. The association has the right to set the terms of such contracts and supervise service providers.

ix. **Right to support services** – Subject to government policies or agreed conditions, the association has the right of access to support services it needs in order to function properly. This may include access to credit, banking services, agricultural extension, technical advisory services, subsidies, conflict resolution support and other legal services, marketing assistance, training and so on.

2.7 Constraints and Opportunities of Irrigation Development in Tanzania

The crucial constraints facing the irrigation sector which the government shall address so as to realise the envisaged targets and therefore achieving the green revolution for increased crop production (URT, 2010) include:

i. Inadequate funding for irrigation investments
ii. Low capacity and participation of private sector in irrigation development
iii. Low level of irrigation skills of the farmers
iv. Low production and inefficient marketing systems to absorb the produce from irrigation farming
v. Inadequate institutional capacity at national level with respect to planning, implementation and sustainable management of irrigation development in Tanzania
vi. Inadequate capacity of institutions at Local Government Authority level (LGA) to handle irrigation investments, implementation and sustainable management
vii. Low irrigation water use efficiency
viii. Ineffective and inefficient control of irrigation water which limits the application of the principles of Water use permit
ix. Lack of legal and regulatory framework for irrigation development
x. Lack of proper agricultural land use and management plans
xi. Inadequate irrigation production support services that is supported by research and technical innovations
xii. Inadequate farm power for various farm operations
xiii. Inadequate data base for irrigation development
xiv. Inadequate attention to drainage
xv. Inadequate storage of water for irrigation
xvi. Competing demand for water with other users such as Hydropower, domestic use, livestock and wild life and
xvii. Changes in the river flow patterns as a result of catchments degradation and climatic changes.

Despite of the constraints of the irrigation development in Tanzania, there are existing opportunities for its development (URT, 2010) including:

(a) Presence of 29.4 million ha potential for irrigation identified by the National Irrigation Master Plan

(b) Presence of nine water basins for the purpose of effective management, planning and development of the water resources. These water basins are namely Rufiji, Pangani, Ruvuma, Wami/Ruvu, Internal Drainage, Lake Rukwa, Lake Nyasa, Lake Tanganyika and Lake Victoria

(c) Presence of market for crops produced through irrigated agriculture in the country. This is due to the increasing population, change of eating habit of most Tanzanians towards more consumption of rice which requires more water to grow

(d) Supply demand of irrigated crop especially rice from the neighbouring countries and the Eastern, Central and Southern African region as a whole which are not endowed with high irrigation potential

(e) Geographical location strategically placed for easy and convenient export outlets to external markets

(f) Existence of institutional set up with qualified personnel with different disciplines related to irrigation such as Irrigation Engineers, Sociologists, Soil Scientists, Environmentalists, Agronomists, Economists, Land Surveyors, Mechanical Engineers, and Irrigation Technicians

(g) Government priority to irrigation development which is emphasized within the National policy frameworks and

(h) Government priority to the management of the nation’s water resources.

2.8 An Overview of Some Similar Studies Conducted in the Past

Some of the previous studies include the Economics of Irrigated paddy in Usangu Basin (Kadigi *et al.*, 2004), Economic analysis of Farmer - managed Irrigation schemes in Tanzania: A case study of Mombo, Kivulini and Lekitatu (Mkojera, 2008) and Water for irrigation or hydropower generation? – Complex questions regarding water allocation in Tanzania (Ashimogo *et al.*, 2008).

Mkojera (2008) employed farm enterprise budget analysis and multiple linear regression methods successfully. The results showed that major crops grown included paddy supplemented by maize, beans and vegetables. Average profitability from farming in the schemes for 2006/07 season observed to be Tshs 1 162 751 per household including both major and supplementary crops. Average value of irrigated water was found to be 14 Tshs/m^3 and that the estimated average water productivity for paddy is 0.05 kg/m^3. Regression analysis results showed that all coefficients attached to the estimated parameters as expected were positively related to the dependent variable and that the majority was statistically significant ($p<0.05$).

The major concern in the study by Kadigi *et al.* (2004) was a general lack of consensus on how the available water resources can be allocated efficiently and equitably among its competing uses. In agriculture for instance, the question is how this sector can be balanced in the manner that it produces more ‘crop per drop’ using less water and releasing adequate water for use by other sectors while concurrently enhancing rural income and livelihoods. Using Residual Imputation Approach in the analysis, average water productivity (in kg/m^3) and the average value of irrigation water (in Tsh/m^3) were observed.

A similar study to the one previously described in this chapter that was conducted by Kadigi *et al.* (2004), is that carried by Ashimogo *et al.* (2008) titled Water for irrigation or hydropower generation? – Complex questions regarding water allocation in Tanzania. The concern was the quest for having a good understanding of the value of water in its different uses. Using the *Change in Net Income Model*, a simplified model derived from the residual imputation approach, it was observed in monetary term that, the value of water in irrigated paddy estimated at 15 Tsh/m^3 (for water withdrawn) and 0.19 Tsh/m^3 (for water consumed). The value of water for hydropower generation is relatively higher than for irrigated paddy ranging from 59 to 226 Tsh/m^3. Yet it was established that irrigated paddy also supported livelihoods of about 30 000 agrarian families in the Great Ruaha River Catchment (GRRC), with gross revenue of about Tsh 15.9 million per annum and GRRC contributed about 14 – 24% of national rice production.

The study on Water for irrigation or hydropower generation by Ashimogo *et al*. (2008) concluded that balancing water demands between sectors requires a good understanding of the values of water in different uses and the opportunity costs of water transfer from one sector to another. This is particularly challenging where agriculture competes with other sectors and where water reallocation decisions may imply transferring a significant amount of water from the sector generating the highest pro-poor returns (agriculture in this case) to the sectors generating highest economic returns (hydropower generation and industrial uses). Balancing water demands in such circumstances can involve difficult decisions as the data from the GRRC in Tanzania suggested.

2.9 Conceptual Framework

Economic performance of the small scale irrigation scheme is considered to be related to the crop yield, profitability and economic value of irrigation water. These parameters are significant for the irrigation performances therefore are included in the main objective of the national irrigation policy whose statement is "To ensure sustainable availability of irrigation water and its efficient use for enhanced crop production, productivity and profitability that will contribute to food security and poverty reduction".

2.9.1 Crop productivity

Yield of most crops can be increased through properly and managed irrigation practice. Increased productivity is an important task in small scale irrigation schemes through which achievement contribute significantly to their economic performance. This hypothetical assertion is posited with other factors crucial for the productivity in the schemes. Such factors include cultivated plot size (ha), capital invested in farming (Tsh), irrigation water availability and credits accessibility to the farmers in Kinyope and Kitere irrigation schemes.

Cultivated plot size (ha), capital invested in farming (Tsh), irrigation water availability and credits accessibility to the farmers are assumed to be positively related to the productivity in Kinyope and Kitere irrigation schemes and influence significantly. It is observed that, productivity is a function of factors within farmers' ability and from those which can be intervened by the government and/or other stakeholders for effective production.

2.9.2 Crop profitability

Crop profitability varies from one scheme to another due to differences in revenues accrued and costs incurred during production activities in respective schemes. Irrigation scheme with larger profitability is considered performing economically better than otherwise. For crop profitability to be realized, the difference between the revenue (product of quantity of crop produced and its price) and costs (fixed and variable costs) should bear a positive magnitude. In small scale irrigation schemes, revenue from crop sales is prone to unstabilized pricing system especially in the grain crops liberalized market. Fixed cost incurred in the schemes include irrigation water cost and depreciation of farm implements, machineries and tools like tractors, power tillers etc. whereby variable costs include that of labour, fertilizer, improved seeds, herbicides and pesticides. In this respect external interventions are necessary to realize profitability in the irrigation schemes. Such interventions include agricultural input subsidies and cheap credits to farmers.

2.9.3 Economic value of irrigation water

Estimating economic value of water is a relatively new area of research in developing countries. As a result, most decisions regarding water allocation have been made without a comprehensive understanding of the value in its different uses and the opportunity cost of water transferred from one use to another (Kadigi, 2008). Water is considered as being an economic and social good. As an economic good according to the economic efficiency principle, the resource should be allowed to flow to the sector generating the highest marginal value or the sector generating economic benefits preferably through market forces.

Considering market mechanisms unable to solve many problems of water allocation especially when poor and disadvantaged groups are concerned, it is maintained that water should be treated as a social good and people are entitled to use it even when they cannot afford to pay the full price of its provision (Perry and Petra, 2006). As such irrigation water in this study is attached with an economic value derived from crop revenue, non-water input costs (labour, land and capital) and the amount of water required for irrigation. It can be seen as a measure of how irrigation water is valued in the scheme and thus rationally used in production. Scheme with higher water economic value is regarded to do better in its economic performance than the one with low water economic value. Fig.1 is a conceptual framework providing an understanding of the theoretical relationships between important variables and economic performance of the small scale farmers' managed irrigation schemes.

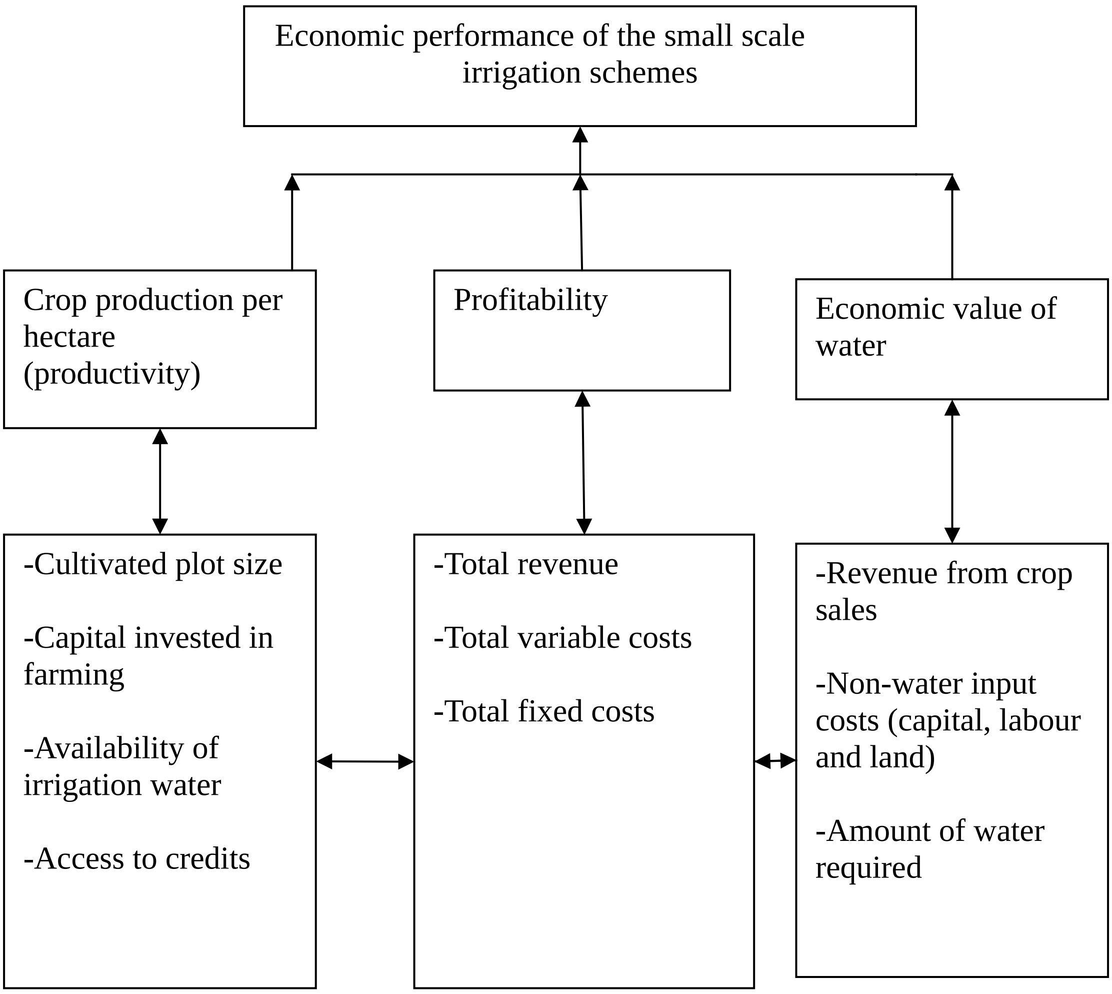

Figure 1: Economic performance of small scale farmers' managed irrigation schemes (A conceptual framework)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

Kitere and Kinyope are small scale surface irrigation schemes found in Mtwara and Lindi districts respectively. These two schemes are found in Mtwara irrigation zone which is among other seven zones in the country. Other irrigation zones are Kilimanjaro, Mbeya, Morogoro, Manyara, Tabora, and Mwanza. Among other schemes managed by farmers in Mtwara and Lindi, these two schemes have been selected based on their long experience in irrigation and because they have not been studied to determine performance in terms of crops profitability, economic value of irrigation water as well as the influence of some technical and institutional factors on paddy yields (DALDO Lindi 2011 and DALDO Mtwara, 2011).

Kitere irrigation scheme is located in Mtwara district, 64 km from Mtwara municipal (Fig. 2). It is found in Kitere ward situated in Mpapura division having command area of 160 ha out of 946 ha of irrigable land owned by farmers through their registered water users association (WUA). Due to water shortage, the scheme practices two irrigation seasons in only 60 ha whereas the remaining 100 ha practice irrigation in one main season (during long rain season). The scheme has a night reservoir into which water is abstracted through a pump before being discharged into the canals by gravity. The scheme is expanding the command area and renovating the existing canals and pumping system. A total of 100 ha will be established when expansion is over. The main crop grown in this scheme is paddy whereas vegetables and maize are grown during dry season (DALDO Mtwara, 2011).

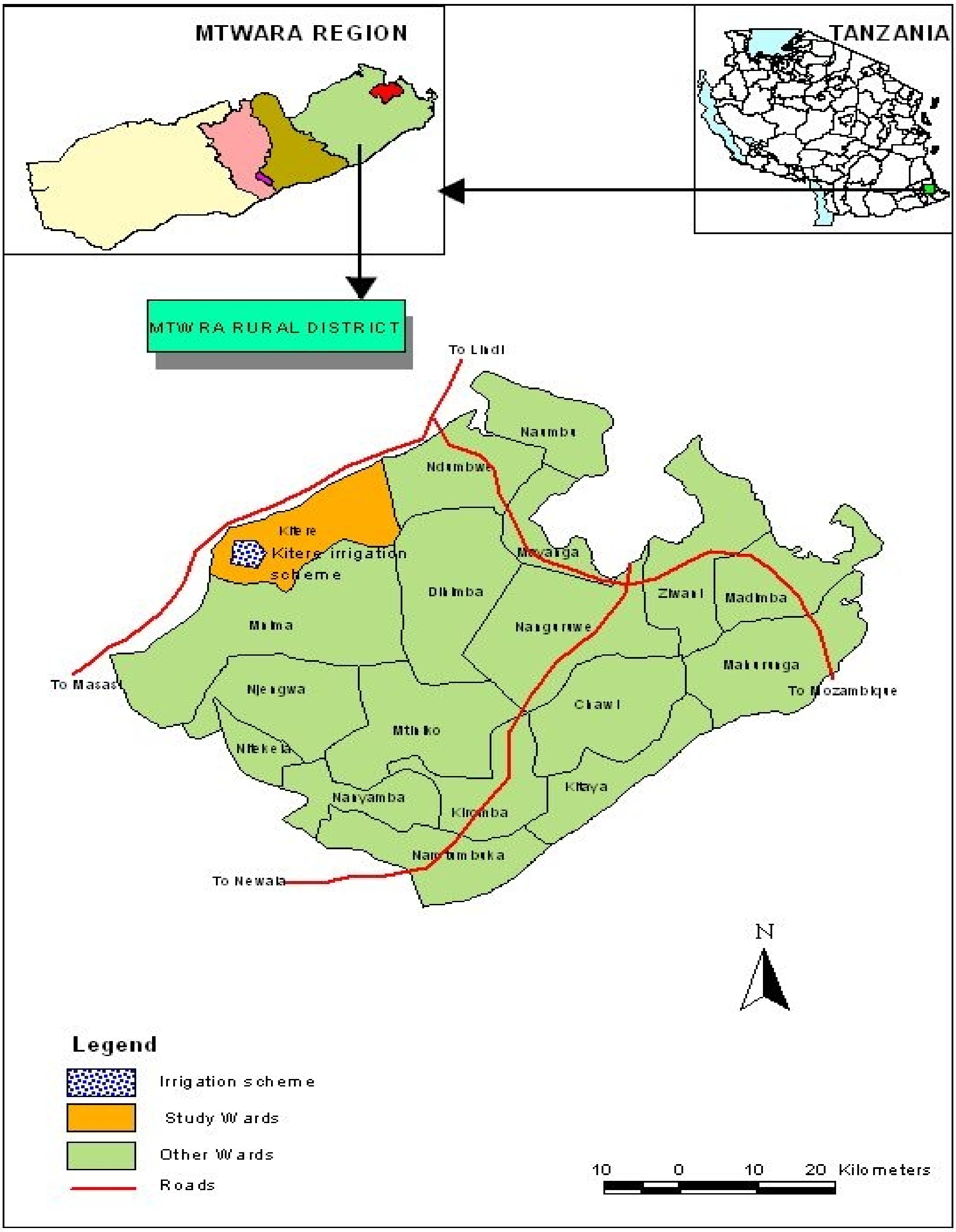

Figure 2: Map of Mtwara District showing a study area

Source: Tanzania Administrative Boundaries, Ministry of Land and Natural Resources (2002)

Kinyope irrigation scheme is 48 km from Lindi town. It is found in Rutamba ward located in Milola division (Fig. 3). The water source in this scheme is a permanent river with gravity abstraction system of water discharge to the plots. The scheme has no night reservoir but water is usually available to the farmers' fields whenever required. Total area of command in the scheme is 600 ha. Farmers in this scheme practice two overlapping seasons per year growing paddy, maize and vegetables such as tomatoes, spinaches okra and egg plants, paddy being the main crop. The scheme is funded by DADP and DIDF whereby construction of weirs and canals is in progress (DALDO Lindi, 2011).

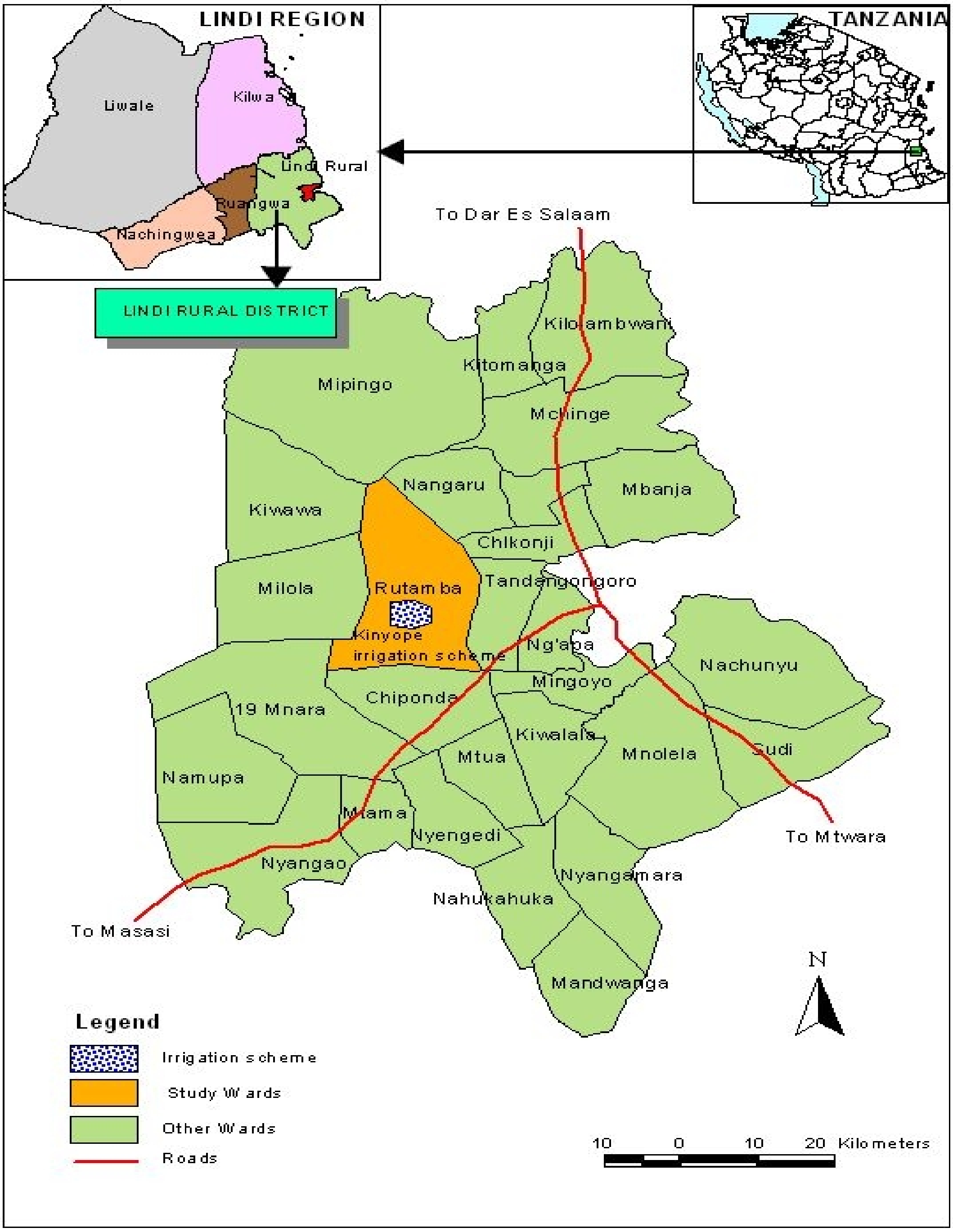

Figure 3: Map of Lindi District showing a study area

Source: Tanzania Administrative Boundaries, Ministry of Land and Natural Resources (2002)

3.2 Research Design

Cross sectional survey was used for this study. The design allows data to be collected at a single point in time without repetition from the target population (Babbie, 1990). This is an economic benefit in utilizing resources in terms of time and funds. Apart from its ability to be used for data collection on relevant variables within a short time frame, the design is also opted due its advantages. Some of these advantages include the ability to collect data on many variables at a time, data collection from a large number of a sample population, data collection from a dispersed study population, data collection on attitudes and behaviours of a study population, usefulness of collected data to many different researchers and answers questions on who, what when and where.

3.3 Study Population, Sampling and Sample Size

Study population constituted farmers who conducted farming in the respective schemes during 2009/10. Leaders of the WUAs, extension staffs, and technical irrigation personnel from Mtwara and Lindi DALDOs' office and from Mtwara irrigation zonal office were also interviewed. Interviewed farmers from each scheme were randomly picked from the registration book. A total of 55 farmers from Kitere and 75 farmers from Kinyope irrigation schemes were interviewed (Table 1). Selection of interviewed farmers based on schemes' area of command, a criteria adopted by JICA/NIA in 1991. This makes total number of respondents interviewed from these two schemes to be 130. Adjustment was made in both schemes for respondents to be obtained; from Kitere irrigation scheme with a command area of 160 ha (less than 210 ha which is a minimum according to the criterion), 55 respondents instead of 50 were randomly picked, whereas from Kinyope irrigation scheme having a command area of 600 ha, 75 respondents instead of 70 were selected. This adjustment was due to actual size of scheme area of command for Kitere and due to the time availability to enable interviewing more respondents from Kinyope irrigation scheme.

Table 1: Sample size determination using scheme size criterion

Area (ha)	**Number of respondents suggested by the criteria**	**Respondents that were selected**	
		Kitere irrigation scheme	**Kinyope irrigation scheme**
201 – 300	50	55	
301 – 400	60		
> 400	70		75

3.4 Data Collection Procedure

Primary data were collected through structured questionnaires administered to randomly selected farmers. Some Participatory Rural Appraisal (PRA) methods were also used for data collection which included transect walks and interviewing key informants (scheme and village leaders, extension workers and elders) in the respective irrigation schemes. Secondary data were collected from several sources including Sokoine National Agricultural Library (SNAL), Mtwara and Lindi district council's agricultural office department, Mtwara zonal irrigation office, Ministry of Water and Irrigation and the Internet. For instance, some of the variables for which secondary data were collected include estimated seasonal irrigation water demand (m^3) for Kinyope and Kitere schemes, depreciation cost of farm implements and machineries (Tsh) like power tillers and tractor used for cultivation in Kitere irrigation scheme, and the total area of command for both Kinyope and Kitere irrigation schemes.

3.5 Data Analysis

Data were analyzed using two statistical package computer software, *i.e.* Statistical Package for Social Sciences (SPSS) and Microsoft Excel. Statistical and descriptive analysis including frequencies, means, percentages and cross tabulations were used.

For the analysis of crop profitability, economic value of irrigation water and factors influencing paddy yield in the Kinyope and Kitere irrigation schemes, analytical models namely farm enterprise budget analysis, residual imputation approach and multiple regression respectively were employed.

3.5.1 Crop profitability in the small scale farmers' managed irrigation schemes

Farm enterprise budget analysis has been used to estimate profitability of the main crops in the schemes. This analytical model considers the estimates of income, costs and profits associated with the production of agricultural produces (George and Jayson, 1994). Farm enterprise budget is a powerful model for analyzing crop profitability due to the inclusion of fixed and variable costs in the analysis. Sections contained in the information of farm enterprise budget are gross income, fixed and variable costs, and the net income above selected costs (Lessey *et al.*, 2004).

Gross Income (GI)

GI is a function of output level and price per unit of output. It is computed by multiplying amount of crops harvested (in kg) and the price in Tanzanian shillings per unit of a given crop.

Variable Costs (VC)

Variable costs are those whose value depends on the level of output. They include the costs of things like family labour, casual labour, inputs (fertilizer, improved seeds, herbicides and pesticides) and operating expenses.

Fixed Costs (FC)

These are costs of production which do not vary with the level of output. Whether output is produced or otherwise, these costs are incurred in the scheme. Estimated FC includes opportunity cost of land, depreciation cost of tractors or power tillers and water charges.

Opportunity cost against the land is charged as a fixed cost since one cannot use the capital investment in an alternative endeavour (Lessey *et al*., 2004).

Income above costs (net income, NI)

This is the remaining income after the coverage of costs in the budget. Total costs, that is fixed and variable costs, are subtracted from the gross income.

Prices and labour valuation

In economic analysis, market prices are normally used although there may be differences in price right after harvest and the prices received after farmers have stored their produce (Mkojera, 2008). Therefore it is necessary for one to decide whether to use current prices versus constant price before hand as it has implications in incorporating inflation in the calculation. Senkondo *et al* (2004) argued that constant prices normally are used because of the assumptions that general inflation will exert the same effect on both costs and benefits. Transfer payments, including taxes, subsidies and credit transactions are eliminated from prices used to value inputs and outputs in order to reflect economic analysis. Market prices which are believed to reflect the opportunity cost have been adopted in this study. Apart from market price reflecting the opportunity costs, decision for its use in prices and labour valuation in this study is also based on the following reasons. Market price method uses prevailing prices for goods and services traded in markets. It represents the value of an additional unit of that good or service, assuming the good is sold through a perfectly competitive market, that is, a market where there is full information, identical products being sold and no taxes or subsidies.

The use of market price method prices and labour valuation is also associated with the following advantages. First, the method reflects an individual’s willingness to pay for costs and benefits of goods that are bought and sold in the markets, thus people’s values are likely to be well-defined. Second, the price, quantity and cost data are relatively easy to obtain for established markets. The third advantage is that the method uses observed data of actual consumer preferences.

The farm enterprise budget analysis model employed the formula;

NI= TR – TC

TR= Qy x Py

TC = TFC + TVC

Where, NI is the Net Income (profitability), TR is the Total crop Revenue, TC is the Total Costs, Qy is the Quantity of the crop output y in Kg, Py is the price of the crop output y (in Tsh) TFC is the Total Fixed Costs, and TVC is the Total variable costs.

3.5.2 Economic value of water in Kinyope and Kitere small scale irrigation schemes

To derive the residual value of water in small scale irrigation schemes, Residual Imputation Approach was employed in this study. More often than not, evaluation of a proposed irrigation project is based on residual imputation of water values, which means that the combined economic worth of factors of production other than water is subtracted from commodity sales revenues, the difference between the two being assigned to water (Babel *et al.*, 2011). The "residual" method has been widely used to derive economic values of water, especially in irrigated agriculture (Kadigi *et al.*, 2004).

For the production function of the crop output Y produced under irrigation by the factors capital (K), labour (L), and other natural resources like land (R) and water (W); the production function is represented by the relation:

$$Y = \int (K, L, R, W) \qquad \text{(i)}$$

If competitive factor and product markets are assumed (prices can be treated as constants) it then followed that:

$$TVP_Y = (VMP_K \times Q_K) + (VMP_L \times Q_L) + (VMP_R \times Q_R) + (VMP_W \times Q_W) \qquad \text{(ii)}$$

Where;

TVP is total value of product, *Y.*

VMP is the value of marginal product of resource, *i.*

Q is the quantity of resource, *i*.

Assuming VMP = P*i* (value of marginal products equals prices of resources), by substitution and rearrangement of the equation;

$P_W = \{TVP_Y – [(P_K \times Q_K) + (P_L \times Q_L) + (P_R \times Q_R)]\}/ Q_W$.. (iii)

This provides the shadow price of water, P_W, which is essentially the economic value of irrigation water. The Residual Imputation Approach as a model for computing economic value of water was successfully used by Kadigi in the study of economics of irrigated paddy in Usangu Basin in Tanzania (Kadigi *et al*., 2004).

3.5.3 Factors influencing paddy yield in the small scale irrigation schemes

To identify factors influencing paddy yield in the irrigation schemes, multiple regression model was adopted. The factors examined included cultivated plot size, capital invested in farming, irrigation water availability, and access to credit. Only paddy yield was regressed against these factors because paddy is the major crop in Kinyope and Kitere irrigation scheme, maize and vegetables are grown in small scale by only few farmers when irrigation water become too scarce. The relationship for the used regression model to analyse these factors was;

$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \varepsilon$………………………………….………………(iv)

Where;

Y_i is the average paddy production per hectare, *i.e*. yield (Kg/ha)

β_0 is the intercept

$\beta_1, \beta_2, \beta_3, \beta_4$ are the coefficients

X_1 is the cultivated plot size (ha).

X_2 is the capital invested in farming (Tsh).

X_3 is the irrigation water availability (0=Not enough, 1=Enough).

X_4 is the credits accessibility to the farmers (Dummy 0=No, 1=Yes)

ε is the error term (other independent variables not included that influence dependent variable and error due to measurement).

3.5.4 Expected influence of the independent variables on the dependent variables

(i) Cultivated plot size

Farm size is expected to influence paddy yield positively such that the larger the cultivated plot size the better paddy yield to farmers**.** Farming on larger scale has been more efficient than farming on small scale because the cost per unit area has been lower on large farms especially with the introduction of modern farming technology where economies of scale have grown considerably. For instance, mechanisation requires larger area to work on than the small farm, furthermore, agro-input purchase and application is cost effective in large farms than in small ones.

(ii) Capital invested in irrigation farming

Proper and timely farming operations accomplishment as well as timely purchases and application of farm inputs depends on the capital available. Therefore it is expected that capital will influence paddy yield positively such that the great the capital invested in farming the higher yield of paddy.

(iii) Availability of irrigation water in the schemes

Irrigation water availability is expected to be positively influencing paddy yield in Kinyope and Kitere irrigation schemes such that as much irrigation water available the higher paddy yield is obtained. Moisture is a necessary condition for proper growth and development of plants. Lowland paddy (paddy varieties grown in water logged soils as in irrigation schemes) for instance, is very susceptible to moisture deficit such that yield is negatively influenced by lack of enough water.

(iv) Access to credits

It is expected that access to credit give farmers an opportunity to improve their capital hence affect paddy yield positively. Cheap credit is necessary for the farmers to be able to purchase farm inputs and timely accomplishment of farming operations.

The same model was successfully used by Philip (2001) on economic analysis of medium scale agricultural enterprises in a predominantly smallholder agriculture sector where the results revealed that there was positive relationship between gross margin and farm size, education level and access to credit.

Some problems are encountered when regression equation generated by ordinary least square is used. Such problems include heteroskedasticity, multicollinearity and autocorrelation (Gujarati, 1998; Mkojera, 2008). It is likely that production data obtained from cross-sectional research design in this study have heteroskedasticity and multicollinearity problems. With heteroskedasticity, ordinary least squares estimators while still linear and unbiased can no longer provide minimum variance making the least square estimators unreliable, *i.e*. the variance will be large leading to small t-values. The small t-value associated with large variance leads to a situation whereby the explanatory variable' parameters are rejected more frequently than necessary. To contend with this situation in the study, a natural logarithm transformation of the dependent variable data was adopted, because changing the functional form of the model can treat heteroskedasticity problem. Multicollinearity problem is caused by the existence of the linear relationships among the explanatory variable. Symptoms suggesting the existence of the multicollinearity include:

existence of the very high coefficient of determination (R^2), illogical signs of the parameters included in the model and F- ratios being highly significant but most of the individual t-ratios insignificant. Step wise regression method was used to correct for multicollinearity by gradual addition of variables (Moshi, 2007).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Respondents

Studying socio-economic characteristics is important because it provides an understanding of the general behaviour of the farmers in their respective irrigation schemes. The results show that gender participation in irrigation farming is not balanced in the two irrigation schemes. While participation in Kinyope irrigation scheme is 41.3% females and 58.7% males, that of Kitere irrigation scheme is 43.6% females and 56.4% males. This makes an average to be 42.5% females and 57.5% males for the two schemes (Table 2). Both females and males have an opportunity to engage with farming in the schemes despite of the gender imbalance observed. To achieve participation balance, more training effort on gender equality is required to enable more females participate. This is necessary because comparatively, country statistics in agriculture reveals that the sector employs 14.7 million people which are about 79% of the total economically active population where 54% of agricultural workers are females (URT, 2008).

On average, 85.3% of the community in the two irrigation schemes has enough education to be able to catch up basic knowledge and farming skills if such opportunity is provided. This proportion of 85.3% farmers is a total of those with adult education 22.4%, primary education 56.9% and with secondary and post secondary education 6% observed in Table 2. There is also a small proportion of 14.7% farmers in the two studied schemes with informal education. This group can be improved by providing it with proper farming knowledge and techniques through extension services irrespective of their education level as there is also an opportunity of practical knowledge and skills that can be adopted from other farmers in the schemes.

When placed into age groups, an average percentage of youths (below 35 years old), adults (between 35 and 60 years old) and the olds (age above 60 years) is observed to be 34.5, 36.9, and 28.6 respectively (Table 2). This observation is associated with an evolution of a positive altitude among the youths towards agriculture. To most of the youths, rain-fed agriculture is seen not to be a paying activity and therefore keeps away from it and instead, migrate to the cities and towns leaving the business to the adults and olds. In this manner, it is obvious that irrigation farming attracts, encourage and motivate the youths to join the industry. Improvement of the small scale irrigation schemes is therefore a means of retaining youths' labour force in farming activities, avoiding agricultural labour erosion through migration.

Table 2: General sample household characteristics in the irrigation schemes (in %) (N=130)

		Name of the Irrigation scheme		
Item		Kinyope	Kitere	All
Gender	Female	41.3	43.6	42.5
	Male	58.7	56.4	57.5
Education Level	Informal education	9.3	20.0	14.7
	Adult education	26.7	18.2	22.4
	Primary education	52.0	61.8	56.9
	Secondary and post secondary education	12.0	0	6.0
Age groups	Youth (< 35 yrs)	45.3	23.7	34.5
	Adult (35 – 60 yrs)	32.0	41.8	36.9
	Old (> 60 yrs)	22.7	34.5	28.6

4.2 Land Ownership and Allocation to Various Crops in Irrigation Schemes

Different land ownership types exist in different small scale irrigation schemes. Two types of land ownership were observed in the studied schemes namely personal and communal ownership described under section 4.2.1. It is also observed that land allocation to various crops for irrigation farming differs from one scheme to another, though paddy is given with a major part of the land in the schemes. Land is allocated for paddy, vegetables and maize cultivation as described under section 4.2.2.

4.2.1 Land ownership in the small scale irrigation schemes

Table 3 shows how land is owned in small scale irrigation schemes. Among the interviewed farmers at Kinyope small scale irrigation scheme, 89.3% showed that land is personally owned, and that 98.7% of the respondents in this scheme agreed that individual farmers can make decision over their plots on whether to sell to other individuals or not. In Kitere small scale irrigation scheme, majority of the interviewed farmers had an opposite response unlike that obtained at Kinyope irrigation scheme. About 94.5% of the interviewed farmers in Kitere irrigation scheme showed that land is communally owned where an individual farmer, according to 85.5% respondents from this scheme cannot decide to sell their plots.

From this observation, it is noted that, land ownership in irrigation schemes is of different types including personal and communal ownership. In irrigation schemes with communal land ownership, land belongs to the scheme or village community. To obtain a plot, the procedure is that one has to apply to the scheme management and if a plot is available an applicant can be allocated with a plot in the scheme. Farmers continue farming the same plot after land allocation unless fail to comply with the rules and regulations governing the land allocation. When were interviewed, the key informants described some factors whose failure of the farmers allocated with plots to adhere, may lead to one being stopped from farming in the scheme. Some of the factors include farming of the allowed crops, timely land preparation, paying water fees and participating in operation and maintenance. This does not allow uninterested farmers allocated with plots to sell and for the interested farmers to extend their holdings. The communal ownership does not allow land transfer by farmers nor does it lead to the flexible rental markets in irrigated land, creating a barrier for the land to achieve its full productive potential though ensures easy enforcement of rules and regulations.

Furthermore, apart from communal land ownership practiced in some irrigation schemes as observed, other irrigation schemes have private land ownership where farmers can decide what to do with their land, whether to continue farming, renting or selling. This may bring difficulties in stopping farmers from farming in the schemes because of not adhering to the rules and regulations in the schemes unless a certain power is exercised by the leadership to enforce the regulations. Here the advantage is supposed that the land can achieve its full productive potential provided that farming husbandry is followed by farmers since those uninterested farmers from continuing farming can decide to sell the land to those interested.

Table 3: Types of land ownership in the small scale irrigation schemes (in %)

Item		**Name of the Irrigation scheme**		
		Kinyope	**Kitere**	**All**
Type of Land Ownership	Communal	10.7	94.5	46.2
	Personal	89.3	5.5	53.8
Can owned plot be sold to others	Yes	98.7	14.5	63.1
	No	1.3	85.5	36.9

4.2.2 Land allocation for the crop cultivation in small scale irrigation schemes

In both studied irrigation schemes, paddy is the major crop which is grown in 53.5% of the total irrigated land in the irrigation schemes, followed by vegetables particularly tomatoes grown in 25.85% of the land in the schemes and maize which is grown in 20.65% of the total irrigated land. Table 4 which show average areas in percentages grown with different crops, reveals that most farmers allocate more land to paddy than other crops despite the size of these paddy plots owned by an individual farmer to be small as observed in the field that almost most farmers own a half an acre plot. This means that paddy is the most preferred crop and given the first priority by farmers in the small scale irrigation schemes because crops other paddy face market uncertainty as the key informants explained when were interviewed.

If managed properly, small scale irrigation schemes can accelerate the current initiatives of the government to scale up paddy agricultural irrigation and significantly help to achieve the target of increasing annual production of paddy in the country. Of the two grown crops in the schemes other than paddy, tomatoes are allocated with 25.85% of the total land in the irrigation schemes. This implies that vegetables are the second crop in importance grown by farmers in the irrigation schemes. Vegetables particularly tomatoes fetch a good market and its demand seem to expand in the country.

Table 4: Land allocation for various crops in the irrigation schemes (in %)

Type of crops	Name of irrigation schemes		
	Kinyope	**Kitere**	**All**
Paddy	49	58	53.50
Maize	27	14.3	20.65
Tomato	24	27.7	25.85

4.3 Extension Services and Crop Management Practices in Irrigation Schemes

In order to increase crop output in the small scale irrigation schemes, intensive farming rather than extensive farming is deemed necessary. This is because the potential for enlarging the actual areas of farm land is limited. Intensive farming requires farmers to abide on farming practices rather than expanding the farm sizes as in extensive farming.

Such important practices as bund construction, field levelling, correct line spacing, fertilizer application and timely weeding were evaluated in this study. The levels of extension service delivery to farmers were also examined. These practices are delivered to the farmers through extension services which were observed to exist in the studied schemes.

4.3.1 Field management techniques for irrigated paddy in irrigation schemes

Table 5 shows some management techniques practiced in irrigated paddy which include bund construction/repair, field levelling, correct line spacing, fertilizer application and weeding. Bund construction in paddy irrigated farms is practiced by 88% and 87.3% of the farmers in Kinyope and Kitere irrigation schemes respectively, whereby 89.3% farmers in Kinyope and 89.1 farmers in Kitere practice field levelling after bund construction. Out of the total farmers in Kinyope, only 42.7% do transplanting in correct spacing compared to 98.2% farmers in Kitere who transplant in recommended spacing. The level of fertilizer application was also evaluated and observed that only 57.3% of farmers in Kinyope apply fertilizer in their plots whereas in Kitere the technique is practiced by 98.2% of the farmers. Another technique observed was timely weeding of paddy which shows that 85.3% of farmers in Kinyope conduct timely weeding (*i.e*. within 21 days after transplanting) and 91.5% of farmers practice early weeding in Kitere irrigation scheme.

With these observations, it is noted that farmers in different irrigation schemes and within schemes have different performances regarding the farm management techniques. While majority of the farmers within the schemes construct bunds, level their fields, and conduct timely weeding, few farmers don’t construct bunds, not level their plots and/or conduct late weeding. Across different schemes, performance of these practices show variations too.

Only 1.8% of the farmers in Kitere does not use fertilizer and also don't follow recommended plant spacing, but on the other side about 57.3% of the farmers in Kinyope do not use recommended plant spacing, and 42.7% of farmers in this scheme do not make use of fertilizers in their plots.

Farming without proper plant spacing and fertilizer application leads to low yield output. When conducted transect walks across Kinyope irrigation scheme, observed farmers transplanting paddy randomly in their plots. When were interviewed the reasons for not following recommended spacing the response was simply that "transplanting seedlings with correct line spacing is laborious and time consuming procedure which is not necessary". In this situation farmers need to be assisted by the extension workers to follow the recommended spacing and fertilizer application in their fields. Proper plant spacing ensures required plant population rather than random transplanting which usually end up with low plant population per cultivated area. Fertilizer application is essential because of its ability to boost yield even in exhausted soils. Since farmers practice repeated farming in irrigation schemes and often of the same crop without rotation, possibly soil has lost its fertility which necessitate fertilizer application.

Table 5: Field management practices in irrigated paddy (in %)

	Name of the Irrigation scheme		
	Kinyope	**Kitere**	**All**
Band construction			
Yes	88.0	87.3	87.7
No	12.0	12.7	12.3
Field levelling			

Yes	89.3	89.1	89.2
No	10.7	10.9	10.8
Correct line spacing	42.7	98.2	70.5
Yes	57.3	1.8	29.5
No			
Fertilizer application			
Yes	57.3	98.2	77.7
No	42.7	1.8	22.3
Weeding			
Early weeding	85.3	91.5	88.4
Late weeding	14.7	8.5	11.6

4.3.2 Field management practices for crops other than paddy in irrigation schemes

The level of management of crops other than paddy (maize and tomatoes) is generally low as compared to paddy in all studied schemes. Management practices evaluated for these crops include bund repair, field levelling, fertilizer application and frequency of weeding. In all studied schemes, an average of 3.8% of farmers do bund repair or construction, 5.4% of farmers do field levelling, 43.8% of farmers apply fertilizer in their plots and about 43.1% of farmers conduct at most two weeding in their plots (Table 6). These techniques are interdependent to one another such that for a sounding expected results, one needs to employ many techniques at a time.

The observation is clearly showing that very little attention is paid to crops other than paddy grown in irrigation schemes. This observation is based on the fact that all practices are performed by less than half the number of farmers in all schemes. Less attention paid to these crops reduces the yield resulting to low productivity of the schemes. For these small scale irrigation schemes to improve livelihood and well being of individual households, the irrigators should abide to the farming husbandry techniques by making use of those practices to all crops cultivated in their irrigation schemes.

Table 6: Field management practices for irrigated crops other than paddy (in %) (N=130)

Item	Name of the Irrigation scheme		All
	Kinyope	Kitere	
Bund repair	2.7	5.5	3.8
Yes	97.3	94.5	96.2
No			
Field levelling	2.7	9.1	5.4
Yes	97.3	90.9	94.6
No			
Fertilizer application			
Yes	64.0	16.4	43.8
No	36.0	83.6	56.2
Number of weeding			
One weeding	37.3	67.3	50.0
Two weeding	54.7	27.3	43.1
Three weeding	8.0	5.5	6.9

These techniques are interdependent to one another such that for a sounding expected results, one needs to employ many techniques at a time.

4.3.3 Sufficiency of extension services to farmers in the irrigation schemes

Table 7 shows how extension services are obtained by farmers in Kinyope and Kitere irrigation schemes. It shows whether irrigation technicians in the schemes are present or not, farmers' efforts to seek for extension advice and whether extension services in the schemes are sufficient or not. A total of 49.3% of farmers interviewed at Kinyope irrigation scheme ranked the extension services availability as being quite enough and that 61.3% of farmers devote time to seek for extension advice. About 90.7% of farmers agree that irrigation technicians are present in this irrigation scheme. At Kitere irrigation scheme, 52.8% of the respondents ranked extension services to be not enough while 67.3% of the respondents from this scheme seek for extension advice. About 98.2% of the farmers agree that their scheme has irrigation technicians.

From these observations, it is noted that more than half of the total number of farmers in Kinyope and Kitere irrigation schemes devote time to seek for extension services pertaining farming techniques. This is justified by the presence of 61.3% and 67.3% of the farmers in Kinyope and Kitere respectively who are looking to find for the advice on proper farming techniques. This is a good farming attitude that farmers, particularly those in irrigation schemes are expected to behave in order to maximise returns in crop productions.

Presence of agricultural extension personnel such as irrigation technicians is not fully utilized by farmers in Kinyope and Kitere irrigation schemes. Table 7 shows that despite 90.7% and 98.2% of the interviewed farmers from Kinyope and Kitere respectively agreed that extension staffs are present, still 38.7% and 32.7% of farmers in Kinyope and Kitere irrigation schemes respectively don't make use of this opportunity, and yet there are 26.7% and 52.8% of farmers from these respective schemes claim that the extension services to farmers are not enough.

Table 7: Extension services provision in small scale irrigation schemes in %

Item	Name of the Irrigation scheme		
	Kinyope	**Kitere**	**All**
Presence of the irrigation technicians			
Yes	90.7	98.2	93.8
No	9.3	1.8	6.2
Effort to seek for extension advise			
Yes	61.3	67.3	64.3
No	38.7	32.7	35.7
Sufficiency of extension services			
Quite enough	49.3	14.5	31.9
Partially enough	24.0	32.7	28.35
Not enough	26.7	52.8	39.75

4.4 Crop Profitability in Small Scale Farmers' Managed Irrigation Schemes

Total revenue from crops in Kinyope and Kitere irrigation schemes as shown in Table 8 are 2 499 985 Tsh/ha at Kinyope and 3 990 535 Tsh/ha at Kitere irrigation schemes. To obtain this revenue, a total cost of 1 738 434 Tsh/ha at Kinyope and 2 663 671 Tsh/ha at Kitere irrigation schemes were incurred. Total cost included fixed and variable costs which were 1 563 434 Tsh/ha and 175 000 Tsh/ha for variable and fixed cost respectively in Kinyope, and 2 058 671 Tsh/ha of variable cost and a fixed cost of 605 000 Tsh/ha at Kitere irrigation scheme. The average crop profitability for the two schemes per hectare is observed to be 1 044 207 in Tanzanian shillings. Crop profitability for Kinyope irrigation scheme as shown in Table 8 is 761 550 shillings per hectare, whereas that of Kitere irrigation scheme is 1 326 864 Tsh/ha. In the study on economic analysis of small scale irrigation schemes conducted in Mombo, Kivulini and Lekitatu, Mkojera (2008) obtained the results which showed the respective profitability to be 841 428 Tsh/ha, 1 276 518 Tsh/ha and 1 263 198 Tsh/ha. Comparing these findings to those obtained in the present study in Kinyope and Kitere, it can be observed that profitability of Kinyope is relatively low than in other schemes whereas that of Kitere is higher. In other words, this implies that performance of Kinyope irrigation scheme is low whereas that of Kitere is higher than all other schemes. Ignoring these variations in profitability among the schemes while considering positive magnitude and the obtained profitability levels which seem to be fairly good, it is convincingly to say that small scale irrigation schemes performs better in terms of crop profitability.

Higher profitability is realized from paddy than in any other crop justifying that paddy is the major crop in Kinyope and Kitere as in many other small scale irrigation schemes. Differences in profitability levels in Kinyope and Kitere irrigation schemes are contributed by several factors. Some of the factors for profitability level difference include how agro-inputs are committed in farming in a given scheme and the proper use of many field management practices by individual farmers in the respective schemes. These factors all together have a positive impact to the crop output in the farm enterprise if are correctly employed.

Cultivation in Kinyope irrigation scheme is typically by the use of hand hoes commonly used in Mtwara and Lindi which is called by the indigenous name "*Chingondolo*". This type of a hand hoe is small in size such that its efficiency in terms of ability in tilling the land and the size of cultivated plot per man day is very small. The difference in profitability is associated to be due to yield differences caused by the differences in the employed levels of field management techniques. Field management techniques such as correct plant spacing and fertilizer application in paddy production as observed under the section of field management techniques for irrigated paddy summarised in Table 5, are not properly practiced by many farmers in Kinyope irrigation scheme where 57.3% of the farmers don't use correct plant spacing as they are practicing random transplanting. This implies that plant population in their paddy plots is small. Again about 42.7% of the farmers in this scheme don't apply fertilizer in their paddy plots. The observation is also associated with the low levels of field management techniques such as bund construction/repair, field levelling and early weeding practices for crops other than irrigated paddy as summarised in Table 6.

Table 8: Farm enterprise budget for paddy, maize and tomatoes

	Irrigation schemes		
Item	**Kinyope**	**Kitere**	**Average**
Revenue from sales of crops per Ha			

(Tsh)			
Average revenue per household from paddy	740 300.00	2 676 920	1 708 610
Average revenue per household from maize	46 2 980.00	228 290.	345 635
Average revenue per household from tomato	1 296 705	1 085 325	1.191 015
Total revenue	2 499 985	3 990 535	3 245 260
Costs per Ha (Variable costs in Tsh)			
Seeds	148 518	161 290	154 904
Fertilizer	137 832	101 427	119 629
Insecticides	38 446	45 483	41 965
Family labour	536 890	670 907	603 898
Hired labour	701 746	1 079 563	890 654
Cost per Ha (Fixed costs in Tsh)			
Water charges	-	5 000	5 000
Land value	175 000	350 000	262 500
Depreciation	-	250 000	250 000
Total costs	1 738 434	2 663 671	2 201 053
Profitability	761 550	1 326 864	1 044 207

4.5 Farmers Perceptions Regarding the Impact of the Scheme on their Incomes

Many farmers in all studied irrigation schemes accepted that their income is increasing since started irrigation farming. When farmers were interviewed about their income from irrigation farming, the response from many farmers was that there is an increasing income received from irrigation farming.

In Kinyope irrigation scheme, 85.3% of the farmers have their income increasing and only 14.7% of the farmers observed no significant change of the income. In Kitere irrigation scheme, income trend for 81.8% of the farmers is increasing whereby the remaining 18.2% of the total farmers have a constant income trend.

The observation shows that irrigation is a means of improving income for majority of farmers in rural areas where agriculture dominate as the major income generating activity. On average, 83.8% of the total farmers in all schemes have increasing income from crop production and only a small proportion of about 16.2% of the total farmers in these schemes have not experienced an increasing income. This implies that irrigation development is a reliable strategy to raise farmers' income because can significantly reduce key crop production risks associated with unreliable rainfall.

4.6 Economic Value of Irrigation Water in Small Scale Irrigation Schemes

The value of irrigation water was calculated in all two schemes for only paddy because it was the identified major crop in the schemes. If crops other than paddy were used to calculate the value of irrigation water, the value to be obtained would not truly reflect the economic value of irrigation water since these crops didn't use water with a good return. Table 9 shows an average value of irrigation water in the two studied schemes to be 14.04 Tsh/m^3 of irrigation water. Kitere irrigation scheme has a high estimated economic value of irrigation water of 22.87 Tsh/m^3compared to that of Kinyope which is 5.20 Tsh/m^3. A study on the economics of irrigated paddy in Usangu basin by Kadigi *et al*. (2004) revealed the average value of irrigation water to be 26.81 Tsh/m^3 of water which is higher than in the two studied schemes. An average productivity of irrigation water (paddy produced per drop of water) for the two schemes is 0.04 kg/m^3 which is very low compared with the one obtained in Usangu basin in 2004 in the study by Kadigi on the economics of irrigated paddy which was observed to be 0.18 kg/m^3 and with the average productivity value of irrigation water for Sub Sahara African countries (SSA) which is about 0.25 kg/m^3 (Kadigi *et al*., 2004). These results implies that small scale irrigation schemes, Kinyope and Kitere in this case, have low paddy produced per drop of water than that in large scale irrigation schemes like the case in Usangu basin or those in Sub Saharan African countries.

Though Kinyope and Kitere are all the farmers managed small scale irrigation schemes, there is a great variability of the value of irrigation water. It is observed that the variation in economic value of irrigation water between the two studied schemes is much contributed by the level of revenue obtained in these schemes. Since the average price per kilogram of paddy was the same, the difference in revenue from paddy in the two schemes is caused by their difference in yields. Yields difference between these two small scale irrigation schemes is caused by the differences in the employed levels of field management techniques including correct plant spacing and fertilizer application as summarised in Table 5. The difference in paddy yields seem also to be a contributing factor for the low water productivity between the two schemes but also between these schemes compared to water productivity obtained in Usangu basin in 2004 and that in SSA (Kadigi *et al*., 2004).

Table 9: Estimated value of paddy irrigation water in the small scale irrigation schemes

	Irrigation Scheme		
Parameter	**Kinyope**	**Kitere**	**All**
Average revenue from paddy per season (Tsh)	740 300	2 676 920	1 708 610
Average cost for non - water inputs per season (Tsh)	324 790	308 201	316 496
Average residual revenue attributable to water (Tsh)	415 510	2 368 719	1 392 114
Estimated seasonal water demand (m^3)	79 905	103 552	91 728
Estimated average value of irrigation water (Tsh/m^3)	5.20	22.87	14.04
Average paddy yields (Kg/Ha)	1 480.60	5 353.85	3 417.23
Estimated average water productivity (Kg/m^3)	0.02	0.05	0.04

4.7 Regression Analysis Results for the Factors Influencing Paddy Yields

Regression analysis was adopted to investigate factors influencing paddy yields in small scale farmers' managed irrigation schemes. Model diagnostics was done to test for misspecification errors. The investigated variables included cultivated plot size, capital invested in farming, irrigation water availability in the schemes, and access to credits to the farmers.

It can be noted from the results in Table 10 that all coefficients, as expected, were positively related to the paddy yield. The coefficient of determination (R^2) is 76.8%, meaning that the independent variables all together account for 76.8 percent of the total variations in the paddy yields. On the other hand the results suggest that 23.2 percent of the variations in the paddy yields are attributed by other factors not included in the model. The results show that all coefficients were positively related to the dependent variable, and that collectively the estimated variables were statistically significant ($P<0.05$).

- **Cultivated plot size in the irrigation schemes**

  Cultivated plot size whose coefficient sign is positive, had significant relationship with paddy yields ($P<0.05$) meaning that it influences the paddy yields significantly. Philip (2001) in his study on economic analysis of medium scale agricultural enterprises in a predominantly smallholder agriculture sector found similar results between the size and profitability. The relationship was associated with the widening of capital bases which are known to have positive influence on farm productivity. Relatively, wider capital bases enable farmers to access inputs like herbicides and fertilizers and to carry out field agronomic practices easily and in time which in turn the paddy yield is increased.

- **Capital invested in irrigation farming**

This variable is positively related and has significant influence on paddy yields (at $P<0.05$) in Kinyope and Kitere irrigation schemes. Capital can be invested in technology adoption. As farmers invest more in adopting new technologies in irrigation farming, paddy yields is positively influenced which in turn the income increases, resulting into poverty level and food insecurity among poor farmers reduced.

- **Credit access to the farmers in the irrigation schemes**

The variable farmers' access to credits observed to be positively related and at 5% significance level influence paddy yields in Kinyope and Kitere irrigation schemes. This relationship between access to credits from financial institutions and paddy yields is likely due to the fact that credits can be used by the farmers to access improved inputs such as fertilizers, herbicides and seeds. If properly used in the farm enterprises, improved farm inputs positively influence crop yields particularly paddy under irrigated agriculture.

- **Irrigation water availability in the irrigation schemes**

Irrigation water availability in Kinyope and Kitere irrigation schemes was observed to be significantly influencing paddy yields and as well positively related. Irrigation water is essentially vital requirement for any irrigation scheme to exist and farmers to realise expected output. Ashimogo (2007) noted that irrigable land is only useful in combination with secure access to irrigation water. Yields are expected to be increased if irrigation water is available in the irrigation schemes and provided that farmers efficiently make use of it with combination of other field agronomic practices.

Table 10: Regression analysis results for the two small scale irrigation schemes

Variable	Coefficient	Std Error	T-ratio	Significance
Intercept	2.1377	0.6282	3.4027	0.8946
Plot size	0.0575	0.0376	1.5280**	0.0016
Capital invested	0.0318	0.0035	16.4317*	0.0271
Irrigation water	0.0862	0.0545	1.7254*	0.0342
Credit access	0.0250	0.02341	0.4367*	0.0432

Dependent variable: Natural logarithm for the average paddy yields in the schemes

Note: R^2 = 76.8%, Adjusted R^2 = 75.4%, F-value = 67.9**,*Significant at 5% and **Significant at 1%

4.8 Associations and Credit Accessibility in Small Scale Irrigation Schemes

The studied irrigation schemes are managed by farmers through their registered water users associations (WUAs). In both the schemes farmers are expected to be the members in these associations. Whether joining in the WUA or not remains to be an individual decision. Table 11 shows how individual farmers get involved in the irrigation associations of the respective schemes and credit accessibility. About 77.3% of the farmers in Kinyope irrigation scheme are the members in the WUA whereas 22.7% of the remaining farmers are not the members. In Kitere irrigation scheme, all farmers, *i.e*. 100% of the interviewed farmers are the members in their association. With credit accessibility, 96% of the interviewed farmers in Kinyope irrigation scheme responded to have no access to credits from any financial institution for their farming activities. Likewise in Kitere, about 96.4% of the farmers responded to have no credits access. Otherwise the observation implies that only 4% and 3.6% which are very small proportions of the total farmers in the respective schemes had an access to the credits. This implies that some farmers do not find it necessary to join with the farmers association established in their schemes, and that cheap credits are only available to very few small-scale farmers practicing irrigation farming in the small scale irrigation schemes. One of the national irrigation policy statements states "to provide technical facilitation for farmers to form Irrigators Organisations for management of their irrigation schemes as a step towards commercialisation and participation in the market economy". WUAs in irrigation schemes enable farmers to participate in decision making regarding planning, management and implementation of their farming activities. It is a tool which can collectively raise their voices.

It is also noted that Kinyope and Kitere irrigation schemes are facing problems on cheap credits availability. Abedullah *et al*. (2009) described that credit is a back bone for any business and so for agriculture which has traditionally been a nonmonetary activity for the rural population. In developing countries like Tanzania where most farmers are poor, cheap credits (credit available at low rates of interest) are necessary to enhance technologies adoption by small-scale farmers. Examples of these technologies that can be obtained through cheap credits in irrigation farming include agricultural inputs like improved seeds, fertilizers, pesticides and herbicides. Cheap credits shall enable farmers purchase and use processing machines for paddy and other crops grown in the schemes, adding values to these produces which in turn raise income levels of farmers, as such the government should make sure that enough subsidies are timely available to the farmers.

Table 11: Membership in irrigation associations and credit availability (in %)

	Name of the Irrigation schemes		
	Kinyope	**Kitere**	**All**
Membership in water users' associations			
Yes	77.3	100.0	86.9
No	22.7	0	13.1
Credit availability			
Yes	4.0	3.6	3.8
No	96.0	96.4	96.2

4.9 Benefits Obtained and Problems Facing Households in the Irrigation Schemes

Several benefits have been obtained by farmers from irrigation farming in their schemes. From the studied schemes, the benefits included the ability of the households to meet food requirements throughout the year, construction of good family houses, to meet health requirements, education and clothing for the family members. Farmers in these schemes are also facing some problems including broken irrigation infrastructures, dirty canals and drainage systems, high price of agro-inputs, unimproved irrigation infrastructures, untimely arrival of subsidized agro-inputs, inadequate farming techniques and lack of efficient markets for their produces.

4.9.1 Benefits derived from irrigation farming

Fig. 2 shows different kinds of benefits that farmers in both studied schemes have obtained from irrigation farming. Many of the interviewed farmers, *i.e.* 87 farmers which are about 66.9%, are food secured due to their engagement in irrigation agriculture. However, some other benefits have been noted to be obtained by farmers apart from the food security to most of the farmers. These benefits include construction of better houses, being able to meet education expenses to the family members, payment of health fee expenses, and to meet clothing expenses to the family members. The statistics presented in Fig. 2 shows that 26 farmers (20%) out of the total interviewed farmers managed to build better houses for their families, 12 farmers (9.2%) managed to pay family education expenses, 4 farmers (3.1%) have been able to pay for health expenses, 1 farmer (1%) met clothing requirement for the family members and 17 farmers (13%) obtained both benefits.

Irrigation development through small scale irrigation schemes can be used to implement the government's strategy stressed on attainment of national food security, increased productivity and income to the people. This is because majority of farmers under small scale irrigation farming derive food requirements as well as improving their livelihoods by achieving basic needs for their household requirements including education, housing, health and clothing through irrigated agriculture.

Self sufficiency in food production enhances the national sovereignty, freedom and security. It also allows the nation to have an opportunity to spare more resources for planning and implementing development interventions to its people (URT, 2010). The development of irrigation sector has an unprecedented opportunity to facilitate the Tanzania agriculture sector to be transformed from subsistence to a modern and highly commercial sector.

Figure 4: Benefits derived from farming in the small scale irrigation schemes

4.9.2 Problems facing farmers in the irrigation schemes

Farmers in Kinyope and Kitere are faced by some constrains. Some of the constraints that farmers in these two schemes are facing include high price of agro-inputs, unimproved irrigation infrastructures, untimely arrival of subsidized agro-inputs, inadequate farming techniques, lack of efficient markets for agricultural produce, broken irrigation infrastructures and dirty canals and drainage. Many farmers provided multiple responses when were interviewed about the problems facing their schemes as shown in Tables 12 and 13.

4.9.2.1 Problems facing farmers in Kinyope irrigation scheme

In Kinyope irrigation scheme respondents described several problems that reduce the crop output. Interviewed farmers provided multiple responses on the problems facing Kinyope irrigation scheme as shown in Table 12. Unimproved irrigation infrastructures especially weirs and drainage canals is a major problem. About 50.7% respondents described that their scheme is facing the problem of having unimproved irrigation infrastructures which was also observed during transect walk around the plots in the scheme. This problem results into a loss of much water before reaching the farmers' plots. Inadequate farming techniques is a constrain which scored the second by 46.7% responses. Proper agronomic practices such as correct plant spacing, use of improved seed varieties, timely transplanting and fertilizer application are not practiced by many farmers. For instance, Table 5 shows that 57.3% of the farmers don't use correct plant spacing instead are practicing random transplanting. Again about 42.7% of the farmers in this scheme don't apply fertilizer in their paddy plots. Lack of efficient market for agricultural produces, high price of agro-inputs like improved seed varieties and untimely arrival of subsidized agro-inputs to the farmers, are the other problems facing farmers in this scheme.

Table 12: Some of the problems facing farmers in Kinyope irrigation schemes (N=75)

Problems facing farmers	Frequency	Percentage	Percentage of responses
High price of agro-inputs like seeds, fertilizers and herbicides	25	16.9	33.3
Unimproved irrigation infrastructures (weirs, canals)	38	25.7	50.7
Untimely arrival of subsidized agro-inputs	21	14.2	28.0
Inadequate farming techniques	35	23.6	46.7
Lack of efficient markets for agricultural produces	29	19.6	38.7

4.9.2.2 Problems facing farmers in Kitere irrigation scheme

Several problems were observed during transect walk around Kitere irrigation scheme. Unlike Kinyope irrigation scheme where most irrigation infrastructures are not improved, Kitere irrigation scheme has improved infrastructures but most of them are broken and dirty. Table 13 shows that broken irrigation infrastructures (like drainage canals) and dirty canals are the major problems facing farmers in this scheme. It is observed that about 56.4% respondents in Kitere irrigation scheme pointed out these two problems as their major constrain. As such, there is a great shortage of water in most of the farmers' plots with most plots being unable to be irrigated during dry season, *i.e.* only few farmers with their plots close to the head are able to irrigate during dry season. Untimely arrival of subsidized agricultural inputs like fertilizers and improved seed varieties is observed to face farmers in this scheme, where about 45.5% of respondents pointed this constrain.

Late coming of subsidized agricultural inputs like improved seeds varieties for instance, result into the use of local seed varieties obtained from the stock of the previous harvest since most of the farmers can't afford to buy unsubsidized inputs sold at a relatively high market price according to 40% respondents. Other problems facing farmers in this scheme are the lack of efficient markets for agricultural produces, inadequate farming techniques and unimproved irrigation infrastructures. All these problems play a part in reducing the output in Kitere irrigation scheme.

Table 13: Some problems facing farmers in Kitere irrigation scheme (N=55)

Problems facing farmers	Frequency	Percentage	Percentage of responses
Broken irrigation infrastructures (drainage, canals)	31	23.3	56.4

High price of agro-inputs like seeds fertilizers and herbicides	22	16.5	40.0
Dirty canals and drainage	31	23.3	56.4
Unimproved irrigation infrastructures (weirs, canals)	1	0.8	1.4
Untimely arrival of subsidized agro-inputs	25	28.8	45.5
Inadequate farming techniques	5	3.8	9.1
Lack of efficient markets for agricultural produces	18	13.5	32.7

CHAPTER FIVE

5.0 CONCLUSSION AND RECOMMENDATIONS

5.1 Conclusion

The major objective of this study was to investigate the economic performance of the small scale farmers' managed irrigation schemes of Kinyope and Kitere found in Lindi and Mtwara districts so as to establish how such schemes could be used to improve the performance of the agriculture sector in the country. The specific objectives of the study were:

i. To examine economic performance of Kinyope and Kitere small scale farmers' managed irrigation schemes in terms of crops profitability.
ii. To assess economic value of irrigation water in Kinyope and Kitere small scale farmers' managed irrigation schemes.
iii. To identify technical and institutional factors influencing paddy yields in Kinyope and Kitere small scale farmers' managed irrigation schemes.

For the first objective, by the use of farm enterprise budget analysis model, the study observed that the average profitability for the two schemes is 1 044 207 shillings per hectare. Crop profitability of Kinyope and Kitere irrigation schemes are 761 550 and 1 326 864 Tsh/ha respectively. Following a positive value of profitability, and an average of 1 044 207 Tsh/ha received which is fairly good, it is concluded that small scale irrigation schemes perform better in terms of crop profitability.

The second objective was to assess economic value of irrigation water in Kinyope and Kitere small scale farmers' managed irrigation schemes. This objective was tested using the Residual Imputation Approach model. The model test is based on determination of average economic value of water and the average water productivity. The average value of irrigation water observed to be 14.04 Tsh/m^3 and the average water productivity in these schemes was 0.04 kg/m^3. The average economic value of irrigation water was compared to economic value of irrigation water from other schemes like 26.81 Tsh/m^3 of water in Usangu basin obtained by Kadigi *et al*. (2004). Furthermore, the value 0.04 kg/m^3 for the average water productivity of these two schemes was compared to 0.12 kg/m^3 and 0.25kg/m^3 water productivity values for Usangu by Kadigi *et al*. (2004) and for SSA respectively. This comparison showed the values from the studied irrigation schemes to be very low and concluded that irrigation water in small scale irrigation schemes has no appreciable economic value.

The third specific objective which is to identify technical and institutional factors influencing paddy yields in Kinyope and Kitere small scale farmers' managed irrigation schemes was tested by employing multiple linear regression analysis model. Average paddy production per hectare (yield) was regressed against factors including cultivated plot size, capital invested in farming, irrigation water availability, and access to credits. The results revealed that at 95% confidence interval paddy yields is significantly affected by the regressed variables. All independent variables were positively related and statistically significant. It is concluded that cultivated plot size, capital invested in farming, irrigation water availability, and access to credit significantly influence paddy yields in Kinyope and Kitere irrigation schemes.

The study observed that small scale irrigation schemes largely contribute to the household food security and extreme poverty reduction. For example, 87% of the interviewed farmers are food secured throughout the year and yet an average profitability of 1 044 207 shillings is generated by a household per hectare cultivated in the irrigation schemes. This implies that, improving farming in small scale irrigation schemes ensures food security and poverty alleviation to the farmers in these schemes and nation at large.

5.2 Recommendations

The following recommendations are given to the responsible authorities with regards to the observations obtained during this study.

i. The government should organise the financial institutions and NGO's to provide farmers in irrigation schemes with cheap credits for them to access improved technologies in farming such as agro-inputs and farming tools and implements. This shall also enable farmers manage to carry out the appropriate agronomic practices at appropriate time unlike the situation prevailed in the Kitere and Kinyope irrigation schemes as shown in Table 11.

ii. Local government in respective district councils should facilitate the farmers through their irrigation associations to carry on regular rehabilitations of water distribution infrastructures and supervise schemes' management committees in collection and expenditure of water fees and the daily management of the schemes. Many farmers in Kitere and Kinyope irrigation schemes are members in their respective WUAs as in Table 11, but seems not well organised to maintain the infrastructures in their schemes since most of them are damaged or dirty as observed during field visit especially those in Kitere.

iii. Farmers should be given on – farm trainings and study visits to the relatively improved irrigation schemes. During these training and visits, emphasis should be on proper irrigated crop management husbandry, use of improved farming tools and equipments like power tillers and tractors such that farmers can adhere to the farming techniques and shift from the use of indigenous hand hoes commonly known as *chingondolo* as observed to be used all over the studied schemes. This is because of the observed tendency among farmers in who do not make use of proper correct line spacing, bund construction, field levelling, fertilizer application and early weeding with frequency being larger in Kinyope as Table 5 shows.

iv. Local government should ensure small scale farmers' managed irrigation schemes have sufficient agricultural extension staffs. The local government should also ensure the efficient utilization of the available extension staffs by the farmers, that is, farmers should create an effort of obtaining services from these staffs. Extension staffs availability in Kinyope and Kitere irrigation schemes not only are not enough but many farmers don't make use of the available staffs by seeking advices on good agricultural practices as shown in Table 7.

v. The government should continue with the efforts of expanding schemes size in order that more farmers access land for irrigated agriculture. The expansion of the schemes shall also enable farmers practising irrigated agriculture to expand plot size for them to realise good net profit which can ultimately reduce poverty. Although most the irrigated land is allocated for the paddy cultivation both in Kinyope and Kitere irrigation schemes as Table 4 shows, the field visit in these schemes revealed small plots owned and cultivated with paddy by an individual farmer. Most of the farmers own about half an acre plot for paddy cultivation. Such a plot size is small for the farmers to realize good profit from irrigation farming

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APPENDICES

Appendix 1: Questionnaire for Farmers

Questionnaire No……………….

Date of Interview………………..

A. General Information

1. Name of the Scheme……………………………………………………..
2. Gender of the respondent; 1 = Female, 2 = Male ( )
3. Age of the respondent in years; ( )

4. Education level of the respondent?
    i. Informal education ( )
    ii. Adult education ( )
    iii. Primary education ( )
    iv. Secondary and above ( )

B. Land ownership and Value

5. What type of land ownership exist in the scheme; 1 = communal, 2 = private ( )
6. What is the total size of the plot you cultivated in the scheme during 2009/2010 season…………………… acres
7. Can you sell the plot you own to another person? 1=YES, 2=NO ( )
8. What was the price of renting one acre plot in 2009/10 season? …… Tshs
9. How much money have you spent in 2009/10 season as capital in farming activities …………Tshs

C. Information on income from crops

10. What was the crop production you obtained in 2009/10 season?..........Kgs

s/n	Type of crop	Area grown (acres)	Variety	Total harvest
1.	Rice			
2.	Maize			
3.	Tomatoes			

11. Crops marketing 2009/10 season

S/n	Type of crop	Unit of measure	Unit prices	Total value
1.	Paddy			
2.	Maize			
3.	Tomatoes			

12. What amount did you spent as production costs for paddy?

a. Input (material) costs

S/n	Item/Operation	Costs
i.	Variety	
ii.	Size of the plot/field cultivated (acres)	
iii.	Cost of seeds	
iv.	Costs of fertilizers	
v	Insecticides costs	
vi.	Water charges	
vii.	Other costs	

b. Labour costs for Paddy:

S/n	Item/Operation	Hired Labour used (man days)	Family labour (man days)	Costs per man day
i.	Size of the plot/field (acres)			

ii.	Land clearing			
iii.	Bund repairing			
iv.	Ploughing			
v	Paddling			
vi.	Nursery preparation			
vii.	Field levelling			
viii.	Transplanting			
ix.	Weeding			
x.	Fertilizers application			
xi.	Insecticides application			
xii	Bird scaring			
xiii.	Harvesting			
xiv.	Transportation from the field			
xv.	Other charges			

13. Production costs for other crops

a. Inputs (material) costs

	Item	**Maize**	**Peas (Cow peas)**	**Vegetables**
i.	Size of the plot/field			
ii.	Cost of seeds			
iii.	Costs of fertilizers			
iv	Insecticides costs			
v.	Water charges			
vi.	Other charges			

b. Labour (Hired) costs

	Item	**Maize**		**Peas (cow peas)**		**Vegetables**	
		Man-days	Cost per Man-day	Man-days	Cost per Man-day	Man-days	Cost per Man-day
i.	Size of the plot/field						
ii.	Land preparation						
iii.	Ploughing						
iv.	Planting						
v	Costs of Weeding						
vi.	Costs of fertilizers application						
vii.	Insecticides application						
viii	Harvesting						

ix.	Transportation from the field						
x.	Other charges						

a. Labour (Family) costs

	Item	**Maize**		**Beans**		**Vegetables**	
		Man-days	Cost per Man-day	Man-days	Cost per Man-day	Man-days	Cost per Man-day
i.	Size of the plot/field						
ii.	Land preparation						
iii.	Ploughing						
iv.	Planting						
v	Costs of Weeding						
vi.	Costs of fertilizers application						
vii.	Insecticides application						
viii	Harvesting						
ix.	Transportation from the field						
x.	Other charges						

D. Benefit from farming in the scheme

18. What are the benefits you get from the scheme?

i. Food security

ii. Managed to build good house

iii. Able to meet health requirement for the family

iv. Able to meet education requirement for the family

v. Able to meet dressing requirement

vi. Others (specify) ………………………………… (   )

19. What is the trend of your income from farming activities in the scheme?

i. Increasing

ii. Decreasing

iii. No change

E. Farming techniques for Rice

20. Did you repair/construct plot bund before ploughing or paddling?1=Yes 2=No
21. Did you level your field at paddling? 1=Yes, 2=No ( )
22. Did you transplant in line? 1=Yes, 2=No ( )
23. How many days after transplanting do you conduct 1st weeding? ( ) days
24. Do you use fertilizer in rice cultivation? 1=Yes, 2=No ( )
25. Do you pay for irrigation water used in crop production in the scheme? 1=Yes 2=No ( )
26. How much did you pay for irrigation water in 2009/2010…………….Tsh.
27. Was the irrigation water sufficient to make the crop grow well
    i. Quite enough
    ii. Partially enough
    iii. Not at all ( )

F. Farming techniques for other crops

28. Did you repair/construct plot bund before ploughing 1=Yes, 2=No ( )
29. Did you level your field at before planting? 1=Yes, 2=No ( )
30. How many times did you conduct weeding? ( ) times
31. Do you use fertilizer? 1=Yes, 2=No ( )
32. Was the irrigation water sufficient to make your crop mature well?
    i. Quite enough
    ii. Partially enough
    iii. Not at all ( )

G. Information Base on irrigation Farming techniques in the scheme

33. Do you know how to construct farm bands? 1=Yes, 2=No ( )
34. Do you know how to level your farm plots? 1=Yes, 2=No ( )
35. Do you know water requirements for various crops? 1=Yes, 2=No ( )

36. Do you know the importance of the improved seeds in agriculture?

1=Yes, 2=No (   )

37. Are you aware of the importance of timely weeding? 1=Yes, 2=No (   )

H. Other information

38. Are you a member of the farmers' organization in the scheme?

1=Yes, 2=No   (   )

39. Are there farmers who are not members of the organisation in the scheme? 1=Yes, 2=No (   )

40. If Yes, what reason makes them not members in the organisation?………………

41. Is there any contribution required to be paid by the members in the organization?

1=Yes, 2=No (   )

42. Are there any irrigation technical personnel in the scheme? 1=Yes, 2=No (   )

43. On your opinion, are the technical advices or services provided adequate?

i. Completely adequate

ii. Partially adequate

iii. Not adequate (   )

44. Are there any organization providing credits in terms of capital, inputs, operation services etc. to farmers' in the scheme? ; 1 = No, 2 = Yes (   ).

41. What kind of machineries did you use in the field 2009/10 season?

………………………………………………………………………………………

42. What are the problems related to the scheme leadership and operation? ………………

43. What are the problems related to the infrastructures and water management?................

44. What problems related to water distribution and management that limits farmers' efforts in the irrigation scheme?...

45. In your opinion, provide suggestions on what should be done in your scheme by the government and other stakeholders in order to improve irrigation performance……………………………………………………………………………………

THANK YOU FOR YOUR RESPONSE.

Appendix 2: Questions (Checklist) for the Irrigation Zonal office

1. What are the obligations of the irrigation zone office towards improving performance of the farmers managed irrigation schemes?
2. What kinds of organization are you advocating that farmers should form and why?
3. Do the farmers involve in O&M activities of the schemes found in this zone?
4. Is it necessary that every scheme get the water right? Why?
5. Who is responsible to make sure that the scheme gets the water right?
6. What is the estimated annual water demand (in m^3) for the following schemes?;

   (a) Kinyope...

   (b) Kitere..
7. What are the problems (technical or managerial) facing the following irrigation schemes located in your zone;

   (a) Kinyope irrigation scheme;

   ....

   ....

   ....

   Kitere..

   ....

   ....

   ....

THANK YOU FOR YOUR COOPERATION

Appendix 3: Labour and input costs

Irrigation Scheme	Crop	Average Area (Ha)	Seed Cost	Seed Cost/ Ha	Fertilizer Cost	Fert.Cost/ Ha	Pestcide Cost	Pestcide Cost/Ha
Kinyope	Paddy	53.2	2,050,000	38,533.83	1,352,500	25,422.93		
	Maize	26	949,000	36,500	1,277,000	49,115.38		
	Tomato	26.4	1,940,000	73,484.85	1,670,973	63,294.43	1,014,998	45,483
		Total	4,939,000	148,518	4,300,473	137,832	1,014,998	45,483
Kitere	Paddy	26	974,000	37,461.54	1,667,000	64,115.38		
	Maize	6.4	126,964	19,838.28	212,500	33,203.13		
	Tomato	12.4	1,289,490	103,991.13	50,948	4,108.71	563,990	45,483
		TOTAL	2,390,454	161,290	1,930,448	101,427	563,990	45,483

TYPE OF LABOUR	IRRIGATION SCHEME	CROP	AVERAGE CULTIV. AREA (Ha)	LAND PREPARATION		BAND PREPARATION		PLOUGHING		PADDLING		NURSERY PREPARATION		FIELD LEVELING	
				Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha
CASUAL	KINYOPE	PADDY	53.2	-	-	1 184 000	22 255.64	4 912 904	92 347.82	1 517 844	28 530.90	18 000	338.35		
FAMILY			53.2	-	-	1 230 641	23 132.35	281 600	5 293.23	2 648 400	49 781.95	1 295 001	24 342.12		
CASUAL	KITERE	PADDY	26	60 000	2 307.69	563 000	21 653.85	2 520 003	96 928.19	483 038	18 578.38	59 000	2 269.23	15 000	576.92
FAMILY			26	-	-	1 225 021	47 116.19	-	-	935 000	35 961.54	612 006	23 538.69	210 000	8 076.92
TRANSPLANTING		WEEDING		FERTILIZER APPLICATION		BIRD SCARING		HARVESTING		TRANSPORTATION COST		Total cost			
Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Cost/ha			
2 795 923	52 554 . 94	576 000	10 827.07	18 000	338.35	778 959	14 642.09	3 021 918	56 802.97	1 126 035	21 166.07	299 804.35			
1 209 000	22 725.56	2 113 515	39 727.73	743 034	13 966.80	4 979 000	93 590.23	705 800	13 266.92	357 000	6 710.53	292 537.53			
3 000 007	115 384.88	5 142 000	197 769.23	11 000	423.08	205 050	7 886.54	3 850 024	148 077.85	382 537	14 712.96	626 563.80			
265 000	10 192.31	970 045	37 309.42	512 506	19 711.77	2 940 500	113 096.15	2 087 000	80 269.23	517 600	19 907.91	395 179.91			

TYPE OF LABOUR	IRRIGATION SCHEME	CROP	AVERAGE CULT. AREA (Ha)	LAND PREPARATION		PLOUGHING		SOWING		WEEDING		FERTILIZER APPLICATION	
				Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha
CASUAL	KINYOPE	MAIZE	26	180 000	6 923.07	2 322 007	89 307.96	620 003	26 846.26	160 000	6 153.84	75 000	2 884.61
FAMILY			26	-	-	40 000	1 538.46	40 071	1 541.19	1 139 012	43 808.15	252 000	9 692.31
CASUAL	KITERE	MAIZE	6.4	324 000	50 625	125 051	19 539.22	180 040	28 131.25	180 000	28 125	47 000	7 343.75
FAMILY			6.4	20 000	3 125	-	-	35 051	5 476.72	207 043	32 350.47	50 000	7 812.50
HARVESTING		TRANSPORT. COST		TOTAL									
Total Cost	Cost/ha	Total Cost	Cost/ha	Cost/ha									
20 000	769.23	20 000	769.23	130 654.23									
851 004	32 730.92	848 003	32 615.50	121 926.53									
60 000	9 375	52 000	8 125	151 264.47									
243 037	37 974.53	165 035	25 786.72	112 525.94									

TYPE OF LABOUR	IRRIGATION SCHEME	CROP	AVERAGE CULT. AREA (Ha)	LAND PREPARATION		PLOUGHING		TRANSPLANTING		WEEDING	
				Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha
CASUAL	KINYOPE	TOMATO	26.4	4 068 002	154 090.98	85 000	3 219.69	1 203 000	45 568.18	1 478 000	55 984.85
FAMILY			26.4	-	-	-	-	75 071	2 843.59	195 067	7 388.90
CASUAL	KITERE	TOMATO	12.4	1 540 012	124 194.52	40 000	3 225.81	1 371 000	110 564.52	480 000	38 709.68
FAMILY			12.4	-	-	-	-	80 051	6 455.73	392 037	31 615.89
FERTILIZER APPLICATION		HERBICIDE APPLICATION		HARVESTING		TRANSPORTATION COST		TOTAL			
Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Total Cost	Cost/ha	Cost/ha			
142 000	5 378.79	116 000	4 393.94	35 000	1 325.76	35 000	1 325.76	271 287.95			
249 045	9 433.52	497 016	18 826.36	1 511 451	57 251.93	704 402	26 681.89	122 426.19			
-	-	47 000	3 790.32	124 000	10 000	139 500	11 250	301 734.85			
5 054	407.58	120 523	9 719.59	578 517	46 654.59	847 516	68 348.06	163 201.44			

Appendix 4: Paddy production in Kinyope and Kitere irrigation schemes

Irrigation Scheme	Crop	Total Production (Kg)	Total Area (Ha)	Yield (Kg/Ha)
Kinyope	Paddy	78 768	53.2	1 480
Kitere	Paddy	139 200	26	5 353