IMPACT OF IRRIGATION ON POVERTY REDUCTION: A CASE OF RICE IRRIGATION SCHEME IN ULANGA DISTRICT

BY

CATHERINE MHINA

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ABSTRACT

The overall objective of this study was to assess the impact of irrigation on rice productivity and its implication on poverty reduction in Minepa Scheme in Ulanga District. In order to compare the relative impact of irrigation, cross sectional data were collected from a sample of 44 irrigating and 57 non-irrigating rice farmers. A structured questionnaire was used to collect the required data. Results indicate that rice productivity is significantly ($p<0.05$) higher under irrigation farming as compared to rainfed farming. Gross Margin analysis further indicates significantly higher margins among irrigators than non-irrigators at ($p<0.05$). In addition to that, linear regression (OLS) results show that participation in irrigation increased rice output significantly ($p<0.01$). The results indicate a significant ($p<0.01$) positive relationship between farm size and farm output while off-farm incomes and incomes from competing crops appeared to have a significant ($p<0.01$) negative relationship with rice production. Furthermore, education level, farm type, household size, numbers of extension service visits increased significantly ($p<0.01$) the rice output thus farm income. However, increased number of dependants was seen to be significant but negatively associated with rice production. The study concluded that irrigation has an eminent positive impact on rice productivity and hence on income needed to reduce poverty among rice producers. Based on the findings, the study recommends for a wider promotion of smallholder irrigation schemes through increased public investment and technology transfer, establishment of standard pricing and measurement systems for paddy and increase of paddy production under irrigation as a way of improving farm productivity and increased farmers' incomes thus helping in income poverty reduction.

DECLARATION

I **Catherine Mhina**, do hereby declare to the Senate of Sokoine University of Agriculture that this thesis has not been submitted for a degree award to any other University and that it is my own original work

11|11|2009

Ms. Catherine Mhina

(MSc. Candidate)

Date

11|11|09

Prof. E.M.M. Senkondo

(Supervisor)

Date

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DEDICATION

I dedicate this work to my beloved parents the Late Dr. and Mrs. Mhina who laid the concrete foundation of my education (***May their souls rest in peace)***.

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ANRT	Agriculture Natural Resource Team
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GM	Gross Margin
ICID	International Commission on Irrigation and Drainage
IFPRI	International Food policy Research Institute
JICA	Japan International Cooperation Agency
Kg	Kilogram
MAFC	Ministry of Agriculture, Food and Cooperatives
SSA	Sub Saharan Africa
SWMRG	Soil-Water Management Research Group
TANCID	Tanzania National Committec for Irrigation and Drainage
Tsh	Tanzania shilling
URT	United Republic of Tanzania
WMO	World Meteorological Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Irrigated agriculture is one of the critical components of world food production, which has contributed significantly to maintaining world food security and to the reduction of rural poverty (Shah *et al.*, 2000; Bhattarai *et al.*, 2002). It presents the largest investment in the agricultural and rural development sectors in developing countries (World Bank, 2003). Irrigated agriculture is often considered as the largest consumer of water virtually everywhere it is practiced. It is estimated to withdraw about 70% of all the global water. Currently, the sector is reported as accounting for about 40% of the global food production even though it represents only 17% of global cropland (WMO, 1997).

However government of Tanzania recognizes that the economy will continue to depend heavily on agriculture at least in the foreseeable future (Kalinga *et al.*, 2001). From a macroeconomic perspective, agriculture plays a dominant role in the economy, accounting for nearly 45% of GDP in 2003 and employing around 70% of labour force (MAFC, 2007). This role has been recognized in both the country's former Poverty Reduction Strategy (PRS) and the current National Strategy for Growth and Reduction of Poverty (NSGRP), known by its Swahili acronym 'MKUKUTA' (URT, 2005). Recognizing this fact the Tanzanian government stresses improvement of agricultural productivity through special focus on smallholder farmers (who characterize Tanzanian agriculture and who use 85% of the arable land) as a source of economic development (URT, 2001).

Agriculture is both the direct source of food for the majority of the population and raw material for industries. For example over 82% of the poor live in rural areas and their livelihoods depend on agriculture (URT, 2006b). However, Agriculture has been growing albeit at an inadequate pace of 5% (URT, 2006a). Although this is greater than the growth rate of population, the rate is considered to be unsatisfactory because it has failed to improve the livelihoods of the rural people. Given the importance of agriculture as the mainstay of rural livelihoods, agriculture must grow faster, at least at an average rate of 7% if eradication of rural poverty is to become a reality (URT, 2001). In terms of poverty reduction strategies; one important weapon is investment in agriculture, with a great concern on agricultural technologies such as irrigation (MAFC, 2007).

The Government of Tanzania is placing more emphasis on enhancing irrigation projects. These projects are vital especially when the drought affects key food production areas. The development of irrigated agriculture in Tanzania has been very slow. Various reports indicate poor performance. The rate of implementation of new schemes and the operational performance of existing schemes are inadequate as visualized by the Task Force of National Agricultural Policy. According to this task force, poor performance of irrigation schemes in Tanzania is contributed by absence of irrigation policy, reliance on sophisticated irrigation technique, lack of staff experienced in designing and constructing large scale irrigation schemes and poor planning of irrigation projects, particularly peasant irrigation schemes (ICID, 2008).

Irrigation potential is estimated by the 2002 Study on the National Irrigation Master Plan (NIMP) to be 2.1 million ha in mainland Tanzania, while for Zanzibar it is estimated to be 8,521 ha. The criteria for this estimate are water resources potential, land resources potential and socio-economic potential (TANCID, 2007). Out of 2.1 million ha of cultivated area suitable for irrigation, 0.2 million ha only is currently irrigated in mainland Tanzania. It means that land and water resources are not effectively utilized so far (MAFC, 2007).

1.1.1 Need for irrigated agriculture in Morogoro region

Despite the fact that Morogoro region has a good land which has natural fertility, reliable rainfall and 142 rivers which flow the whole year which are potential for irrigated agriculture, this opportunity has not been exploited. In June, 2006 the President of the United Republic of Tanzania announced Morogoro region to be the National Granary. The aim of announcing Morogoro to be the National Granary is to tap its comparative advantage in production to eradicate recurring food shortage problem in Tanzania (URT, 2007).

Morogoro region has been given national commitment to use many opportunities available and to eradicate present constraints in agriculture so as to increase productivity and farmers' incomes. Growth in incomes of the farmers and farm labourers create increased demand for labour and non-farm products and services (FAO, 2002). In order to achieve this, Morogoro region launched an operation called "The operation to make Morogoro Region be the National Granary". One of the challenges facing this operation is on how to use great irrigation opportunities available in the region for increased production (URT, 2007).

1.2 Problem Statement and Justification

Tanzanian agricultural policy stresses on the need for increased production of three main staples, maize, rice and wheat. Maize and paddy are mostly cultivated by smallholder farmers, and their productions are remarkably low mainly due to dependence on rainfed cultivation. Recently cultivated areas and production of maize and paddy have largely fluctuated year by year depending on weather condition (MAFC, 2007). By the very nature of its agronomy, paddy/rice needs more agricultural water for better yields compared to maize.

Erratic rainfalls always hinder crop production, not to mention other factors (SWMRG, 2005). Tanzania is blessed with abundant natural resources; these are not effectively utilized especially for agriculture. Rainfed cultivation is prevailing, which leads to low and large fluctuation in crop production (MAFC, 2007).

Poor productive capacity due to low and erratic rainfall has led to endemic food shocks and income poverty among the agrarian families in the many rural areas of Tanzania. More than 80% of inhabitants in rural areas, who are mostly smallholders, are included in poverty category. Rural poverty is widespread but it is severe in regions with unreliable rainfall (Bagachwa, 1997; Hatibu *et al.*, 1999; Leach and Mearnns, 1997; Hatibu *et al.*, 2004).

The development of irrigation systems is seen as an important aspect of the agricultural development strategy in Tanzania. One of its main objectives is improvement of food security by increasing the production of rice which depends mainly on irrigation and maize through supplementary irrigation on predominantly rain fed fields (URT, 2007). Irrigated agriculture in Tanzania has been relatively underdeveloped in relation to the potential. Empirical data are sparse however, including time series data that illustrate the growth of irrigated subsectors.

The proportion of farming households using irrigation is low and it has not changed much for the past ten years. The area under irrigation has also remained almost unchanged over the last two decades. Given the fact that several public funded irrigation projects were implemented in the past, the unchanged area suggests that some irrigated land has been abandoned, most prevalently due to lack of appropriate investment and skills in operation and maintenance (MAFC, 2006).

Morogoro is among the four regions in Tanzania renown for surplus production of rice. Despite of its high agricultural potential, agricultural sector continues to have poor performance. The region has 123,507 ha of land which is suitable for irrigated agriculture (≈ 5.5% of total region's land suitable for agriculture). But it is only 7.13% (equivalent to 8,804 ha) that has been developed to irrigated agriculture, 0.11% of it located in Ulanga district (URT, 2007).

The government has recognized the problem of underdevelopment in irrigated agriculture, and has incorporated some mitigation measures within its development Vision (SWMRG, 2005). However, more attention is needed from the central and local governments to prioritize irrigated agriculture. More emphasis should be on the small and medium scale projects together with construction of rain water harvesting systems and building of dams improve irrigated agriculture.

It is envisaged that the findings and information from this study will draw lessons that can be supportive of efforts aimed at empowering and improving livelihood of the farmers through irrigated agriculture and paddy production in particular. Furthermore, it is hoped that the findings will inform to researchers, policy makers, administrators and extension workers on how irrigated paddy production can be helpful in reducing income poverty.

1.3 Objective of the Study

The main objective of this study was to assess the impact of irrigation on rice productivity and its implication on poverty reduction in Ulanga district.

1.3.1 Specific objectives

1. To analyze the productivity of the rice in irrigated and rainfed rice production systems
2. To compare the profitability of irrigated rice farming with rainfed rice farming
3. To assess the contribution of irrigated rice farming on farmers income
4. To identify current problems and/or challenges encountered in irrigated agriculture projects in Ulanga District

1.4 Hypotheses

1. Irrigated rice farming is more profitable than rainfed rice farming
2. Irrigated rice farming contributes significantly to farmers income than rainfed rice farming
3. Irrigated rice farming has higher productivity than rainfed rice farming

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

The importance of agricultural sector in the economy of developing countries such as Tanzania is widely recognized. Due to that, agriculture sector has a key role in economic development and poverty reduction. However it is very much affected by inadequacy, seasonality and unreliability of rainfall as well as periodic droughts. In this regard, focus should be on scaling up investments in irrigated agriculture to increase productivity and profitability of the sector.

2.2 Importance of Rice to Tanzania

Rice was introduced in Tanzania between 1890-1920 and has become an important food staple for about 60% of the population. To meet growing demands, the total cultivated area for rice has increased substantially over the past several decades. Rice traditionally was grown in the river valleys using irrigation fed by springs and river diversions. Rice consumption in Tanzania is estimated to be 232.7 kg per person (for comparison, the United States consumes approximately 11.3 kg per year per person (Belden *et al.*, 2004).

2.3 Role of Irrigation

Irrigation can be defined as the method of applying water for supplementing rainfall, to improve crop yield and quality in areas where rainfall is insufficient or ill-timed (Vaughn *et al.*, 1979; Juma, 2000). The primary objective of irrigation is to increase crop productivity and harvest frequencies of up to two or more per year.

Historically, irrigation originated as a method for improving natural production by increasing the productivity of available land and thereby expanding total agricultural production especially in the arid and semi-arid regions of the world (Bhattarai *et al.*, 2002). Various types of irrigation methods can be used depending on the local conditions, cost, crop types and the type of water resources that are being utilized. Rivers, dams, reservoirs and ground water sources are relevant both for large and small scale irrigation systems.

2.3.1 Irrigation context overview

The study by Huang and Wang (2002) on the impact of irrigation investment in China on incomes, in general and income and poverty alleviation in poor areas in particular show positive differences between irrigated and non-irrigated yields and large t-statistics (for tests of differences between means) for almost all crops. The yields of irrigated plots exceed significantly those of non-irrigated ones.

However, a statistical and econometric approach was done by Yilma and Berger (2006) on a justification for increased irrigation investment in the less-favored areas of SSA observed high correlation on household's irrigation use and to most of the explanatory variables included in the models (like distance of household from irrigation projects and the use of fertilizers). Chiza (2005) used cost and benefit analysis of irrigation in Pangani and Rufiji basins and observed returns accrue from increased crop yield upon irrigation agriculture.

Bhattarai *et al.* (2002) compared the effects in irrigated and un-irrigated agro environments, farm production and farm income; they found out that irrigation access increase crop yield and production and in turn result in increased farm income.

Senkondo *et al.* (2004) studied on the profitability of Rainwater Harvesting for agricultural Production in Semi Arid Areas of Tanzania. The study showed positive average gross margin on rice and other crops, the results on Net Profit Value was positive for all crops including rice, Benefit and Cost Returns were all greater than one and IRR was greater than opportunity cost of capital. Overall results implied that investment in irrigation by rain water harvesting for crop production is profitable in the long run as farmers can pay for investment and operational costs and yet attain profit.

Nevertheless, Bhatia (1991) reported that the scale of irrigation impacts by comparing the performance of farm financial indicators across irrigated and non-irrigated regions in the state of Bihar, India. He showed the extent of variation in gross margin, net farm family income as well as the structures of farm expenditure between the irrigated and non irrigated regions in Bihar. The data and indicators clearly demonstrated the extent of irrigation impacts on the degree of farm intensification and the level of inputs used in farms, and in turn the difference of farm income between the two agro-environments.

2.3.2 The history of Irrigation sub-sector in Tanzania

Irrigation in Tanzania took place on tradition irrigation schemes, some of which are many hundred of years old. The traditional schemes became increasingly inadequate in recent decades due to sharp increases in population, tear and wear, catchment's degradation and other environmental problems such as water logging and salinity (ICID, 2005).

After some years the government decided to invest in Irrigation where it started with large scale irrigation scheme. The first Irrigation scheme to be constructed was TPC Moshi, in 1930, for sugar cane production. Other large irrigation schemes were constructed there after such as Kapunga, Mbarali and Lower Moshi to mention just few (Nassoro, 2006). Despite heavy investment, these irrigation schemes have not realized the proposed benefits. Kalinga *et al.* (2001) reported that the performance on operation and maintenance of all irrigation schemes has been below the expected levels.

Competition for water across sectors is among factors hindering good performance of the irrigation sub-sector. Water is finite and increasingly becoming a scarce resource (Seyam *et al.*, 2000: Ines *et al.*, 2002: Pereira *et al.*, 2002: Shangguan *et al., 2002*). Humankind has been able to expand the capacity for capturing water and increasing water use efficiency rather than expanding the basic resource itself. Costs of irrigation are growing rapidly and even more complex irrigation structures are required to mitigate decreasing water resources (Nassoro, 2006). To overcome constraints in government-managed schemes, a policy of disengagement has been promoted to transfer management from direct control towards a limited government involvement and put farmers in charge of operation and maintenance (FAO, 1998).

Recently irrigation farming in Tanzania is progressing due to sound policies and programmes that the government has put emphasis on. There is drastic improvement in irrigation farming triggered by development of irrigation schemes, construction of irrigation dams and rain water harvesting irrigation schemes (ICID, 2005). Various initiative and inputs have been made to maintain and improve them to produce more although the development of irrigated agriculture in Tanzania has been very slow which led to their poor performance. Yet, improving irrigation efficiencies is paramount under water scarce situations because high efficiency would represent conditions of near optimal use of the water (Pereira *et al.,* 2002).

The government has placed much emphasis on small-scale irrigation as an option. To reduce costs and raise rural living standards through irrigated agriculture more rapidly small scale irrigation has been increasingly recognized as a valid and attractive option in irrigation development (FAO, 1998). Small scale irrigation systems which are simple by deign and low cost would be more effective under smallholder conditions than large and capital intensive schemes.

2.3.3 An institutional review of the irrigation subsector in Tanzania

Tanzania's agriculture is facing a great general opportunity to transform itself from a traditional, rather backward system, to a modern, strongly commercial sector. Under the Tanzanian National Strategy for Growth and Reduction of Poverty (NSGRP) and in line with The Agriculture Sector Development Strategy (ASDS), He the President of The United Republic of Tanzania has declared irrigation a particularly high priority (URT, 2006).

The Tanzanian government has decided to focus its Agricultural Sector Development Programme (ASDP) on irrigation (Wolter, 2008). The Agricultural Sector

Development Programme (ASDP) now includes two irrigation components. One is concerned with demand driven smallholder schemes implemented at the District level. The other, which will operate at the national level, is concerned with the provision of irrigation service, the development of service infrastructure and the facilitation of increased private sector irrigation and service delivery (URT, 2006).

2.4 Investment in Irrigation

FAO (2002) reported that the highest crop yield obtained from irrigation is more than double the highest yield from rainfed agriculture, and that even low input irrigation is more productive than high input rainfed farming. Irrigated areas worldwide have most doubled in recent decades and contributed much to the growth in agricultural productivity over the last 50 years (FAO, 2002).

FAO (2003) also reported on agricultural production in 93 developing countries, some of which are Sub-Saharan Africa, rainfed and irrigated agriculture is expected to increase by 49 and 81% respectively, over the period 1998 – 2030. Therefore, much of the additional world food production is expected to come from irrigated land. About 2.4 billion people of the developing countries depend directly on irrigated agriculture for food and employment. Even though the importance of irrigation seems obvious, there has been a decline in investment in irrigation.

Rosegrant and Perez (1997) argue that irrigation investment in Africa may have a significant impact on increased food production and lower world commodity prices and thus poverty reduction. In considering the causal connections between output, prices, consumption and well-being it is useful to distinguish between producers or wholesale prices on the one hand, and retail prices, on the other. Declining food prices have also created less incentive for national governments and international development agencies to provide additional funding to the irrigation sector.

The reduced price of food grains in world markets is one of the reasons for the recent reduction of rate of returns from irrigation projects, limiting the incentives provided by governments, development agencies and private sector investment to the irrigation sector (Lipton *et al.*, 2003). Due to the inelastic nature of demand for food, farmers are not the only beneficiaries of increased food production in the face of declining food commodity prices. Rather, a larger section of society benefits from improved irrigation and expanded crop production. Direct benefits of irrigation accrued at farm level, such as increased crop yield and farm income, are often only a small fraction of the total benefits to society.

In light of this, employment generation also needs to be actively promoted along with investment in irrigation. However, it is sometimes argued that increases in the real wage rate in fact outstrip increases in agricultural labour productivity, at times even rising when productivity is on the decline (Fan *et al.,* 1999). In fact, employment creation and poverty alleviation and development of a region (country) are some of the major societal objectives, which the society is trying to meet through the irrigation development.

In Tanzania, irrigated agriculture seems to be the better option for sustaining and improving food production to meet the growing population. Although a greater percentage of the Tanzania farming population is engaged in rainfed agriculture, farmers are increasingly frustrated by the poorly distributed and highly variable rainfall pattern across the country (Chiza, 2005). Furthermore, statistics shows that Tanzania has only 240,253 Ha under irrigation which is about 3% of the total land in Tanzania suitale for agriculture (URT, 2007).

The government has initiated programmes to promote and encourage irrigated agriculture by developing a National Irrigation Master Plan (JICA/MAFS, 2002). Investment in irrigation development may achieve additional goals such as enhancing economic growth and poverty alleviation in rural areas. Nonetheless, the question may be asked whether investments in other parts of the infrastructure are not more likely to achieve these goals (Fan *et al.*, 1999).

2.4.1 Existing types of irrigation systems in Tanzania

Smallholders traditionally use water as a common property. Water is used according to customary laws of each area and proximity guides the rights to use water. Two main sources are common in the smallholder irrigation: (a) direct river diversion, where the gravity method of irrigation is practiced, in regions such as Arusha, Iringa, Kigoma, Kilimanjaro, Lindi, Mara, Mbeya, Morogoro, Mtwara, Rukwa, Ruvuma and Tanga. This method accounts for about 60 percent of the total area under smallholder irrigation; (b) water harvesting, where flood waters from seasonal streams/rivers are captured and stored for future use, in regions like Dodoma, Tabora, Singida, Mwanza and Shinyanga. This source accounts for about 30 percent of the irrigated area. Average size of irrigation plots varies from 0.1 to 0.5 ha with farmers owning two to three plots (Palasami, 2008).

There is a wide variety of irrigation systems used in our country. The predominant one is surface irrigation. In this system which is very common for small holders, distribution is usually by lined and unlined canals. Included in this category is the water harvesting or use of flood recession, which although informal but its still considered as surface method. Furrows and basins are widely used in this. This system does give rise to salinity, but once attention is paid to adequate drainage, the problem is overcome (URT, 2005).

Another variety of irrigation system is Conventional sprinkler irrigation. This is widely used by large scale commercial farmers. It is not common among the smallholders as these are too many mechanical parts to break or lose but also requires pumping. In Tanzania, very few schemes use this approach (URT, 2005)

Drip irrigation is widely used on coffee and other crops. If well designed the system performs well. The system is rarely used in Tanzania (URT, 2005)

2.5 National Irrigation Policy Framework

The purpose of the National Irrigation Policy framework is to outline the current position of the irrigation sub-sector, address the challenges which the irrigation sub-sector faces and to propose policies and strategies which can promote a more effective irrigated agriculture in Tanzania and thereby boost food security, exports, employment and reduce poverty (ESRF, 1997). In 1994 the National Irrigation Development Plan (NIDP) was launched which aimed at stability in crop production and increased food.

Apart from the policies laid down after NIDP, in 2002 the Government prepared the National Irrigation Master Plan – NIMP which has revealed that Tanzania has a total irrigation development potential of 29.4 million hectares at varying levels. 2.3 million hectares have a high development potential, 4.8 million hectares, medium potential and 22.3 million hectares, low potential. The area under irrigation currently is estimated to be only 227,486 hectares (Chiza, 2005).

NIMP was intended to contribute to the achievement of the objectives of the Agriculture Sector Development Strategy of increased agricultural productivity and profitability by establishing a framework for sustainable irrigation development. Agricultural Sector Development Strategy calls for stabilization of rainfed agriculture, expansion of the irrigated sub-sector, increased commercialization, diversification and private sector investment. The Government aims at achieving sustainable irrigation development through effective use of national resources with a view to increasing agricultural production and productivity (Chiza, 2005).

2.6 The Concept of Productivity of Water

Increasing water scarcity poses a threat to food security and safe domestic water supplies. Irrigated agriculture is a major driver in leading to water scarcity because of its high consumption of water resources. Increasing productivity of water in agriculture by producing more agricultural output with the same amount of available water is a key strategy for addressing water scarcity (Molden *et al.*, 2001).

Water productivity is the amount of food produced per unit volume of water used, and is vital parameter to assess the performance of smallholder irrigated agriculture

(FAO, 2003). Improving water use productivity is often understood in terms of obtaining as large quantity of crops as possible per cubic meter of water – 'more crop per drop'. Water productivity relative to depth of irrigation required can directly measure the significance of water in space and time (Ines *et al.*, 2002).

Increasing the productivity of water in agriculture is a critical consideration because, simply stated, the more we produce with the same amount of water, the less the water is needed to meet future irrigation demands and the more water that is available for the environment and other uses. This includes improving productivity of water in both rain-fed and irrigated areas. The key opportunities to improve water productivity are to increase productivity on irrigated lands and to use water to supplement rainfall in marginal areas (Molden *et al.*, 2001).

The increase in agricultural productivity and concomitant economic gains associated with higher irrigation intensities will work towards alleviating poverty among the poorest households (Renwick, 2001). Financially astute farmers may prefer to target a maximum income per cubic meter. This may also mean deriving more benefit, or achieving more welfare, for every unit of water withdrawn from natural water bodies.

In irrigated agriculture, improving the productivity of water can be defined as the physical output per unit of water depleted meaning that water is rendered unavailable for uses further downstream. It can be expressed in kg of yield/m3 of water. In many areas, the potential productivity of water is not realized and this is, in large part, due to poor irrigation management. Without stable irrigation deliveries, farmers cannot take advantage of production potential (Molden *et al.*, 2001).

Another appealing option is to increase the productivity from rain-fed agriculture through water harvesting and supplemental irrigation. Giving one irrigation turn at the right time can tremendously increase land yield and the productivity of water. In marginal areas where rainfall is not reliable for full production and access to full irrigation is difficult or expensive supplemental irrigation may hold an important key to the productivity of water. Out of one million hectares suitable for irrigated agriculture only 0.2 million hectares are under irrigation (TARP II-SUA, 2005).

The main constraints facing irrigated agriculture in the country include low productivity of land, underdeveloped water potentials and effects of environmental degradation (URT, 2005). However, in most irrigation schemes water productivity is low. This calls for remedial measures to ensure sustainability of the irrigated land and environmental integrity. Improving water productivity in irrigation is a key to water shortage problem since irrigation is the major water use (SMUWC, 2000).

2.6.1 Modernizing irrigation and water management

Modernizing water management in irrigation system can be interpreted in different ways depending on the local circumstances. One type of modernization is the introduction of modern technologies, such as water application and distribution through pipes rather than open channels, and the use of computerized soil water sensors to trigger water applications (Facon and Renault, 1999). Modernization can also be defined as a process of improving the use of resources (water, land, labour, and environmental economy) through upgrading the hardware and software of the irrigation project, maintaining and improving services of water supplied to the field.

However, it also comprises older capital-intensive techniques, such as canal lining and land leveling. These techniques can only be introduced and used successfully where the farmers can be trained in their use or already posses the necessary skills (Facon and Renault, 1999). FAO has defined modernization as "a process of technical and managerial upgrading of irrigation schemes combined with institutional reforms, if required, with the objective to improve resource utilization and water delivery service to farms".

Implementing modernization of irrigation is an important content in industrialization and modernization of agriculture in rural areas. Development of irrigation systems should be given priority towards integrated utilization to supply water for environment improvement as well as disaster control and mitigation. Application of advanced technology in irrigation and drainage for saving water in constructing and managing irrigation systems is very important (Kasambala, 2004).

Irrigation institutions need to adopt a service orientation and improve their performance in economic and environmental terms. This entails adopting new technologies, modernizing infrastructure, applying improved administrative principles and techniques, and promoting the participation of water users. Irrigation sector institutions need to link their central task of providing irrigation services to agricultural production and to integrate their water demands and uses with other users at basin level (Molden *et al.*, 2001)

An enhanced appreciation of the water cascades and flows across landscapes and the circulation of groundwater within aquifers will lead to informed decisions on the use and reuse of agricultural water. In addition, failure is likely if the public irrigation organization continues as before without the involvement and participation of the water users in the system's operation and management. Only through their involvement from the beginning of a modernization project can farmers develop a sense of ownership and be likely to care for the system (Samad and Vermillion, 1999).

This sense of ownership should prevent several of the problems that often arise after a short time, field channels being demolished, gates being stolen or damaged, field drainage systems becoming blocked, open drains filling with sediments and weeds and graded land becoming spoiled by bad tillage (Samad and Vermillion, 1999). Providing farmers with appropriate technical assistance requires considerable attention. Despite the training provided, there are still large gaps in knowledge about farming practices, water requirements and irrigation scheduling. Nonetheless, modernization is more likely to succeed if the ideas come from the farmers (Renault and Makin, 1999).

2.7 Measuring Productivity in Rice Production

Productivity refers to the relationship between inputs, such as labour, capital and natural resources, measured in real terms based on the concept of production function. And further that, a production function can be expressed in mathematical relationship between the output and various inputs. Productivity is a measure of efficiency in resource use or technical efficiency. Higher agricultural productivity comes from two main sources, the use of additional input and higher productivity resulting from improved technology (Isinika, 1995).

The simplest measure for productivity is the ratio of output to a single input such as land productivity (yield per hectare). Though easy to compute, it could mislead as it takes into account of only one input instead of multi-inputs. However productivity can be measured using a number of approaches. The approaches to productivity measurement in literature range from the Cobb Douglas functions, Linear programming, indexes based on the Translog Transformation function, the Divisia Index, Laspeyers quantity Index and many other econometric transformations based on modern production theory (Nabbumba and Bahiigwa, 2004).

Hussain *et al.* (2000) used both Cobb-Douglas and Data envelopment analysis to measure productivity as yield per hectare for maize and litres of milk per lactating animal. Isinika (1995) used Cobb-Douglas function to study the effect of agricultural research expenditure on agricultural productivity in Tanzania. The choice of method to use has generally depended on the problem being addressed and the available database (Nabbumba and Bahiigwa, 2004). Hussain *et al.* (2000) used Cobb-Douglas production function on algebraic signs, plausibility of estimated parameters and their statistical significance.

2.8 Impact of Irrigation on Poverty

While there is empirical evidence that irrigation development has, in some cases, a substantial impact on poverty reduction, it becomes increasingly clear that such impact is determined by the type of irrigated agriculture, the scheme size, the type of operation and maintenance, the system of water allocation, etc. Irrigation development can have substantial impact on poverty reduction through direct product gains, lower food prices, and indirect effects through forward and backward linkages, in particular through increased employment opportunities (Lipton *et al.*, 2003). Agricultural development based on water conservation and irrigation is often considered a promising avenue for poverty alleviation in rural areas (FAO, 2002).

Small scale irrigated agriculture with its higher crop yields is expected to have greater impact by reducing the incidence of poverty and malnutrition (Van Koppen *et al.*, 2002). Furthermore researchers argue that irrigation development mainly benefits the rich segments of the rural population and thus increases social differences. A comparative analysis of the performance of irrigated agriculture with respect to poverty does not exist, yet the investments in irrigation infrastructure continue to be significant and interest of donors in poverty alleviation is increasing (Lipton *et al.*, 2003).

CHAPTER THREE

3.0 METHODOLOGY

This chapter presents the methods used to obtain and analyzing data on the impact of irrigation on rice productivity and contribution to farm income. It also covers description of the study area, research design, sampling procedures and techniques, tools of data analysis and source of data used.

3.1 Description of the area

3.1.1 Location and size

This study was carried out in Ulanga District. The district is located to the South West of Morogoro Municipality. The district covers and an area of 24 560 km^2. It is the largest district in Morogoro region and the sixth largest district in the Tanzania (Ulanga District Council, 2006). The district is located between latitude 8^0 10' S and 9^0 58' S and between longitude 35^0 13' E and 37^0 44' E. It also lies south of Tanzania-Zambia Railway Authority (TAZARA) and Kilombero River.

3.1.2 Climate

The climate is conducive for human settlement and agriculture. Temperatures vary from 16.2^{0}C – 27^{0}C along the Mahenge mountains to 25^{0}C – 32^{0}C in the lowland/flood plains. The district is characterized by bimodal rainfall falling mostly between October and May with two peaks occurring in December and March. It rains during the 'Masika' or rainy season (October to January) while the latter constitute 'Vuli' rains or short rainy season (March to May). The rainfall ranges from 300 mm in flood plains up to 600 mm in mountain locations (Ulanga District Council, 2006).

The actual rainy days are 121 per year (Morogoro Regional Statistical Abstract, 1995).

3.1.3 Population

Ulanga district is divided into 5 administrative divisions namely Mwaya, Mahenge, Lupilo, Mtimbira and Malinyi, with a total population of 212 597 people (Ulanga Agricultural Report, 2007) growing at the rate of 2.6% annually. The average household size is 4.6 (Population and Housing Census, 2002). Mwaya and Mahenge alone account for 70 percent of the total population of the district. The main ethnic groups are the Pogoro, Ndamba, Ngindo, Bena, Ngoni and Mbunga. The Ndamba, Bena and Ngindo are mainly anglers whereas the Pogoro, Ngoni and Mbunga are peasant (Mlambiti and Mlay, 1992). However, there has been an influx of nomadic Sukuma in the district.

3.1.4 Why Chose Rice?

A smallholder farmer has multiple objectives that contribute to maximising family satisfaction. Any enterprise or productive process that allows the family food security and satisfaction might take precedence over those that are more profitable. Paddy/rice is the main crop grown in the area. All farmers in Ulanga grow paddy and other crops as well such as maize, cassava and bananas. Paddy acts as both food crop and cash crop because farmers sell it to get money for catering their needs.

3.2 Research Design

This study used a cross sectional research design. Data from farmers were collected at a single point without repetition from the representative population. According to

Bailey (1997), the design is economical to conduct in terms of time and it allows a comparison of the variables. The population of interest constituted rice farmers under irrigation and farmers under rainfed farming in Ulanga District (Minepa Village).

3.3 Sampling Procedures and Techniques

The study involved rice farmers in Minepa village. It compared the performance of farmers under rainfed farming and those under irrigation farming in Minepa Irrigation Scheme which draws its water from Luli River. The study intended to employ 120 respondents but due to some technical difficulties in the study area, only 101 respondents were obtained. A representative sample from the village based on Boyd's formula. The technique was adopted because is an appropriate approach when the sample elements are to fulfill a certain criteria or posses certain characteristics under study (Boyd *et al.*, 1981).

A combination of random and purposive sampling was employed to obtain farmers cultivating rice in the study area. Farmers were stratified on the basis of method used to cultivate rice. Forty four farmers were those under the irrigation scheme and another 57 were those under rainfed farming. Gender was also considered to have equal representation. Key informants (more knowledgeable individuals) who provide relevant information on the irrigation scheme were identified and interviewed.

3.4 Data Collection

3.5.1 Primary data

Primary data were collected from the field for the analysis through personal interviews conducted in Minepa village in Ulanga. Research tools used for data collection included structured questionnaire and an interview guide (Appendix I). The questionnaire contained both open ended and close-ended questions. The questions were developed to capture the information needed to address the specific objectives. The questions were designed in English and translated in Swahili to facilitate communication during field survey. The main source of primary data was field surveys where data was collected on socioeconomic characteristics of the farmers, contribution of irrigation to farmers income, problems and challenges encountered in irrigation agriculture development, farmers' income and performance of the present irrigation scheme in terms of productivity.

3.5.2 Secondary data

These data were obtained from Sokoine University of Agriculture, Mzumbe University and University of Dar es salaam Libraries. Additional data were collected from the internet, different evaluation reports, Regional and District Agricultural Officers, District Agricultural Office, Ministry of Agriculture, Food Security and Cooperatives, Food and Agriculture Organization of the United Nations (FAO), World Food Programme (WFP) and other related sources.

3.6 Data Analysis

3.6.1 Qualitative data analysis

Information was collected, summarized and coded with specific values that represent study variables. Coded data was analyzed by Statistical Package for Social Science (SPSS) software (Version 12). In this statistical package descriptive statistics namely frequencies, percentages and means of different variables were calculated to measure the relationship between variables where as qualitative data were summarized and presented in tables.

3.6.2 Quantitative data analysis

3.6.2.1 Analysis of the performance of rice irrigation scheme in terms of productivity in comparison with rainfed rice farming.

Productivity was obtained from the ratio of output to a single input such as land productivity (yield per hectare). In this case productivity was presented in terms of Tsh/hectare. Productivity from each farming system i.e. irrigated and non-irrigated farming was calculated and the results were compared to conclude which faming system performs better than the other. Furthermore, t-statistics and chi-square were used to provide significance of differences obtained in the two groups.

3.6.2.2 Comparison of profitability of irrigated rice farming with rainfed rice farming

Gross margin was used for analyzing the performance of rice irrigation scheme. Gross margin refers to the returns over variable costs and is an appropriate measure of profitability for comparing the enterprise performance in a short run. Gross margin is the difference between the gross value of output and the total variable costs incurred in the production process. The return to labour and capital invested was obtained by dividing the gross margin by man-days and production cost per hectare respectively.

The gross output includes the amount of products for instance rice sold, consumed and that given away freely to relatives and friends. Variable costs consist primarily of seed, fertilizers, pesticides and labour used specifically for rice production (Hill, 1990). In this study, gross margins were calculated for irrigators and non-irrigators, and then they were tested statistically using students' T test. Overall gross margin for both irrigated and non-irrigated farmers was calculated for comparison. The mathematical expression of the gross margin used is as follows;

$$GM = TR_i - TVC_i$$

Where;

GM = Gross margin of the ith farmer (Tsh/ha)

TR_i = Total rice output value (Tsh/ha)

TVC_i = Total variable costs (Tsh/ha)

3.6.2.3 Assessment of the contribution of irrigated rice farming on farmers' income.

Multiple regression analysis was used in identification of the factors influencing the amount of farm income for both farmers who are using irrigation and those under rainfed farming. The regression model was estimated by using Ordinary Least Square (OLS) technique.

Regression of rice output sold

$$FIL_i = \beta_o + \beta_1 FEL_i + \beta_2 HHS_i + \beta_3 NDH_i + \beta_4 PII_i + \beta_5 RFS_i + \beta_6 OFI_i + \beta_7 FSCC_i + \mu$$

Where;

FIL_i= **Total rice output** – the variable was obtained from the amount of rice a farmer obtained in the farming season of 2006-07

FEL_i= **Farmer's education level (years of schooling)** - this variable was obtained by asking the respondent her/his education level in years.

HHS_i= **Household size** - the variable was obtained by asking the respondent the number of household members in his/her household.

NDH = **Number of dependants in the household** - the variable was obtained by asking the respondent number of household members who do not participate in production activities such as elderly people and younger children of over 60 and under 15 years of age respectively.

FTY_i= **Farm type** – this was obtained by checking on the farming system the farmer is practicing whether irrigated farming or rainfed farming.

PII_i= **Dummy for participation in irrigation (1 if yes, otherwise 0)** – if a respondent participated in irrigation was accredited 1 otherwise 0.

RFS_i= **Rice farm size** – the variable was obtained asking the respondents the size of rice farm they have in acres. Then a farm size in acres was converted to hectares which is the standard unit of land size.

OFI = **Off farm income** – the variable was obtained adding up the incomes from non farm activities such as fishing and small business.

$FSCC$= **Income of competing crops** – the variable was obtained by adding up incomes from crops other than rice which competes with rice for various resources such as labour and capital.

β = Constant

μ = Error term

3.6.2.4 Identification of current problems and/or challenges in encountered irrigated agriculture

The analysis was done by checking and comparing the frequencies of responses of farmers when asked on the problems that they are facing in irrigation farming. The results were presented in percentages.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socioeconomic attributes of the respondents

The socioeconomic attributes of the respondents examined include age, level of education, marital status, family size and its composition. Like other household, demographic and surveillance surveys, this study considered a household to be composed of people who eat and sleep in the same house. For the case where the man was away or not living in the household, the woman became the *de facto* household head (Regnard, 2006).

4.1.1 Age of respondents

The distribution of the interviewed smallholder farmers by age is presented in (Table 1). The results reveal that age of the farm operator significantly influenced involvement in either irrigation or rainfed farming. A great proportion (39.6%) of all farmers belonged to the age group of 26 – 35 years of age.

Table 1: Age of respondents

Age	Farmers' status				Overall	
	Irrigating farmers		Non-irrigating farmers			
	N	%	n	%	n	%
< 18 years	1	2.3	15	26.3	16	15.8
18 – 25 years	9	20.5	20	35.1	29	28.7
26 – 35 years	19	43.1	21	36.8	40	39.6
36 – 45 years	3	6.8	1	1.8	4	4.0
> 45 years	12	27.3	0	0	12	11.9

This shows that older people are much more involved in irrigation as compared to relatively younger one. The group consisted of 43.1% and 36.8% of irrigating and non-irrigating farmers respectively. On the other hand, 27.3% of irrigating farmers were above 45 years of age while none was found in that group on the side of non-irrigating farmers (Table 1).

4.1.2 Gender of the respondents

Gender distribution is shown in Table 2. It was observed that female involvements in irrigation were higher (38.6%) as compared to 19.3% in rainfed agriculture. The results further show that most men (80.7%) go for rainfed farming. The difference in gender for both irrigating and non-irrigating farmers is significant ($p<0.005$). The observed dominance of men in irrigation farming affirms the assertion by Bastidas (1999) that farmers especially irrigators are predominantly males where the societies assume that farm household resources and labor are effectively controlled and allocated by males.

Table 2: Gender of respondents

Gender	Farmers' status				Overall	
	Irrigating farmers		Non-irrigating farmers			
	N	%	n	%	n	%
Male	27	61.4	46	80.7	73	72.3
Female	17	38.6	11	19.3	28	27.7

Failure to recognize gender issues affects the agricultural productivity of irrigated crops negatively, and that women's lack of independent access to, and control of, land and water threatens household food security. Poor people, and in particular poor women who are mainly responsible for accessing these resources, are increasingly being excluded from this key source of their livelihoods (Beck and Nesmith, 2001). Roles of men and women in crop production are based on the cultural or the prescribed norms and what people actually do in reality. According to van Koppen *et al.* (2002), in female headed households women tend to be the main producers in agriculture.

4.1.3 Education level of respondents

Education especially literacy level is expected to increase farmers' ability to obtain, understand, analyse different instructions and knowledge provided by experts in agriculture. Findings show that majority of interviewed farmers both irrigating and non-irrigating farmers attained primary education. Results in Table 3 show that 83.7% and 86% of irrigating and non-irrigating farmers attained primary school education.

Table 3: Education level of respondents

Education level	Farmers' status				Overall	
	Irrigating farmers		Non-irrigating farmers			
	N	%	N	%	n	%
No education	0	0	3	5.3	3	3.0
Primary education	36	83.7	49	86.0	85	85.0
O'level	4	9.3	3	5.3	7	7.0
A'level	2	4.7	2	3.5	4	4.0
Tertiary education	1	2.3	0	0	1	1.0

The low level of education attained by most farmers suggests that farmers need additional knowledge on the adoption of new farming technologies. This shows that farmers should get assistance from more knowledgeable individuals on the importance of involvement in a more productive farming system. According to Pender *et al.* (2003), education may promote adoption of new technologies by increasing households' access to information and their ability to adapt to new opportunities. On the other hand, more educated households may be less likely to invest in inputs or labor-intensive land investments and management practices, since the opportunity costs of their labor and capital may be increased by education.

4.1.4 Main source of income

It was observed that farming was the primary source of income of both irrigators and non-irrigators (Table 4). The findings show that 93.2% of irrigators depend on farming only as their main source of income. The study also shows that 64.9% of non irrigators depend on farming as their main source of income, but still 8.8% and 26.3% of respondents who are non-irrigators depends on mixed farming that is crop farming plus livestock keeping and crop farming plus fishing respectively as their alternative sources of income. This might be explained by the fact that rainfed farming does not provide security enough for farmers to only depend on it as a sole source of income, therefore they engage themselves in other economic activities so as to increase their household income. The low-income groups derived a large proportion of their off-farm income from unskilled informal labor activities.

Table 4: Main sources of income of respondents

Source of income	Farmers' status				Overall	
	Irrigating farmers		Non-irrigating farmers			
	N	%	N	%	N	%
Farming	41	93.1	37	64.9	78	77.2
Livestock keeping	2	4.5	5	8.8	7	6.9
Fishing	1	2.3	15	26.3	16	15.8

Lipton *et al.* (2003) argue that irrigation might raise incomes of the poor sufficiently to guarantee enough food consumption, but its ability to affect relative poverty will not only depend whether the poor benefit directly proportionately more than the non-poor but also on the poor's access to other inputs, assets, technology, markets and institutions. They further argue that irrigation may remove part of the variance of incomes across seasons and years, and so reduce the incidence of spells of poverty among those that flip in and out of poverty but it is unclear that the permanently the poor will be lifted out of poverty by irrigation alone.

Just as irrigation can generate a stable flow of income through improved yields and more stable yields across seasons and years, it may also augment employment opportunities, in-migration and real wage rates (Lipton *et al.*, 2003). According to Clay *et al.* 1995, off-farm income (wages from labor for others on-farm and in nonfarm businesses, and income from own nonfarm businesses) is an important part (about one-third) of a household's total income. Since many rural households derive livelihoods from some form of non-farm activity, increasing the profitability and range of such activities would improve their livelihoods security and living conditions (Mwabu and Thorbecke, 2001; Awoyemi, 2004)

4.1.5 Household size

The mean household size was found to be 5.2 persons for both irrigating and non irrigating households. This figure is slightly bigger as compared with the 4.6 reported by Population and Housing Census. Household sizes have effect on production and labour availability. It was also observed that the average number of dependents is 3 and 2.7 for irrigators and non-irrigators respectively. Rapid population growth and declining agricultural productivity affect the livelihoods and survival of millions of rural households throughout Sub-Saharan Africa since farm production is oriented towards subsistence (Clay *et al*,. 1995).

4.2 Productivity of rice among farmers

4.1.1 Crop production

Almost all farmers in the area grow paddy though a few of them grow others crops as complementary crops as well. Paddy is both food crop and cash crop. This is explained in the Tanzanian Agricultural Policy (1997) as a result of agricultural liberalization which has made most of crops be treated as either food or cash crops respectively. Therefore, regardless of which crop farmers grow they can increase production to meet their subsistence (food) and increase income (selling) in the household. Other food crops grown in the area include maize, cassava and bananas. The farmers also grow cash crops such as simsim, cotton, coffee, cowpeas, sweet potatoes, beans, green grams coconut and oil palms.

4.2.2 Land acquisition

In general availability of arable land is not a problem in Ulanga District. Various methods of land acquisition exist. However, one can acquire land through inheritance, hiring, purchase or given by village government. The results in Table 5 revealed that 10.5% of non-irrigators and 4.5% of irrigators were offered land by village authorities. However, 17.5% of non irrigators and 4.5% of irrigators hired the land, 63.2% and 54.5% of non-irrigators and irrigators respectively inherited land. This makes land inheriting be the major way of land acquisition in the area constituting about 59.4% of all farmers in total.

The results also revealed that 8.8% of non irrigators and 20.5% of irrigators acquired land through buying. Many irrigators are seen to acquire the land through buying and hiring. This might explain the fact that due to low economic statuses of most farmers and lack of capital to farm under irrigation, most farmers who own land in the irrigation area fail to cultivate and decide to sell or hire it at higher prices to other farmers so as to get some money to at least be able to accommodate their basic needs. Lipton *et al.*,(2003) argue that irrigation may raise land prices in irrigated areas, out of reach of the landless poor or poor small farmers, but increase their incomes and employment opportunities.

Table 5: Land acquisition

Land acquisition	Farmers' status				Overall	
	Irrigating farmers		Non-irrigating farmers			
	n	%	N	%	N	%
Inherited	24	54.5	36	63.5	60	59.4
Bought	9	20.5	5	8.8	14	13.9
Hired	9	20.5	10	17.5	19	18.8
Given	2	4.5	6	10.5	8	7.9

4.2.3 Farm area under paddy production

The results in Table 6 indicate that a great proportion of 53.5% of land area under paddy production varies between 1 acre and 2.5 acres. It was found that 1.8% of non irrigator and 6.8% of irrigators have less than 1 acre of land under paddy production, 50.9% of non irrigators and 56.8% of irrigators had farm areas under paddy production of between 1 acre and 2.5 acres. The bigger proportion of farm areas of less the 2.5 acres for irrigators might be explained by the fact that since the scheme is not fully developed and due to the fact that there is no enough land in the scheme most farmers tend to have small areas for cultivation.

The results further indicate that 33.3% and 29.5% of non-irrigators and irrigators respectively had land area under paddy production between 2.5 acres and 5 acres, while those farmers with more than 5 acres constituted 14% and 6.8% for non irrigators and irrigators respectively. An inverse trend was noted to farmers with more than 2.5 acres under paddy production where non irrigators are seen to have bigger proportions than irrigators.

Table 6: Land area under paddy production

Land size	Farmers' status				Overall	
	Irrigating farmers		Non-irrigating farmers			
	n	%	N	%	N	%
<1 acre	3	6.8	1	1.8	3	4.0
1 – 2.5 acres	41	93.2	29	50.9	70	69.3
2.6 – 5 acres	0	0	19	33.3	19	18.8
>5 acres	0	0	8	14.0	8	7.9

The study also revealed that average rice farm size under irrigation is 1.7 acres with maximum farm size of 2.5 acres and minimum farm size of 0.25 acres. This implies that the irrigation scheme does allow expansion for increased paddy production. Large farm size allows large operational scale, crops diversification and likely higher output.

4.2.4 Labour requirements

A permanent source of farm labour is provided by the household members who often include relatives. Labour hiring in most cases with implicit payments like local brews is common in some farm operations such as weeding and harvesting. In times when there is food shortage in the area especially during cultivation period, most people work *'Miraba'* and they are given paddy in measurements called *'Kimbo'*.

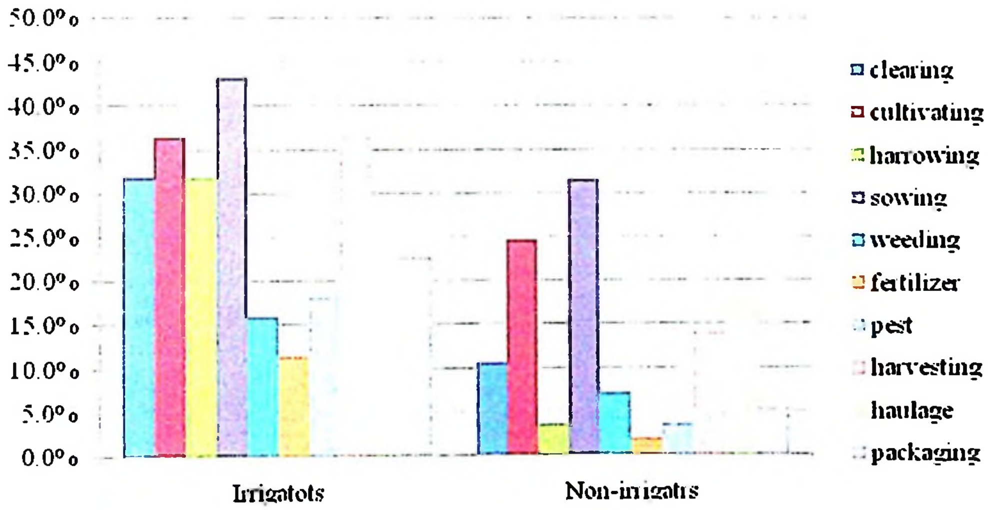

Figure 1: Labour used

It was further observed that more labour is required in irrigated farming than in non-irrigated farming due to intensity of work and amount of farm output in irrigated farming. Irrigators had higher average number of hired labourers as compared to non irrigators (Figure 1). Increased farm output as a result of irrigation will stimulate demand for farm labour both within the main cropping season and across new cropping seasons, increasing both numbers of workers required and length of employment period (Lipton *et al.*, 2003).

4.2.5 Production technology

4.2.5.1 Use of fertilizer and chemicals in paddy production

Use of pesticides in paddy is not very common in Ulanga District. But selective herbicides for control of weeds in paddy farms are highly demanded. The survey showed that 18.2% and 5.3% of irrigators and non irrigators respectively used herbicides in their paddy farms. On the other hand, use of inorganic fertilizer is not so common in the district. The results showed that 38.6% of irrigators and 10.5% of non irrigators interviewed used fertilizer in their farm land (Table 7). There is already ample evidence that inorganic fertilizers can substantially increase yields in SSA (Larson and Frisvold, 1996).

Table 7: Use of chemicals

Chemical use	Farmers' status				Overall	
	Irrigating farmers		Non-irrigating farmers			
	n	%	N	%	N	%
Herbicides/Pesticides	8	18.2	3	5.3	11	10.9
Fertilizers	17	38.6	6	10.5	23	22.8

Despite compelling evidence that chemical fertilizers have a critical role to play in increasing agricultural productivity, average per hectare use of fertilizer in SSA remains the lowest in the world and continues to decline as a share of total use by developing countries. Rice uses more fertilizer than any crop and its response on land productivity is very high (Yanggen *et al.*, 1998) But this good performance in many cases is dependent on production under highly subsidized irrigated conditions. According to Chiza (2005) the use of fertilizers for rainfed crops is on the decline as they are proportionally very expensive for smallholder farmers and in many cases they borrow to purchase. If rains fail then they suffer both from lack of production as well as from cash losses or increased indebtedness. If farmers have both irrigated and rainfed land, they will make their investments in fertilizer for the irrigated rather than the rainfed. They are thus more likely to achieve the projected yields than they will for rainfed land through their risk aversion measures.

4.2.5.2 Extension services

Extension services are important in raising productivity of the agricultural sector. The survey indicated that extension services are very poor. There are no extension officers in the district. According to District extension officer, every village is supposed to have one extension officer.

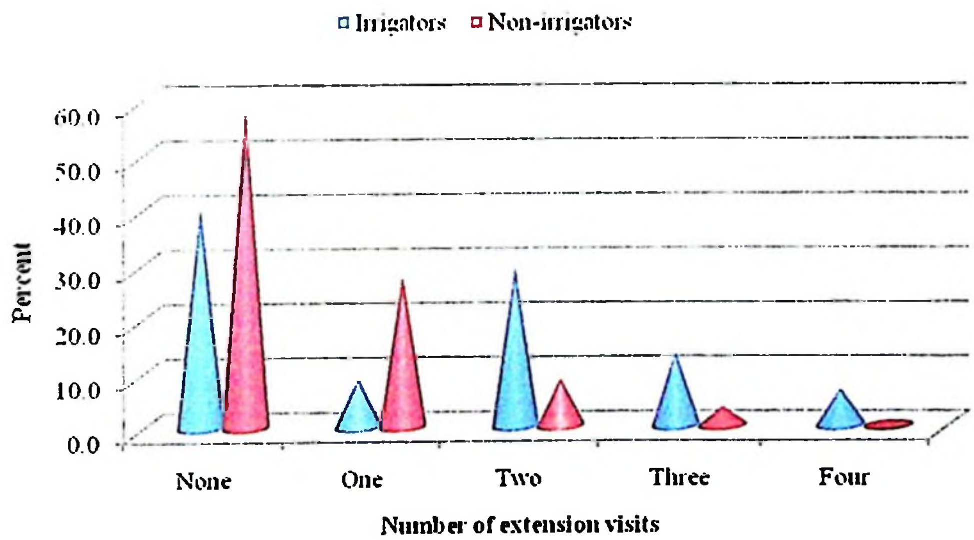

Figure 2: Extension service visits

There are 65 villages but only 12 villages have extension officers that means on average one extension officer has 2 to 5 villages to work with. Thus majority of farmers do not get the service. According to the results, of all the farmers interviewed 38.7% and 29.9% of irrigators and non irrigators got advices from extension officers in the period of 2006-07 (Figure 2).

4.2.5.3 Farm tools

Most of smallholder farmers in Ulanga district use elementary tools in the farming process such as machete, hand hoe and axes to prepare land for paddy farming. The use of these tools has a serious impact on the yield of paddy. The results showed that more irrigators use tractors in cultivation as compared to non irrigators. It was revealed that 20.5% and 22.7% of irrigators use tractors for tillage and harrowing respectively. The results further indicate that on the part of non irrigators 22.8% of farmers interviewed used tractors for tillage and 3.5% use tractors for harrowing (Figure 3).

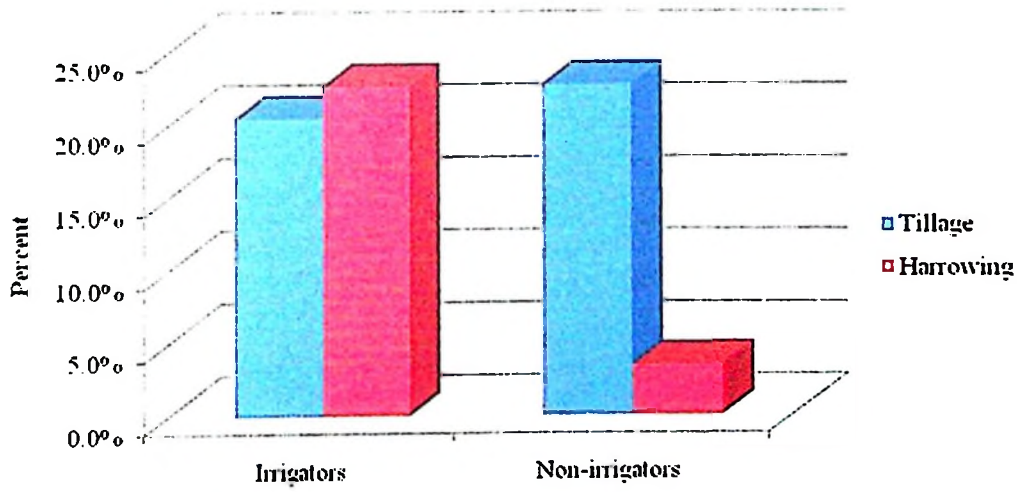

Figure 3: Farm tool use

A smaller percentage on the use of tractors in harrowing for non irrigators might be due to the fact that farmers under rainfed farming do not harrow. In a study of the effect of agricultural research on the productivity of farmers in poor areas, new technology is shown to have not benefited poor area farmers (Jin *et al.*, 2002).

4.2.5.4 Use of improved seeds

The results indicate that 96.5% of non irrigators and 86.4% of irrigators bought their seeds at a price between 200 shillings and 700 Tsh/kg. This implies that most farmers buy seeds with low qualities consequently resulted to low production. The results indicate that most farmers do not use improved seeds. Seed varieties are relatively expensive, and new seeds need to be purchased at the beginning of each season, when farmers have no money. The price of improved seed varieties of paddy is 1200 Tsh/kg. Most farmers buy paddy seeds from their fellow farmers and some keep a small proportion of each year's harvest for seed purposes for the next farming season, so that new seeds do not need to be purchased at the beginning of the season.

4.2.5.5 Storage facilities

Storage is done in tradition structures, *vihenge*, and in residential houses. The houses and *vihenge* are very small to allow large quantities of paddy to be stored for a long time. When a farmer gets more paddy in a season, they get difficulties in storing it. They keep it outside for few days and sell most of it immediately leaving a small portion for food purposes. There are a number of problem facing farmers when storing their produces. These include food theft and presence of rodents. Farmers normally use their homes to temporarily store paddy pending haulage to selling centres (Gabagambi, 1998).

4.2.5.6 Main buyers from farmers

Farmers in the study area sell their paddy to Mohamed Enterprises and to some traders and they are the ones who state the prices. Some farmers take some of their paddy to Ifakara for sale but they complain about high levies charged at Kilombero river gate. Marketing of paddy in Ulanga District is not under direct control by the Central government. The District Council controls paddy traders through imposing fees and direct ban to control outflow of the crop in the district. Council paid little attention on the quality control. This leads to problems of standards in grades and weights.

According to the District Agricultural Officials, Mohamed enterprises buy most paddy from farmers in the area followed by traders. They buy paddy just after harvesting period when the prices are very low. In that period a bag of paddy can be sold up to the lowest price of 10 000/- Tsh, late sell of paddy (in December) the price is between 35 000 – 40 000/- Tsh per bag. Common measurements used during selling of paddy and rice include *kopo/kimbo*, tins and sacks. Standard metric scales are not common. Six tins make up a bag. A tin is approximately 18 kg. This is a serious disadvantage to the producers/farmers because more often than not the tins are not uniform. In the next harvesting period (2007-08) teachers SACCOS will be the main buyer of most paddy, it will process paddy to rice and market the product in and outside the district. In mean time they are fixing their plant at Lupiro.

4.2.6 Productivity per hectare

A key factor in analyzing the impact of irrigated agriculture on the incidence of rural poverty is the extent to which productivity gains 'trickle down' through increases in income and employment for all categories of the poor (Lipton *et al.*, 2003). A larger difference was observed when comparing the productivity of farmers under irrigated and non-irrigated farms. The results depict higher paddy productivity in irrigation farming. The survey results show that average productivity for irrigators was Tsh 507 324.52 ha and that of non irrigators was Tsh 196 330.44 hectare. It was apparent that irrigators' productivity was more than three times that of non irrigators' productivity which means irrigation farming is more productive than rainfed farming.

Examining unconditional differences between irrigated and non-irrigated yields, it was clear that yields of irrigated plots are higher than those of rainfed ones. This implies that irrigation plays a positive significant role in alleviating poverty because irrigation farming enables farmers to produce more thus more income. Independent samples t-test was used for irrigators and non-irrigators farmers. Results of the mean significance t-test indicate that significant differences exist between irrigators and non irrigators in terms of productivity.

Positive differences and large t-statistics of 4.171 indicate that the average yields of irrigated plots exceed significantly those of non-irrigated plots. Nevertheless, the relationship of farm productivity between irrigators and non irrigators was found significant ($p < 0.05$). The empirical results of this study tentatively confirm that irrigation improves crop yields and income thereby contributes to poverty alleviation.

Ray *et al.* (1988) argue that in comparison to non irrigated conditions, the expansion of irrigation has contributed to a substantial extent in reducing instability in the output of food grains as well as of other crops. Because of this, the poor are less likely to need to borrow to smooth subsistence consumption levels and so avoid the high capital market access costs that they usually face.

4.3 Profitability of rice

4.3.1 Gross margin

The results in Table 8 indicate that gross margin per hectare for irrigators was comparatively higher (GM/ha of Tsh 308 279.3) as compared to that of non irrigators (GM/ha of Tsh 107 440.84). Both GMs had positive and above zero GMs implying that total variable costs were recovered in all farming systems. The t-test results further suggest a statistically significant difference between the two groups, thus corroborating the hypothesis that irrigation rice farming is more profitable than rainfed rice farming.

4.3.2 Returns per liquid capital invested

This was calculated by dividing gross margin per hectare by total variable cost per hectare. It indicates the amount of money a farmer gains from each of his/her shilling spent on the production process. Return per shilling invested is lower for non irrigators (1.6) than that of irrigators (2.78). This implies that irrigation farming uses more technologies like tractors than rainfed farming.

4.3.3 Returns per man-day per hectare

Labour days were divided by area in hectares to get labour input per hectare. The gross margin per hectare was divided by labour input per hectare to get return per man-day per hectare. A return on the basis of returns per man-day reveals that irrigation gives higher overall returns per man day of Tsh 6 830.71 as compared to only Tsh 3 617.94 for rainfed farming. This implies that farmers can benefit more from putting much emphasis on irrigation agriculture since the technology ensures more rice outputs.

Table 8: Gross margin for irrigators and non irrigators

	Particulars	Irrigators	Non Irrigators
a.	Land area under paddy (Ha)	1.06	1.62
b.	Total production (kg)	1 777.09	1 131.35
c.	Yield per Ha (kg) (b/a)	2 281.99	895.89
d.	Price (Tsh/kg)	250.00	250.00
e.	Total revenue (Tsh) (b×d)	444 272.75	282 837.70
f.	Total revenue per Ha (Tsh) (e/a)	419 125.24	174 591.04
g.	Variable cost per Ha (Tsh)	110 845.90	67 150.20
h.	Gross margin* per Ha (Tsh) (f-g)	308 279.30	107 440.84
i.	Total labour per Ha	45.13	29.70
j.	Gross margin per Ha/man-day (Tsh) (h/i)	6 830.71	3 617.94
k.	Gross margin per Ha/shilling of variable cost (h/g)	2.78	1.60

*t-statistics 3.013, p=0.004

4.5 Econometric Model results: Assessment of Irrigation contribution to farmers' income.

Table 9 presents the results of the linear (OLS) regression model for the contribution of irrigation farming to farmers' output. According to the results, five out of eight variables included in the analysis have a significant positive effect on the probability of farm output. Significant variables included education level, household size, number of dependants, farm size and frequency of extension officers' visit.

The coefficient values of these variables were observed to have a positive impact on farm output consequently contributing to overall farmers' farm incomes. Off-farm income and income of other competing crops have an insignificant negative effect on farm output and thus farmers' income. The increase in values of these variables decrease the likelihood of farmers' capacity to produce more rice thus obtains less income. The model R^2 was 0.726472, implying that 72.6% of the variation in the farmer's income is explained by explanatory variables included in the model.

The frequency of extension officers visit to farmers had the highest coefficient value, significant at ($p<0.001$) on rice farm output. This implies that adequate knowledge and advices on agriculture from extension officers increases rice output by 56.3%. The results suggest that farmer's performance on agriculture is highly contributed by the availability of extension officers' services on good agricultural practices for increased outputs. Thus, farmers who are frequently getting extension services are more likely to produce more consequently get more farm income. Increased access to extension services would increase farmers' knowledge on good and modern agricultural practices such as use of improved seed varieties, use of better farm tools, fertilizers, pesticides thus increasing farm output.

The results indicate that number of dependants was negatively and significantly ($p<0.001$) with rice farm output. This signifies that for every unit decrease in the number of dependants in a household farm output increases by 36%. The finding coincides with the expectation because it is obvious that higher number of dependants reduces family labour thus low farm output. The little that is produced is used in the household thus making no room for surplus production thus no sell of produces consequently no income.

Table 9: Regression analysis for Irrigation contribution to farmers' rice output

Independent variables	Coefficient (β)	Std Error	ratios	p-value
Education level	0.221	0.082	2.685*	0.0086
Farm type	0.152	0.047	3.266*	0.0015
Farm size	0.358	0.078	4.610*	0.0000
Household size	0.350	0.124	2.816*	0.0060
Number of dependants	-0.360	0.095	-3.776*	0.0003
Off-farm Income	-0.007	0.009	-0.778	0.4386
Income from competing crops	-0.003	0.020	-0.164	0.8702
No. of extension visits	0.563	0.083	6.784*	0.0000
Constant	0.464	0.104	4.447	0.0000

Dependent variable = Output (Amount of crop harvested by the household)
$R^2 = 0.726$
F – Value = 30.54*, N = 101, *Significant at ($p<0.01$), Durbin-Watson = 1.743

Another significant and positive factor influencing farm output is farm size. This variable had the second highest positive and significant coefficient ($p<0.001$). The positive regression coefficient implies that a unit increase in farm size increases the level of output by 35.8%. Thus it entails that an increase in farm size is accompanied by an increase in the use of innovative farming practices than people with smaller farms. Further, disregarding other production factors, large farms are more likely to produce more total crops than smaller farms. Higher crop production levels assure more income to individual farmers as a result poverty alleviation.

Household size was also observed to have a positive significant influence ($p<0.01$) associated with the level of farm output. This outcome suggests that each unit increase in household size increases the level of farm output by 35%. Thus, households with a larger number of members are more likely to produce more since the households have more mouth to feed they are obliged to increase their production. Availability of labour increases the likelihood of a household to cultivate more land thus higher farm output. In fact, large households tend to look for more land to cultivate as a way of meeting their subsistence level. Consequently these households gain more income for the produces they obtained from their farms. Furthermore, households with large quantities of output are more likely to sell their produces for commercial purposes while households with low farm outputs sell their produces only in case of emergencies thus less income and increased poverty.

The results also show that education levels of farmers was associated with increased farm output. The variable was identified to have a positive and significant association with output at ($p<0.01$). High education level increases the likelihood of farmer to new technologies for improved agriculture practices. The coefficient value of this variable suggests that, each additional increase in farmer's education level increases the level of farm output by 22.1%. This positive relationship was expected because education increases farmer's adoption of new technologies in agriculture and understanding of educative changes provided by extension officers on proper agriculture practices which consequently contribute to high farm output and income.

Among the variables entered in the regression model, the result of the dummy for participation in irrigation scheme was positive and statistically significant ($p<0.01$). This finding suggests that farmers who practice irrigated agriculture produce more than those under rainfed agriculture. This indicates that rainfed agriculture is coupled with low farm outputs, low income hence associated with prevalence of poverty among farmers.

Parameter for off-farm income was not significantly connected with farm output and it was negative as it was anticipated. Farmers who engage themselves more in off-farm activities tend to have less farm incomes since they put most of their efforts in off-farm activities neglecting farming. In addition to that off-farm income does not have any contribution on increased farm output rather that affecting it negatively.

Along with other variables incorporated in the model, income from competing crops has negatively albeit not significant association on rice farm output. Income from competing crops does not necessarily reflect that the farmer's income will increase since these competing crops are grown as subsidiary crops to rice. These crops are grown in small plots and in most cases they are basically for consumption. Thus its contribution to farmers' output is insignificant as the findings present.

4.4 Problems and Challenges Encountered in Development of Irrigated Agriculture.

4.4.1 Inadequate knowledge/information on irrigation agriculture

When the respondents were asked about where they heard about irrigation farming, 65.9% said that they heard about irrigation from friends, 27.3% said they heard from government authorities, 4.5% saw their friends practicing irrigation farming and they decided to practice it themselves and 2.3% heard about it form school. This implies that the farmers are not well informed about this new agricultural technology.

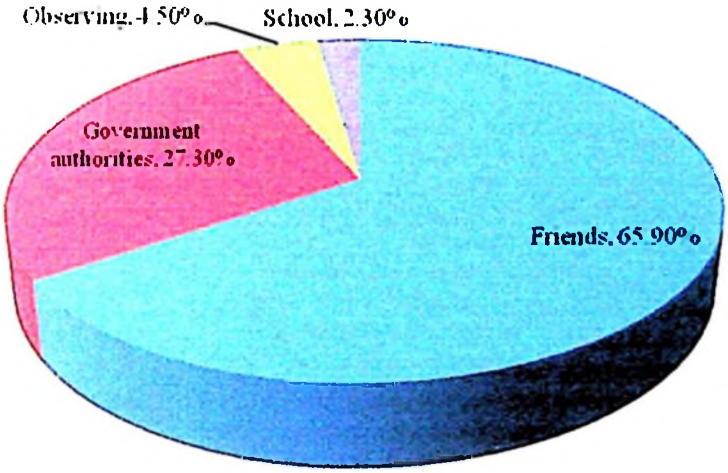

Figure 4: Sources of information on irrigation

There is a big knowledge gap on the importance of irrigation farming for increased paddy production and farmers income consequently poverty alleviation. A bigger percent of the respondents are relatively literate therefore they can understand basic instructions and information on different agricultural technologies.

4.4.2 Pest problem

The presence of crop pests such as birds and mices has been seen as one of the major problem plaguing farmers in the irrigation scheme. About 69% of respondents said that pests hinder their performances in irrigated farming. In comparison with rainfed farms, irrigated farms are more affected by birds due to their location.

4.4.3 Inadequate irrigation facilities

The survey found that 68.8% of the respondents of irrigators said that irrigation facilities are not enough on the District. Further to this, 39.6% of respondents said that the reason behind this is there are few farms in the irrigation scheme as compared to farmers' need as discussed previously in section 4.2.3, 22.9% of respondents said that the scheme itself is not fully developed and 6.3% of respondents said that there is no enough water for irrigation.

4.4.2.1 Pricing irrigation facilities

Pricing of Irrigation facilities in Ulanga is not common. Farmers in irrigation scheme are not charged at all for irrigation facilities. This is a shortcoming in development and maintenance of the irrigation scheme. Under conditions of a reasonable irrigation service fee, the incremental benefits derived by farmers from irrigation are adequate for them to pay the full operation and maintenance cost while retaining a significant increase in net incomes due to irrigation. Tsur and Dinar (1995) also suggest that the majority of pricing mechanisms have little potential effect on income distribution when farmers are homogenous, as equity effects of pricing are primarily dependent on land endowments.

Hussain (2005) also reports that improved recovery of at least operation and maintenance costs of irrigation is important for improving overall performance of irrigation systems. The poor farmers and tail enders suffer more where system performance is unsatisfactory due to poor maintenance resulting from inadequate funding from the public sector or poorly designed irrigation service charging.

4.4.2.1 Underdeveloped irrigation scheme

So long as the government gave priority to funding irrigation systems, there are suggestions to increase farmer involvement as a means of improving irrigation performance. Financial and physical sustainability of the irrigation systems requires some form of collective action among the farmers. The emphasis is on the increasing the participation of resource users in the management of the resources. Participatory irrigation management is important as a means to improve system performance and reduce the fiscal burden of irrigation systems on the government and encourage on farmers' willingness to take on an expanded role in constructing and maintenance of the scheme (Meinzen-Dick *et al.*, 2002).

From the survey, it was observed that the scheme is not fully developed. Maintenance of the main canal and construction of secondary and tertiary canals was still going on and still tertiary canals were not yet built. In some places it was seen that the canal walls were falling down before they are used due to poor constructing materials. When asked about it they answered that there was no enough money to make concrete walls so they just use sand bricks instead. Construction of the scheme canals has led to closure of the scheme for almost six months where it has brought too much effects on farmers' side since they have not been using their farms at irrigation site thus production of crops has stopped.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Empirical analysis of smallholder paddy producers in this study reveals that low productivity of paddy is the main cause of low farm output for most farmers in Ulanga District. The study has uncovered that dependency on rainfed cultivation, large household sizes, too much dependency, small farm sizes, lack of marketing systems and reasonable prices for paddy, under-developed irrigation schemes, little use of agriculture technologies, little knowledge on modern agriculture practices, lack of capital and inadequate extension officers are the main barriers that hinder paddy productivity in Ulanga. If farmers and traders are to be supported to improve production, processing and marketing, they will have secure sources of food and income, and their lives will improve significantly.

On the other hand, a big gap was observed when profitability of irrigators and non irrigators were compared. Findings revealed high values of return per liquid capital invested, returns per-man days and gross margin per hectare for irrigators which imply that irrigation agriculture is more profitable that rainfed farming. Yet most farmers in Ulanga District still practice rainfed agriculture than irrigation agriculture due to prevalence of income poverty among them. Irrigation is seen to be a promising venue for more paddy production but its investment is very slow almost all over Tanzania.

The study further showed that farmers' education level, farm sizes, household size, farm type (that is irrigation or rainfed) and number of extension visits are positively correlated with the level of rice output hence farm income. While increased number of dependants reduced the levels of farm income for paddy. It was also found that the impact of irrigation farming in agricultural development and well being of smallholder farmers in all cases have been generally positive, especially on poverty reduction and food security. For that case, with necessary measure to be taken, there is definitely a room to improve irrigated farming not only in rice but in other crops too. By doing that irrigation farming will modernize agriculture in Tanzania and transform it into a vibrant economy and in the process, will transform small-scale traditional subsistence farmers to commercial scale producing entities in the attempt to reduce poverty.

The primary motivation for this study was to check on the impact increased smallholder rice output, raise farmer incomes and reduce poverty through increased smallholders' participation in irrigated agriculture. Despite rice productivity, profitability and determinants of its output, a number of problems and challenges appeared which posed difficulties on rice output. Inadequate knowledge on irrigated agriculture, the problem of pest, inadequate irrigation facilities, underdeveloped irrigation scheme, less farms on irrigated area and free use of irrigation facilities were the main problems facing irrigating farmers. If these problems were to be tackled, irrigation would ensure promising farm output.

5.2 Recommendations

The results of this study indicate that there are still number of things to be done so that the benefit of irrigated farming to be realized in Tanzania. These include the following:

- In order for rice farmers to lift themselves out of poverty, they should increase paddy productivity significantly by using appropriate farming technology such as irrigated farming, use of fertilizers, improved seed varieties, modern farming tools (tractors and ox-plough as a consequence increase their incomes hence poverty alleviation. A focus should be made by government authorities to enable and encourage farmers to produce more through the provision of adequate knowledge on a more profitable farming system.
- Investment of irrigation in the district is very low and inadequate. To attain maximum crop production capacity, poverty reduction and export, a huge investment and acreage increase under irrigation should be done. Acknowledging the importance of irrigation in crop production, the government must put much emphasis on this profitable agricultural technology. In addition to that participatory irrigation management by farmers themselves should also be encouraged so as to reduce a burden on the part of government when it comes to managing and maintaining the irrigation schemes. The government should also establish a system where farmers will be able to pay some charges for using irrigation facilities since returns in irrigation farming are high enough to allow farmers pay these charges.

- It was observed that traders are the ones who state the price of paddy. Almost all farmers pleaded in for price determination system for paddy to be unfair. This has a big disadvantage on the side of farmers since they are being discriminated by low prices stated by traders. The government should establish standard price systems and standard measurements to allow individual farmers benefit from sales of paddy. In addition to that the government should seek for more market channels for rice/paddy produced, in so doing there will be a big competition for buyers thus rise paddy prices in the market.
- Irrigation farming should be strengthened through special trainings for farmers and irrigation personnel. Water service charges are also important for financing irrigation schemes, so farmers should be made aware of this.

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APPENDICES

Appendix 1: Questionnaire for farmers who are using irrigation

Division .... Village ....

Respondent's name ....

A. **GENERAL INFORMATION**

1. Respondent's Name ....
2. Gender 1. Male
   2. Female
3. Marital Status 1. Single
   2. Married
   3. Divorced
   4. Separated
   5. Widowed
4. What is your level of education?

Level of Education	Tick Appropriate	Years in school	Total
No formal education at all			
Adult education			
Primary education			
Post secondary education			
Others (specify)			

5. Household head 1. Male
   2. Female

6. Relationship to the household head
1. Husband
2. Wife
3. Daughter
4. Son
5. Relative
6. Non relative

7. Household size ....

8. Household Composition

Age	Number of Males	Number of Females
Below 10 years		
11 – 20 years		
21 – 30 years		
31 – 40 years		
41 – 50 years		
Above 50		

8. Which crops do you grow in your farm?
1. ....
2. ....
3. ....
4. ....

B: PERFORMANCE OF THE PRESENT IRRIGATION SCHEME IN TERMS OF YIELD AND PRODUCTIVITY.

9. What is the total land area owned by the family? .... (Hectares)

10. How did you acquire the land
1. Inherited
2. Bought
3. Hired

If bought, how much did you buy it? ....Tshs, when? ...

If hired, how much per hectare/year? ....Tshs

11. Do you irrigate all the land you own? 1. Yes 2. No

11. What is the total area cultivated during the last season (2006/2007) .... (Hectares)

12. For how long have you been practicing irrigation farming? ....

13. Do you plant rice without irrigation? 1. Yes 2. No

If yes, what is the average yield? .... (bags)

If No, why?

....

13. How much rice (bags/acre) did you produce before you started using irrigation? ....

14. Besides rice, what other crops do you grow?

1. Crop ...., Area .... (Acres)

2. Crop ...., Area .... (Acres)

15. Give the amount (in kgs) produced, consumed at home, sold and prices of crops in 2006/2007

Crops	Amount Produced	Amount Consumed	Amount Sold	Unit Price per kg (Tsh)

16. What is the source of labour in your farming activities?

1. Hired
2. Family
3. Both (Family and Hired)

17. Indicate the labour involved in the in the farm operation for rice cultivation

Operation	Family Labour				Hired Labour			
	Hrs/Day	# people		# days	Hrs/Day	# people		# days
		Male	Female			Male	Female	
Land clearing								
Cultivation								
Harrowing								
Sowing								
Weeding								
Fertilizer application								
Pest control								
Harvesting								
Haulage								
Packaging								

18. If used tractor for farming activities, how much were you charged per hectare?

i. Cultivation ....Tsh ii. Harrowing ....Tsh

19. Give information about other inputs used in the farming process

Input type	Quantity (kgs)	Price/unit
Seed		
Fertilizer		
Herbicide		
Sacks		
Pesticide		
Other (Specify)		

C: CONTRIBUTION OF IRRIGATION IN FARMERS INCOME

20. Besides the income received from rice production do you have any other source of income? 1. Yes 2. No

21. If yes, please specify the source(s) and amount earned per year

    a. Source .... Amount per year ....

    b. Source .... Amount per year ....

22. For the period that you have been cultivating by irrigation, what can you say about your income? 1. Increased 2. Decreased 3. Same

23. If your income has increased, how do you spend that money?

    1. Buying farm implements (specify which implements)
    2. House repairing
    3. Paying for school fees
    4. Buying household assets (specify which assets)
    5. Paying for health services
    6. Improving household meals
    7. Putting into the bank
    8. Others (specify)

24. For the period that you have been involving yourself in irrigation, has it been of beneficial to you? 1. Yes 2. No

    If yes, what are the benefits?

    1. ....
    2. ....
    3. ....

D: PROBLEMS AND CHALLENGES ENCOUTERED BY IRRIGATION AGRICULTURE DEVELOPMENT.

25. Where did you first hear about Irrigation farming?

    1. The government
    2. Friends/Family
    3. Seminars
    4. Others (Specify) ....

26. Do you pay any charges when using irrigation furrows? 1. Yes 2. No

    If any, how much per hectare? ....

27. Are irrigation facilities enough for farmers who are using irrigation scheme?

    1. Yes 2. No, If No, how? ....

28. Have you ever contacted extension worker in your areas? 1. Yes 2. No

29. Are the extension workers readily available when you need them? 1. Yes 2. No

30. What are the risks and constraints facing you in irrigation farming system?

    1. ....
    2. ....
    3. ....
    4. ....

31. What are the market outlets of your products?

    1. ....
    2. ....

32. Where do you sell most of your rice/paddy? 1. Village 2. Mahenge 3. Ifakara 4. Dar es Salaam 5. Others (specify) ....

33. What problems do you get when selling your rice?

    1. .... 2. .... 3. ....

Appendix 2: Questionnaire for farmers who are not using irrigation

Division .... Village ....

Respondent's name ....

A. GENERAL INFORMATION

1. Respondent's Name ....
2. Gender 1. Male
   2. Female
3. Marital Status 1. Single
   2. Married
   3. Divorced
   4. Separated
   5. Widowed

4. What is your level of education?

Level of Education	Tick Appropriate	Years in school
No formal education at all		
Adult education		
Primary education		
Post secondary education		
Others (specify)		

5. Household head 1. Male
   2. Female
6. Relationship to the household head 1. Husband
   2. Wife
   3. Daughter
   4. Son
   5. Relative
   6. Non relative
7. Household size ....

8. Household Composition

Age	Number of Males	Number of Females	Total
Below 10 years			
11 – 20 years			
21 – 30 years			
31 – 40 years			
41 – 50 years			
Above 50			

9. Which crops do you grow in your farm?

1. ....
2. ....
3. ....

B: LAND AVAILABILITY AND USE

10. What is the total land area owned by the family? .... (Hectares)

11. How did you acquire the land 1. Inherited
2. Bought
3. Hired

If bought, how much did you buy it? ....Tshs, when? ....

If hired, how much per hectare/year? ....Tshs

12. What is the total area cultivated during the last season (2006/2007) .... (Hectares)

13. Give the amount (in kgs) produced, consumed at home, sold and prices of crops in 2006/2007

Crops	Amount Produced	Amount Consumed	Amount Sold	Unit Price per kg (Tsh)

14. What is the source of labour in your farming activities?

1. Hired
2. Family
3. Both (Family and Hired)

15. Indicate the labour involved in the in the farm operation for rice cultivation

Operation	Family Labour				Hired Labour			
	Hrs/Day	# people		# days	Hrs/Day	# people		# days
		Male	Female			Male	Female	
Land clearing								
Cultivation								
Harrowing								
Sowing								
Weeding								
Fertilizer application								
Pest control								
Harvesting								
Haulage								
Packaging								

16. If used tractor for farming activities, how much were you charged per hectare?

1. Cultivation ....Tsh 2. Harrowing ....Tsh

17. Give information about other inputs used in the farming process

Input type	Quantity (kgs)	Price/unit
Seed		
Fertilizer		
Herbicide		
Sacks		
Pesticide		
Other (Specify)		

C: FARMERS INCOME

18. Besides the income received from rice production do you have any other source of income? 1. Yes 2. No

19. If yes, please specify the source(s) and amount earned per year

    1. Source .... Amount per year ....
    2. Source .... Amount per year ....

20. What can you say about your income and income your fellow farmers who are using irrigation schemes? ....

D: GENERAL INFORMATION

21. Do you know irrigation farming? 1. Yes 2. No

22. If yes, what are the reasons that made you not to practice irrigation farming?

    1. ....
    2. ....
    3. ....