INPUT USE EFFICIENCY IN THE MADIBIRA SMALLHOLDER FARMERS' IRRIGATION SCHEME IN TANZANIA

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ABSTRACT

Efficiency analysis remains an important issue in economic studies, especially for projects which spent tax payers' money, grants and loans. Efficiency has implications on agricultural policy in terms of improving paddy production through improved input use efficiency at Madibira smallholder irrigation scheme. This study sought to determine factors influencing paddy production and technical input use efficiency among farmers at Madibira scheme. The total sample for study was 120 respondents. In addition, the study was also designed to examine specific and some selected characteristics affecting farmers' efficiency at Madibira smallholder famers' irrigation scheme. Descriptive and linear regression analyses were used as analysis tools. The input use efficiency of farmers at Madibira smallholder famers' irrigation scheme was computed using Data Envelopment Analysis (DEA) tool. The study found that land, cost of paddling, and transport cost of bags from the field to the residence were significantly affecting the farmers' efficiency. Other inputs were found to be positive but not significant. The overall technical efficiency of the farmers ranged from 0.423 to 1 with an average of 0.705. This means that farmers were technically efficient since 55% farmers got technical efficiency score of more than 71% which is above the mean score. In addition, the average yield of paddy at Madibira irrigation scheme for the year 2010/2011 was 2.852ton/ha. The average income was TZS 288 9617 in which the maximum and minimum yields were 3.85ton/ha and 1.82ton/ha respectively. To improve efficiency of smallholder farmers at Madibira irrigation scheme Madibira Agricultural and Marketing Cooperative Society (MAMMCOs) should introduce cheap and local technology for seed paddy preparation. Also, loan institutional and cooperative should be strengthened.

DECLARATION

I, Andreas Thomas Kalinga, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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Andreas Thomas Kalinga Date

The above declaration is confirmed

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Dr. Reuben M. J. Kadigi Date

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DEDICATION

I would like to dedicate my dissertation to Almighty God for making this work possible. Secondly, I wish to dedicate this work to my daughters Angel, Kerrin and Faith Kalinga for their spiritual and moral support throughout my studies.

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LIST OF ABBREVIATIONS AND SYMBOLS

ASDP	Agriculture Sector Development Programme
BCC	Banker Charnes Cooper
CCR	Cooper Charnes Rhodes
C-D	Cobb-Douglas production functions
CRDB	Cooperative and Rural Development Bank
DEA	Data Envelopment Analysis
DMU	Decision Making Unity
DR	Decreasing Return to Scale
EE	Economic Efficiency
FAOSTAT	Food and Agriculture Organization Statistics
FFS	Farmers Field School
GDP	Gross Domestic Product
IRS	Increasing Return to Scale
MAMCOS	Madibira Agricultural and marketing cooperative society
MVP	Marginal Value Product
NGO	Non-Governmental Organization
OTE	Overall Technical Efficiency
PTE	Pure Technical Efficiency
RLDC	Rural Livelihood Development Company
SACCO	Savings and Credit Cooperatives
SBM	Slacks Based Measures of Efficiency Model
SE	Scale Efficiency
SNAL	Sokoine National Agriculture Library

TE	Technical Efficiency
U S	United States
URT	United Republic of Tanzania
USDA	United States Department of Agriculture

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

There are wide regional variations in the proportion of irrigated agricultural land worldwide as follows 38 % in Asia, 15% in Latin America; and 4 % in Sub-Saharan Africa. The total irrigated land on the African continent is estimated to be about 12.2 million hectares. Six countries (Egypt, Madagascar, Morocco, Nigeria, South Africa and Sudan) account for nearly 7% of the total irrigated land in Africa (World Bank, 2003).

According to the World Bank (2003), irrigation represents 39% of the value of the World Bank loans to the agricultural sector. Irrigation accounts for 7% more of the loan bank lending in agricultural sector as compared to other sectors. From 1950 through 1993, the Bank lent roughly 31 billion dollars for various forms of irrigation in 614 projects. These projects together with the contributions of government's borrowing, farmers, and co financiers amounted to an investment of 52 billion in 1991 (William, 1995).

Irrigation is the application of specific quantity of water to a particular point of location in order to meet the specific amount of water required for crop growing. Irrigation can be in a form of improved or traditional. Irrigations infrastructure, can involve freely fall gravity or pumping of water. The Government has stressed on the rehabilitation of traditional schemes and improving modern irrigation scheme (URT, 2005).

Apart from other high value crops produced, in many irrigation schemes worldwide, paddy is predominantly grown in these schemes. Today, paddy is grown and harvested on every continent except Antarctica, where conditions make the growth of the crop impossible. Continental paddy production figures are as follows: Asia 574.2 million tons (91% of global paddy harvest), South America 22.6 million tons (3.6% of global paddy harvest), Africa 20 million tons (3% of global paddy harvest), North America 11.1 million tons (1.8% of global paddy harvest) and Europe 3.4 million tons (1% of global paddy harvest) (USDA, 2009).

Paddy production by countries worldwide and their quantities in metric tons are indicated are in bracket. China (197.2) India (120.6), Indonesia (66.4), Bangladesh (49.3), Vietnam (39.9), Myanmar (33.2), Thailand (31.5), Philippines (15.7), Brazil (11.3), United States (11.0) and Japan(10.6). China and India which account for more than one-third of global population, supply over half of the world's paddy. Paddy production in India accounts for 20 % of the overall production (USDA, 2009).

1.1.1 Major paddy producing countries in Africa

In Africa, Egypt is the leading country producing 6.1 million tons of paddy followed by Nigeria 3.6 million tons; the two countries account for 1% and 0.6% of the world paddy production respectively. Another country, which has been doing well in paddy production is Madagascar, which comes close to Nigeria at 3.5 million tons and accounts (0.6%) the world paddy production like Nigeria (USDA, 2009).

1.1.2 Paddy production trend in Tanzania from 2000-2011

Agriculture continues to be the mainstay of the economy in Tanzania, contributing close to 26% of GDP and employing 75% of the labor force, with women contributing more than 75% of the agricultural labor in Tanzania (URT, 2011). Irrigation schemes have been increasing from sixty in 2000/2001 to eighty in 2004/2011, whereas schemes has been constructed covering an area of 249 992 hectares and eleven dams making 1061 hectares of irrigation. In aggregate, the area developed under irrigation up until 2001/2011 was 251 610 hectares, which apart from producing other high value crops, paddy has been a predominant crop making an average of 1 018 440 tons per year;

Paddy production has been increasing annually. Production has been increasing due to increase in number of irrigation scheme. For ten years, paddy production in Tanzania has increased, with an increase of irrigated area. Paddy production in Tanzania would be increased by increasing an irrigated area and effective use of inputs without increase the area of production. For example paddy production has increased from 530 ton in 1998 to 818 ton in 2007 (URT, 2007).

Despite of increasing of irrigation schemes and paddy production, Tanzania is a net importer of rice; however, with improved yields, it could fulfill growing domestic and regional demand (URT, 2011).

Inputs are what go into the farms for transformation to outputs. There are two types of input namely natural inputs (physical) and man-made inputs. Examples of natural inputs include weather, climate, relief, soil fertility, and geology. These natural inputs can sometimes be transformed, but the process is usually costly. For example, climate can be controlled by growing crops in greenhouses; drought can be controlled by starting irrigation schemes. There is adequate evidence that worldwide increased productivity in agriculture has been accounted for by input use efficiency (Umoh, 2006).

To achieve the maximum output with the given quantity of input and technology, efficient use of input is required (Ali and Chaundry, 2007). According to URT (2011), man-made inputs include machinery, fertilizers, pesticides, and seeds to mention but a few. In the context of this study inputs which go into the farm were referred to as water, seeds, fertilizers, tractors, pesticides, insecticides, land, labour (hired family labour) and capital. Declining crop yields have been manifested by declining soil fertility due to leaching, erosion, and human activity in the existing irrigation schemes (Ceesay, 2004)**.** Major factors contributing to the declining soil fertility in the schemes is the low external input use.

According to Morris *et al.* (2007), the substantial difference in agricultural productivity and yields seen between Asia and Africa can largely be explained by differences in morden input use.Statisticaly Morris *et al.* (2007), found that Asia continent use more modern input than the Africa continent.

About 660 kg N ha^{-1}, 75 kg P ha^{-1}, and 450 kg K ha^{-1} have been lost worldwide during the last 30 years from about 200 million ha of cultivated land (Tabu, 2010). Sanchez (2002 cited by Ceesay, 2004) estimated the annual depletion rate of nutrient to be as high as 22 kg of nitrogen (N), 2.5 kg of phosphorus (P), and 15 kg of potassium (K) per hectare of cultivated land over the last 30 years in 37 African countries. Losses of nutrients have been attributed to less input use but more output. During the 1960's and 1970's, external input paradigm drove research and developed the agenda of today. Appropriate use of external inputs namely fertilizer, water and lime are believed to alleviate any constraint to crop production (Tabu, 2010).

The diagnostic studies of fertilizer use in Africa suggest that fertilizer use is low in Africa for four interrelated factors: erratic rainfall, drought, poor landscape management and poverty of farmers to meet the prevailing costs of accessing inputs. Efficient use of fertilizer means a supply of proper amounts of plant nutrients at the correct time to the plants while at the sametime avoiding losses as much as possible (Kimbe and Semoka, 2001). Proper fertilizer application rate, increases crop yields by correcting nutrient difficiency. The optimum rate of fertilizer application to a crop is the rate that produces maximum economic returns (Kimbe and Semoka, 2001). Another important factor for input use efficiency is irrigation, and this is precisely because of the fact that Tanzania receives low amounts of rainfall, and which is erratic and extremely variable in space and time (URT, 1994). Therefore, irrigation is generally considered to be an effective way of increasing agricultural production. It can supply the water needed for crop growth during scarce rainfall periods; in more humid climates, irrigation can bridge dry spells and reduce agricultural risks (URT, 2008).

1.2 Problem Statement and Justification

It is widely held that efficiency is at the heart of agricultural production. This is because the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources. It has been proven that continued inefficient use of inputs in the irrigation schemes will delay or not repay the investment cost incurred during the construction of such schemes (Umoh, 2006).

It is believed that input use efficiency in irrigation schemes could play an important role in rural development because of their potential to provide food security, generate income and provide employment opportunities. However over decades, small scale farmers have removed large quantities of nutrients from their soils; and have failed to use sufficient quantities of manure or fertilizers to replenish the nutrients. On average, the production of paddy at Madibira smallholder farmer’s irrigation scheme was 2.852ton/ha in 2011/2012, this is below the national average paddy production of 4.5ton/ha. Furthermore, the performance and economic success of different irrigation schemes have been poor raising questions on the levels reached of inputs use efficiency. The production of paddy in

Madibira calls for research to ascertain the inefficient use of inputs. It is nevertheless difficult to ascertain whether the use of input is efficient or not, since irrigated agriculture is a multiple input. As Ali and Chaundry (2007) found out, farmers could increase production by a certain percentage if they could operate at a full technical, allocative and economic efficiency levels with their existing technologies. A study by Mwandosya (2008) found out that many developing countries are not food secure, which could probably be attributed to input use inefficiency. According to a study done by Awulachew *et al.* (2005), if input use efficiency is not improved in irrigation schemes, food scarcity will continue to worsen by 2025.

A few studies have been undertaken to measure inputs use efficiency in paddy production in Tanzania. the reason that there are few studies indicate the presence of shortfalls in measuring input use efficiency indicating that outputs could be low with given inputs and existing technologies. Therefore, this study sought to find out whether or not the yields variability of paddy by Madibira smallholder farmers was due to inputs use efficiency. It was envisaged that the findings would assist in setting appropriate policies that might enhance irrigation inputs efficiency.

1.3 Objectives of the Study

1.3.1 General objective

To investigate input use efficiency in Madibira irrigation scheme for improving productivity of the smallholder farmers.

1.3.2 Specific objectives

(i) To identify factors that influence input use efficiency in the paddy production in Madibira smallholder irrigation scheme,

(ii) To determine input use efficiency by smallholder farmer in the irrigation scheme and,

(iii) To determine the constraints facing paddy producers in Madibira smallholder farmer irrigation scheme.

1.4 Research Hypotheses

Ho_1: Socio-economic factors do not contribute significantly to input use efficiency at Madibira irrigation scheme.

Ho_2: Input use efficiency does not contribute to technical input use efficiency.

Ho_3: Availability of inputs at Madibira does not significantly constrain smallholder's farmers at Madibira irrigation scheme.

1.5 Conceptual Framework

Irrigation /water efficiency compares the water outputs, to the water input at different points of the farm or irrigation system. The concept of water use efficiency includes both water use indices (WUI) and irrigation efficiencies. The two terms differs as water use indices compare a production output (yield, return, gross margin) to the water input such as irrigation water, to total water or evapotranspiration at some level in the form or production system. To identify input use efficiency the consistent of water supply to crop is essential through irrigation.

Efficient use of the machinery in this study means proper cost of ploughing and cultivation paid by the farmers to the owner of the machinery. Efficient use of seed means proper use of quality and improved seeds including the amount recomended. Land as input was constant to all farmers, which is one hector for each. From the framework below, proper use of land, working capital, labor, fertilizers, and seeds can lead to input use efficiency, as results to the overall technical efficiency. Out of human cause, inefficiency can be due to outside scope. These outside scope include drought, climate change, and misuse of working capital. Inefficiency causes low paddy production and hence revenue. The efficiency of input use can be attributed to capital management skills, experiences in irrigation scheme particularly paddy production.

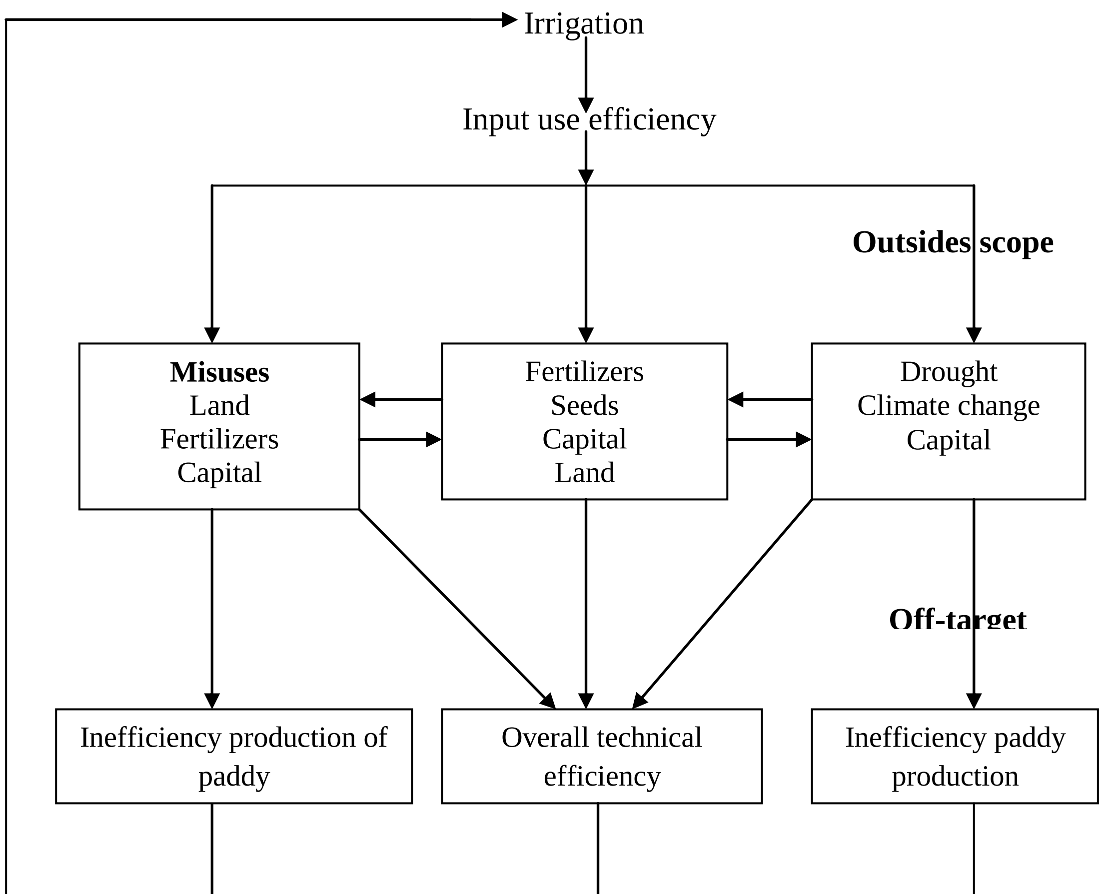

Figure 1: Conceptual Framework

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Policy Review

The development of irrigation systems is seen as an important aspect of the agricultural development strategy, which can help the nation to achieve the following objectives, 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, increasing farmer's productivity and income (URT, 1997).

The policy environment is critical to the development of irrigation, providing the framework of national goals and requirements within which regional and local targets are to be met. The objectives of the National Irrigation policy are to ensure efficient use of irrigation water and sustainability of its use for enhanced crop production, productivity and profitability that will help food security and poverty reduction (URT, 2005).

2.2 Benefits of Irrigation and Input Use Efficiency

According to Droogers (2008), irrigation potential in Tanzania is 29.4 million hectares out of which 2.3 million hectares are high potential, 4.8 million hectares are medium potential and 22.3 million hectares are low potential. Currently, only about 306 000 ha are under irrigation, which is about 2.314% of the cultivated area; and irrigated agriculture needs to be promoted to improve productivity (URT, 2011).

The aim of irrigation is to increase one or more of the following items: cropped area (more land under crops); crop yields (more crop production per ha per season); cropping intensity (more crops per ha per year); and diversity of cropping (more kinds of crops)

(Oosterbaan, 1988). Irrigation contributes to growth of the agricultural sector which employs more than 80% of the country’s population and contributes about 65% of the export revenue generation, and 24% of the GDP (URT, 2009). The development and rehabilitation of 46 000 hectares of irrigated land under the Tanzania ASDP increased the average yields for paddy from 1.9 tons to 4.5 tons per hectare and raised the average gross income per hectare from Tsh 1.5 million to Tsh 3.6 million per year (World Bank, 2010 cited by URT, 2011).

2.3 Input Use Efficiency

Land degradation and soil fertility depletion are considered to be the major threats to food security and natural resource conservation in Sub-Saharan Africa (Semoka *et al.*, 2001). Also, low soil fertility is recognized as an important constraint to increased food production and farm incomes in many parts of Tanzania (Semoka *et al.*, 2001). The nutrient loss is a result of many factors namely leaching, erosion, and poor landscape management. This is definite to the farmers who use fair amounts of inorganic fertilizers and other methods to replenish their soils nutrients. Evidence of a decline in soil fertility has been reported in Mbeya region (Mwamfupe, 1998). The traditional way to overcome nutrients depletion is the use of mineral fertilizers (Ceesay, 2004). Inputs use efficiency, which is an alternative to the traditional method of overcoming nutrients depletion is becoming one of the important factors facing inputs users and managers in irrigation schemes (Droogers, 2008).

An increase in productivity due to input use efficiency is crucial for improving the livelihood of smallholder farmers who make the majority of the poor in Tanzania. Resource use efficiency emphasis is on marginal productivity because it is the most economical and optimal way to maximize the net output in farming; and a resource is said to be efficiently used if its marginal product is equal to the cost of production. If the marginal value product is greater than the unit input price (MVP >Px), it implies under-utilization of the resource and this indicates the scope for raising output efficiently by increasing the use of that particular resource (Idiong *et al.*, 2008).

Technical efficiency (TE) can be defined as the ability of farmers (producers) to attain maximum output given a set of inputs and technology. Allocative efficiency refers to the ability to contrive an optimal allocation of given resources; while the economic efficiency is a combination of technical and allocative efficiency (Ali and Chaundry, 2007). According to Zahidul (2011), several recent studies on technical efficiency (TE), allocative efficiency, and economic efficiency (EE) of crop production for paddy indicated the existence of a 'yield gap'. This 'gap' refers to the difference in productivity between 'best practice farms' and other farms that operate with comparable available resources under similar circumstances in irrigation schemes. Irrigation is becoming an essential factor in productivity growth especially in the developing agrarian economies, where resources are scarce. Inputs use efficiency in a scheme can be measured using different approaches .Hwoeever in this research, the efficiency was estimated by data envelopment analysis (Battese, and Coelli, 1993; 1995).

2.4 Factors Influencing Inputs Use Efficiency in Irrigation Schemes

Paddy production is low and the efforts to increase production are hindered by high input costs, and low yields especially in the smallholder farmers managed schemes. A study by Erastus (2010) found out that inputs were not efficiently utilized in farmer managed irrigation schemes and their sustainability of schemes was low due to lack of experience, and education. In another study, Balirwa (1990) also found out that large irrigation schemes in Tanzania were not economically viable and not sustainable.

Farmers' knowledge on inputs use efficiency is critical for improving output. Efficiency on-farm irrigation depends on energy use, labour and capital investment, and how these aspects relate to production, and profitability. According to Xu and Scott (1995), in developing countries, some new agricultural technologies have only been partially successful in improving production efficiency. This is often attributed to lack of ability and willingness to adjust input levels on the part of producers due to familiarity with traditional agricultural systems.

2.5 Review of Empirical Technical Efficiency Analytical Tools

There are different analytical tools which can be used to estimate frontier technical input use efficiency. The most common ones include stochastic frontier (SF) and Data Envelopment Analysis (DEA) (Battese, 1993; 1995)

2.5.1 Strengths of stochastic frontier analysis model

Stochastic frontier model adopts the production function

$Y = f(x; \beta).\exp(v).\exp(-u)$ $v \leq 0$ and $u \geq 0$…………………………………..………….(i)

Y= is the maximum output producible from a given vector of inputs (x)

Where β=are the production function parameters

$f(x; \beta)$ is the deterministic output

exp (v) is the effect on output of exogenous shocks

exp (-u) is inefficiency

$f(x; \beta).\exp(v)$ is stochastic frontier

From the production function above, Y could be less than the maximum output. In fact, any output less or equal to Y can be produced

$Y = f(x; \beta).\exp(v - u)$

(v – u) composite error term

Error term with 2 components: (v) conventional error term plus term representing deviation from frontier, (-u) is relative inefficiency. Convectional error term can be due to climate change, drought, varieties and pests to mention a few. The stochastic frontier allows for hypothesis testing, and confidence interval such as being significant at 5% or 1%.

2.5.2 Weakness of stochastic frontier analysis model

The Stochastic frontier model assumes a functional form for the production function (i) above. Also it assumes a distributional form of the technical efficiency term, it considers single output dimension, and the frontier depends on the set of countries to be considered (inefficiencies can be underestimated).

2.5.3 Data envelopment analysis

Data Envelopment Analysis (DEA) is a non-parametric methodology used to assess efficiency of a Decision-Making Unit (DMU – e.g. a farmer) in converting a set of inputs into output(s). DEA can be either input or output-oriented. The in-put oriented DEA defines the frontier by seeking the maximum possible proportional reduction in the input usage, holding the output level constant for each DMU (Linh, 2009).

The output-oriented DEA defines the frontier by seeking the maximum possible proportional increase in the output production holding the input level fixed for each Decision Making Unit (DMU). DEA can use Cooper-Charnes-Rhodes (CCR), Banker-Charnes-Cooper (BCC), or Slacks-Based Measure of efficiency Model (SBM). A measure of technical efficiency under the assumption of constant returns-to-scale (CRS) is known as a measure of overall technical efficiency (OTE). To get an overview of the inefficiency source, OTE can further be disaggregated into Pure Technical Efficiency (PTE) and Scale Efficiency (SE) (Linh, 2009).

The PTE measure is obtained by estimating the efficient frontier under the assumption of variables returns-to-scale. The PTE is a measure of technical efficiency without scale efficiency and purely reflects the managerial performance in organizing the inputs in the production process. Thus, PTE measure has been used as an index to capture managerial performance. The ratio of OTE to PTE provides SE measure. The measure of SE provides the ability of the management to choose the optimum size of resources, in other words, to decide on the firm size or to choose the scale of production that will attain the expected production level.

Inappropriate size of a firm (too large or too small) may sometimes be a cause of technical inefficiency. This is referred to as scale inefficiency and takes two forms: decreasing returns-to scale (DRS) and increasing returns-to-scale (IRS). Decreasing returns-to-scale (also known as diseconomies of scale) implies that a firm is too large to take full advantage of scale and has supra-optimum scale size. In contrast, a firm experiencing increasing returns-to-scale (also known as economies of scale) is too small for its scale of operations and, thus, operates at sub-optimum scale size. A firm is scale efficient if it operates at constant returns-to-scale (CRS) (Izah *et al.,* 2011 Gulati *et al.*, 2009; Gul *et al.,* 2009; and Ajibefun, 2009).

Different researchers use DEA approach to calculate efficiency of the firm. For example, Fernandez *et al*. (2009) in their study on technical efficiency in the production of the sugar cane in central Negros Area Philippines used DEA and found that farmers were not efficient in using the inputs. Linh (2009), on the other hand, used both DEA and SFA to estimate efficiency of paddy farming household in Vietnam, and his findings were that many farms in the that country were operating with less than optimal scale of operation. Also Daniel *et al*. (2010) used DEA in explaining production inefficiency in China's agriculture; while Brázdik (2006) used DEA on factors affecting efficiency of West Java paddy farms. Brázdik (*Ibd*) found that famers were not technically efficient due to several factors. On the other hand, Adepoju *et al*. (2009) when studying the no-farm activity and production efficiency of farm households in Egbeda Local Governments Area, Oyo State, applied the DEA and revealed production inefficiencies in many DMUs. In their study, Adepoju *et al*. (*ibd*) used input–output bundle for each farm household (technical, and scale efficiency) and the findings reveal that farmers were not efficient. Similarly, Gulati and Sunil (2008) used DEA to examine technical, pure technical, and scale efficiencies in Indian public bank sectors. The empirical findings reveal that public sector operate at 88.5% level of overall technical efficiency.

A wide range of researchers have also used Data Envelopment Analysis in their studies. The list includes but not limited to Dhungana *et al.* (2004); Sang and Hyunok (2004); Krasachat (2004); Umetsu *et al*. (2003); and Wadud and White (2000 as cited by Brazdik 2006), who at different times evaluated paddy farms' efficiency in the economies of Asian countries and divulge that many DMUs were not economically efficient. Despite all these extensive uses, DEA has got its own strengths and weaknesses.

2.5.4 Strengths and weakness data envelopment analysis

DEA as a tool for data analysis has several strengths over other tools. These include the fact that it can handle multiple inputs and multiple outputs at a time. That is, it can accommodate more than one input and output. Also, DEA doesn't require relating inputs to outputs. Input and output can be different but still computation can be processed.

All the same, DEA can do direct comparisons against peers. In other words, firms which are related in operation with each other can be compared. Strength of DEA is that inputs and outputs can have very different units. Most of the software used in computing efficiency require the units of input and output to be the same, which is different for DEA. Over these advantages against stochastic frontier DEA was adopted in computing results in these researches.

Apart from the strengths of DEA, there are some weaknesses associated with it. For instance, measurement error can cause significant problems; however, the input units can be accurately taken so as to avoid error of results. Another weakness of DEA is that it does not measure “absolute" efficiency. It measures efficiency in comparison with the efficiency of frontier which is one. This implies that any firm which did not score one then it is inefficient. Moreover DEA does not apply statistical tests which are commonly applied in econometric analysis. In using this program, one does not need to know the statistical significance levels such as 5% or 10%. Also, using DEA on large scale, problems can be computationally intensive (Coelli, 1997).

2.5.5 Sensitivity of data envelopment analysis

A critical issue in non-parametric programming technique is its sensitivity to the selection of inputs and outputs to be used because they affect the discriminating power of DEA (Boussonfiane, 1991). DEA is sensitive to a number of variables, so it should be reduced to include the most relevant factors by judgmental screening. It should be achieved by aggregating factors through summing (Battese *et al*., 1995). The number of observation should exceed the number of variables (inputs) and output several times. The higher the number of samples the large is the probability of capturing the performance units which determine the efficiency frontier Golany and Roll (1989).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of Study Area

3.1.1 Location of the study

The study was conducted at Madibira smallholder farmers' irrigation scheme, in Mbarali District. The district lies between latitude $7^0$and 9^0 South and longitude $33.8^0$and 35^0 East. It borders Chunya District in the northern side and Iringa rural District in the northeast. In the northwest, it borders Mbeya rural and Makete Districts in the western side. Mbarali district shares border with Njombe District in the southern part and Mufindi District in the southeast. Madibira irrigation scheme is situated at Madibira Ward. The Ward comprises a total of 9000 ha of cultivatable land, and has four villages which are involved in the cultivation of the area under the scheme. In this study, two villages namely, Mahango and Mkunywa were involved. The respondents were from all the hamlets of the two villages. Other people from other parts of the country can access the plot provided they abide by the by-law of the scheme

Madibira irrigation scheme has a reliable water supply for high efficiency of inputs use. The availability of irrigation water and facilities makes it easy for the land to be used whenever is the need arises rather than when it is available and is an economic or engineering issue. Madibira irrigation scheme deals with paddy production only in every growing season. The land in the scheme is owned by the MAMCOS. MAMCOS rents out the land to farmers (members) who are willing to use irrigation facilities at TZS 85 000 per hectare as annual membership fee. Each member is allowed to rent-in only a hectare (2.5 acres) so as to allow many farmers to have access to the irrigation facilities. The famer who had rented a plot in the scheme could transfer it to someone who did not have the land at a transfer cost ranging from TZS 500 000 to 600 000. Only 3000 ha out of the 9000 ha of irrigable land have improved facilities (infrastructure for irrigation).

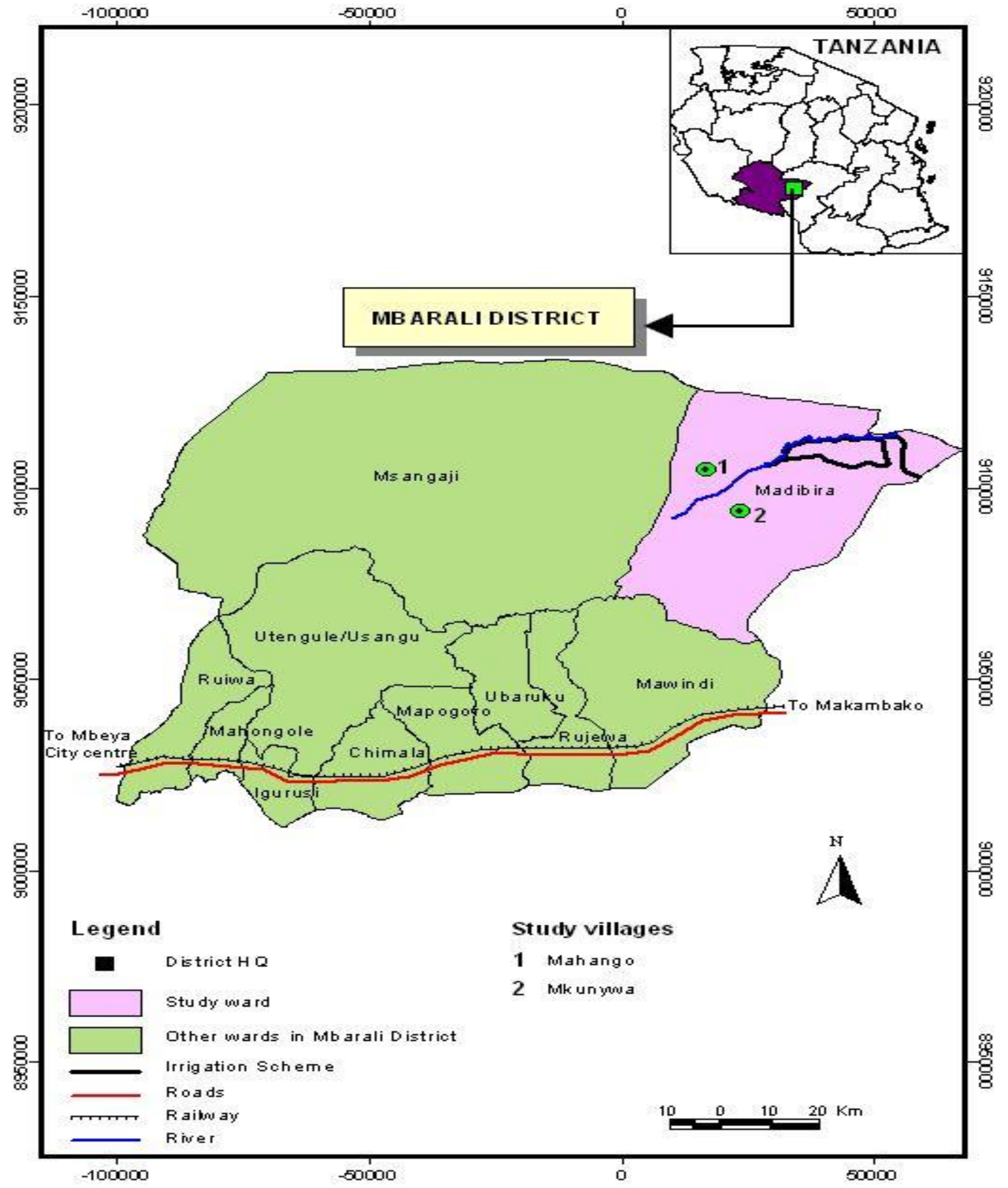

Figure 2: A Map showing location of Madibira irrigation scheme

3.1.2 Population and economic activities

According to URT (2012), the population of Mbarali District was 300 517, out of which 145 867 were males and 154 650 were females. The current population projection is about 282 911 with the growth rate of 2.8% per annum. As for Madibira, the Ward has a population of 24 742 composed of 12 103 males and 12 639 females, making 8.2% population of Mbarali Districts. The Household size of Madibira ward is 4.5 UTR (2012). The economy of Mbarali people depends mainly on agricultural activities, for both crop production and livestock keeping. About 83% of Mbarali communities are engaged in agriculture, mostly paddy farming, and a few are engaged in business, fishing, livestock and civil service employment. Per capita income of Mbarali in the year 2008/09 was TZS 350 000. Paddy and sunflower are the main cash crops used for business transaction, within and outside the district (URT, 2009). Farmers depend heavily on irrigation schemes; these include Madibira irrigation scheme, which has the total area of 3000 ha; Kapunga irrigation scheme with the total area of 3000 ha; Igomelo scheme which has the total area of 312 ha; and Ipatagwa scheme which covers the total land area of 540 ha (URT, 2009).

3.1.3 Research design

The study adopted a cross- sectional research design. According to Babbie (1994), this method allows the collection of information at once in a single point of time. The design was suitable for this study because of the limited time and financial resources needed during data collection.

3.1.4 Sampling procedure

Purposive sampling method was used to select villages which were involved in this study. The villages included Mkunywa and Mahango. In addition, simple random sampling was used in the selection of the respondents from the list of smallholder famers engaged in Madibira irrigation scheme. Eventually, the total sample of 120 farmers was obtained for the study.

3.1.5 Sample size

The table for determining minimum returned sample size for a given population size for continuous and categorical data was used to determine the appropriate sample size for the current study. By using this type of approach, a categorical data of 120 total respondents were selected (Appendix 2).

3.2 Data Collection

3.2.1 Primary data

The study involved multiple data collection tools such as interview schedules, focus group discussion, and information from key informants. The primary data from the interviewees were collected using questionnaires. The tool consisted of both closed and open ended questions. The open ended questions sought to collect information on the respondents' understanding of good agronomic principle and the aspects of inputs use efficiency. On the other hand, focus group discussions and Key informant interviews helped to explore constraints farmers were facing at Madibira irrigation scheme.

3.2.2 Secondary data

Other data were obtained from published and unpublished sources such as journals, reports, and theses of irrigation and input use efficient from Sokoine National Agricultural Library (SNAL) and Ministry of water and Irrigation. Data on input use efficiency and socio-economic factors were included to check for comparisons with the current yield standard of the smallholder farmers at Madibira irrigation scheme and in other parts of world.

3.2.3 Pre-testing of instruments

Before the actual data collection, the instruments for primary data collection were tested by involving stakeholders and non-stakeholders of the scheme users to check for the validity, suitability, and reliability of information to be collected. The findings were used to revise the tools before the final version of the same which was administered to the research sample.

3.2.4 Data analysis

The collected data were coded and analyzed using Statistical Package for Social Sciences (SPSS). Descriptive statistics were carried out to yield means, frequencies, and percentages. To determine factors contributing to the observed input use efficiency, model (i) below was formulated and estimated jointly with the Data envelopment analysis model in a two stage Maximum likelihood estimation procedure using the computer software frontier version 2.1 (Coelli, 1996).

3.2.4.1 Data analysis by specific objectives

(i) Analysis of first objective

The first objective was to identify factors contributing to the observed input –use efficiency in paddy production at Madibira smallholder irrigation scheme. The objective was analyzed using ordinary regression model.

(i)Yi= ß0+ß1ed+ß2Lnd+ß3Hh + ß4Exper+ ß5Loin + ß6Lofm + ε

Where:

Yi=value of the input use efficiency for i^{th} farmer.

$ß_{0=}$is an intercept.

Loninfor = Loan from informal sectors e.g (friends, local lenders) in TZS

Lonforma= Loan from formal sectors eg, (SACCOS, and Banks) in TZS

Ln= Land in (acreage) in ha

Ed=Education (years of schooling)

Hh=House hold size

Experience = Experience of the farmers in irrigation schemes in years

ε= error stands for the factors which are not captured in the model

(ii) **Analysis of second objective**

The second objective was to determine technical input(s) use efficiency in the irrigation scheme among farmers at Madibira smallholder farmers' irrigation scheme. Technical efficiency scores of Madibira smallholder irrigation farmers were analyzed using Data Envelopment Analysis program. The DEA methodology of interest in this study is that of Fare *et al.* (1989). The method involves the use of linear envelopment frontier over the data points such that all observed points lie on or below the production frontier. In-put oriented DEA was selected because DMU or farmers are able to change input quantity to increase output and not fix output while the input is increasing or decreasing.

In this study, input-oriented approach was used to calculate the efficient of each DMU of smallholder farmers sampled at Madibira irrigation scheme. Efficient of input use was analyzed using DEA. Different activities were grouped into one variable according to their similarities or nature. Manual activities such as land clearing, land preparation, nursery preparation, plot leveling, planting/ transplanting, hand weeding (uprooting), fertilizer application, herbicides application, bird scaring, and harvesting were measured in terms of the number of days spent per person. The activities done using machines (i.e. ploughing and paddling by tractors) were measured in terms of hours used. In determining the extent of technical, pure technical, and scale efficiencies of individual farmers, a two-stage of DEA methodology was adopted. In the first-stage of the methodological framework, technical, pure technical, and scale efficiency scores for individual farmers were obtained by employing one popular DEA model, namely CCR, which involves only the conventional inputs and outputs.

In principle, the j^{th} farm out of 'n' farms the input based technical efficiency (TE) under constant return to scale (CRS) is measured as follows;

$TE_j = \text{Min } Q_j^{crs}/Q_j^{crs}$ ………………………………………………………………... (1)

St. $Y_j \leq Y_\lambda$, $Q_j^{crs} X_j \geq X_\lambda, \lambda \geq 0$,………………………………………………………(2)

Where X and Y are the input and output vectors respectively, $\mathbf{Q_j^{crs}}$ is technical efficiency of farm j under CRS and λ is an n×1 vector of weight. In general, $\mathbf{0 \leq Q_j^{crs} \leq 1}$,

$\mathbf{Q_j^{crs} = 1}$ if the farm is producing at the production frontier and hence technically efficient.

When $\mathbf{Q_j^{crs} < 1}$, if the farmer is technically inefficient.

In the case of variable returns to scale, one can find technical efficiency, $\mathbf{Q_\lambda^{vrs}}$ under variables return to scale by adding the convexity constraint $\mathbf{\Sigma\ \lambda_j = 1}$ because the variable return to scale is more flexible so the convex hull envelope the data more tightly than under CRS. $\mathbf{Q_j^{vrs}}$**,** is always equal or greater than $\mathbf{Q_j^{crs}}$. Scale efficiency (SE) is measured by the formula: $SE_j = Q_j^{crs}/Q_j^{vrs}$……………………………..(3)

In general, $\mathbf{0 \leq SE \leq 1}$, with SE=1 representing economies of scale.

SE < 1 implies that the inputs are not scale efficient, which can be either increasing return to scale (IRS) or decreasing return to scale (DRS) (Linh, 2009).

(iii) **Analysis on third objective**

Constraints facing paddy producers at Madibira smallholder farmers' irrigation scheme were counted from the data collection tools. Smallholder farmers were asked to mention the biggest constraints facing them in paddy production. Constraints were counted, were ranked and weighted in accordance with the frequency of being mentioned by farmers.

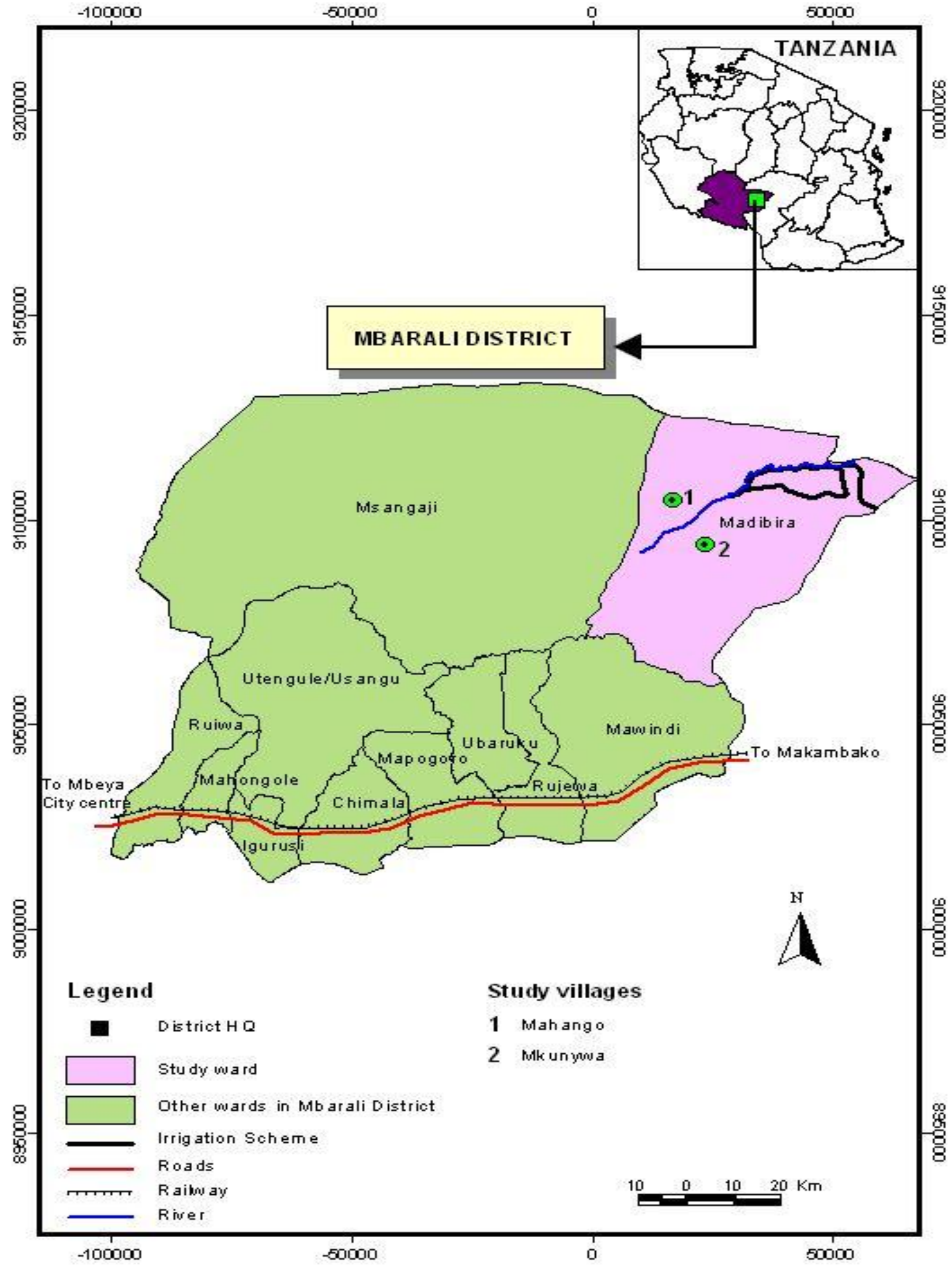

Figure 3: Map of Mbalali District showing Madibira irrigation scheme

Table 1: Summary of the independent variables used in DEA, and regression model

Variables	Description
Edurespo	Years of schooling
Agerespo	Age of respondent in years
Lansize	Size of plot cultivated in ha in 2010/2011
Loaninf	Access to informal loan(local lenders) Dummy 0=no/1= yes
Loansemfo	Access to semiformal loan(SACCOs) Dummy 0=no/1= yes
Capt	Capital invested in 2010/2011 in Tsh
Transport	Weeding time for the first time after transplanting(in days)
Nursery time	Time of seedlings from sowing to transplanting (in days)
Costpadd	Cost of paddling used in 2010/2011 in TZS
Costplou	Cost of ploughing the respondent used in 2010/2011 in TZS
Hrdlob	Hired labour (in man-days*Number of labourer*Cost per each) in TZS
Seeds	In kg
Herbicides cost	Cost of herbicides in TZS
Hand weeding,	In TZS
Yield	in Kgs/ha
Household size	Household size in numbers

3.2.6 Expected signs from the variable coefficients

Education: Education is often associated with efficiency use of input. The expected sign is positive which means that education increases efficiency of input use.

Land-in: The anticipated sign for land is positive or negative depending on the size of land farmers cultivated. The efficient use of land in Africa decreases with an increase in land size and the opposite is true in Asian and European countries under *ceteris peribus*.

Household size: Household size is the major source of labour supply in any firm/field. The anticipated sign of household size was positive because as family increase so does the size of labour force which is instrumental in the productive activities. This helps in capital saving.

Experience**:** Experience of growing paddy in irrigation scheme was treated as numbers of years farmed in the scheme. Experience of growing paddy was expected to influence farmers technical input use efficiency positively.

Loan from semi-formal institutions: as for loans from semiformal institutions, the anticipated sign is positive since loan is expected to improve the working capital, hence efficiency of the farmers.

Loan from non-formal: The anticipated sign for loan from non-formal institutional is negative sign especially due to higher interest rate charged. Although loan improves working capital, the cost of loans from non-formal financial institutions exceeded the benefit, and indeed those who used this loan were not rational.

CHAPTER FOUR

4.0 RESULTS AND DISCUSION

4.1 Socio-economic Characteristics of the respondents

4.1.1 Family size

The findings of the present study show that the average household members at Madibira irrigation scheme were 6 persons per household (Table 2). The maximum number of family members was nine and the minimum was one. The household size of the family in Madibira irrigation scheme was above the national average family size of five per household in the 2012 population census. Family size helps in the availability of labour in the firms. Engaging in the work in the scheme helps the family in saving the working capital.

4.1.2 Age of household

The respondents were categorized by age in three groups (Table 2). The first group comprised of the respondents whose age ranged from 20-35 years; these were referred to as young people. The group of adults consisted of the respondents with the age range of between 35 and 50 years, which is considered to be the working age group. The last group was that of old respondents aged 50 years and above. Descriptive analysis revealed that, on average, 25%, 50% and 24% of the young, adults and old people respectively were participating in the irrigation scheme. This implies that adults participated in the scheme more than did the other age groups.

4.1.3 Securing plots in the scheme by gender

Madibira smallholder irrigation scheme is owned by Madibira Agricultural Marketing Cooperative Society (MAMCOS) where both females and males have an equal chance of securing a plot in the scheme. However, the average participation for males and females in the scheme was 68% and 32% respectively (Table 2). The findings are similar with those in a study by Erastus (2009) who found that participation of females and males was 36.9% and 63.1% respectively.

4.1.4 Education level of household

As indicated in (Table 2), it is evident that all the respondents were literate. Their education level ranged from primary school to college. The findings showed that 88.3% attended primary school, while those who attended secondary school and college were 5.8% for each group. Out of all the respondents, none had either adult or informal education. Similar studies show that most of the farmers participating in irrigation schemes have primary education while few have either secondary or college education. Similar findings are reported by George (2009) who found that 75% of the respondents had primary education whereas only 6% had secondary education.

4.1.5 Average land size

According to MAMCOS regulations, a farmer is entitled to rent only one hectare of land from the scheme. This is meant to give opportunities for more farmers to have access to irrigated land for paddy cultivation. However, this study revealed that the average land size managed by the farmers in the scheme was 1.114 ha in 2010/11 (Table 2). This implies that there were farmers with more than one hectare as the farmer who had rented a land from MAMCOS could transfer that land to another farmer who already had a hectare or more.

4.1.6 Working capital

Farmers at Madibira irrigation scheme obtained their working capital from the SACCOs. In order to become a member of the SACCOs, a farmer was obliged to possess a plot in the scheme. At the time of data collection, farmers could borrow up to TZS 528 333.3 per year from the SACCOS as a working capital which would be returned within one growing season. Loans from local lenders averaged to TZS 31 666.7 and only few farmers borrowed from the local lenders as their interest rates were higher than were the case with those of SACCOs (Table 2).

4.1.7 Yield of paddy

It was revealed that the area under paddy cultivation gave a total yield of 381.2tons in 2010/11 season which is equivalent to an average yield of 2.9ton/ha. The observed maximum yield was 5.8 ton/ha while the minimum was 2.730 ton/ha per person. These findings show that farmers at Madibira irrigation scheme were producing below the recommended yield level of 4.5ton/ha in Tanzania under irrigation (US, 2010). The underproduction could be associated with inefficiencies caused by various reasons as identified in Table 11 on the inefficiency.

Table 2: Results showing socio-economic characteristic (n=120)

Variables	
Age between 20-35 years (working young) (%)	25.0
Age between 36-55 years (working adults) (%)	50.8
Age above 55 years (working old) (%)	24.2
Primary school completed(in years)	88.3
High/secondary school(in years)	5.8
College(in years)	5.8
Household with 1-3 members(small household) (number)	15.8
Household with 4-6members(medium household) (number)	51.7
Household with more than 7 members(large household) (number)	32.5
Male (%)	68.33
Female (%)	31.67
Average land size (acre)	1.114
Average yield (ton/ha)	2.9
Average loan(info) (TZS)	31 666
Average loan(semiformal) (TZS)	528 333

4.1.9 Average revenue of paddy producer in Madibira irrigation scheme

Madibira irrigation scheme has greatly enhanced the revenue of the farmers participating in the project. The scheme's contribution to household revenue and hence livelihood is quite significant. For instance, the maximum revenue earned by a farmer through paddy cultivation in the scheme amounted to TZS 4 080 000, while the minimum was TZS 153 000. Likewise, the average revenue from paddy industry was found to be TZS 2 889 616.7 per farmer per year. On average, smallholder farmers income in Madibira irrigation scheme was higher than the national average income (income per capita), which, according to URT, 2011, stands at TZS 800 000. Paddy producers were also involved in other income generating activities. These activities were livestock keeping, maize farming and business, to mention few (Fig. 5).

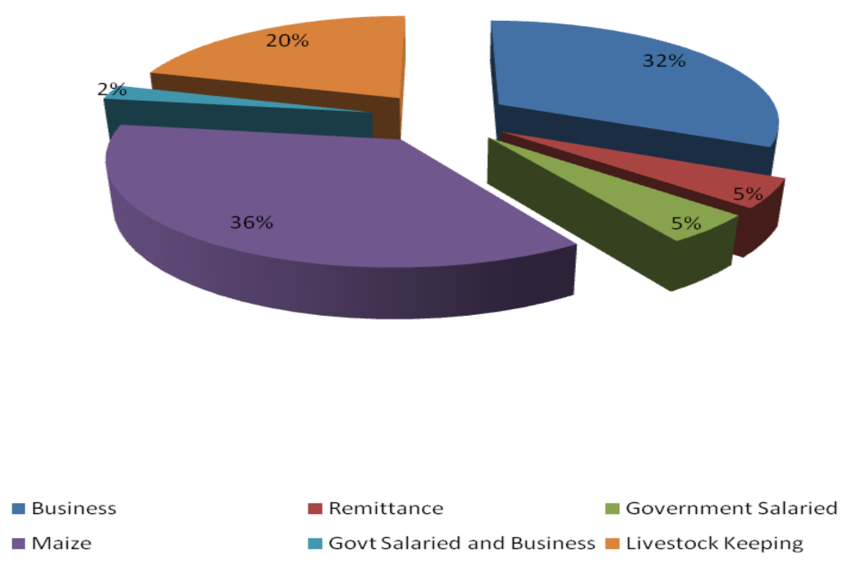

Figure 4: Other sources of income of the respondents in Madibira irrigation scheme

4.2 Factors That Influence Efficiency of Paddy Production at Madibira Irrigation Scheme

One of the study objectives was to identify factors that influence input use efficiency in Madibira irrigation scheme. Regression equation was fitted with the data collected through survey and the results are discussed under their respective sub headings in the following sections**.** Regression results are presented in Table 3.

4.2.1 Land rented-in by paddy producer

Land was one of the variables included in the regression model. The results showed that land had a positive and significant influence on paddy yield at $p<0.01$ level (Table 7). The magnitude of the coefficient was 0.712 implying that a unit increase in land would increase paddy yield by 0.712%. This observation is similar to the one made Umoh (2006) and Shehu (2007) who found that land had a positive relationship with yield in America. Similarly,a study by Masterson (2007) found that the relationship between farm size and efficiency was non-linear, with efficiency first falling and then rising with an increase in size in Paraguay. Asumugha *et al.* (2009), Edward and Steven (2004) found inverse relationship between productivity and farm size in African agriculture. In view of these findings, giving small and manageable plot to farmers in Madibira irrigation scheme would mean increasing paddy production since plot and paddy yield seemed to have positive relationship.

4.2.2 Household size

A house hold is the major source of labour supply in the firm/field. As shown in Table 3, the coefficient of household size was 0.005. This implies that if farmers used family members for the production of paddy at Madibira irrigation scheme for some works, they would increase the yield by 0.005% for each unit increase of land by saving working capital.

4.2.3 Experience of farmers in the scheme

The regression analysis in Table 3 indicates that the coefficient of experience of farmers was positive and significant at $p< 0.01$. Its magnitude was 0.253 which implies that the more the famers farmed in the scheme the more they became efficient in input use. This resulted into an increase in the yield of paddy by 0.253% for farmers at Madibira irrigation scheme.

4.2.4 Loan borrowed from semiformal sources

Madibira SACCOs was found to be the main semiformal financial institution offering loans to farmers in the study area. Farmers were allowed to borrow between TZS 400 000 and 1 000 000 from the institution, depending on the amount or value of bonds the farmer owned in the SACCOs. From regression analysis, the coefficient of loan borrowed from semiformal institution was -0.02. The negative coefficient means that there was a negative relationship between loans from semiformal institutions and paddy yields at the scheme. It also implies that for each shilling taken as a loan from the SACCOs, there was a 0.02% decrease in purchasing power of input. The loan borrowed from semiformal was insignificant at $p>0.01$ (Table 3).

4.2.5 Loan borrowed from informal institutions

The SACCOs was not the only source of loan for farmers in the study area. There were other informal arrangements through which farmers obtained loans. These included loans from local lenders and friends, which in this case, are regarded as informal institutions. The study findings indicate that the coefficient of this variable in the regression was -0.044. It means that for every increase in loan by one shilling there was a decrease in the yield of paddy by 0.044%. Such a trend could be attributed to the fact the loans from local lenders were accompanied by high interest rates. For instance, for each TZS 30 000 the farmer borrowed from the local lender, he/she would be required to repay a bag of paddy weighing 120kg whose value was TZS 80 000 during harvest season. This was significant at $p < 0.05$ (Table 3).

4.2.6 Education of paddy producer in the scheme

As shown in Table 3, the education coefficient is 0.031 meaning that the increase of education contributes to an increase in input use efficient at Madibira irrigation scheme. The more the farmers were educated, the more they became efficient in paddy farming.

4.2.7 Rregression analysis results

The data fitted the model well since they (the data) were explained by the independent variable by 85% as indicated in Table 3. On the other hand, the remaining 15% was not explained by the variables included in the model. This implies that other factors, which are not included in the model, had some influence on the dependent variable such as transport cost, nursery time, and the cost of paddling.

Table 3: The coefficients of regression results

Variables	Std. Error	Beta	t	Sig.
(Constant)	462 390.067		-1.759	0.081
Education respondent reached	130 764.047	0.031	0.392	0.698
Land rented-in	258 082.300	0.712***	9.448	0.000
Hh size	34 052.206	0.005	0.148	0.882
Experience of farmers in schms.	0.373	0.253***	3.700	0.000
Loan applied from (semiformal).	0.227	-0.020	-0.434	0.665
Loan applied (informal).	0.689	-0.044**	-1.520	0.022

, * Significance at 5%, 1% respectively, Std. Error= Standard error, R2 =0.847

4.3 Data Envelopment Analysis Results

The DEA was used to compute input use efficiency of smallholder famers at Madibira irrigation scheme (DMU). DEA Mean efficiency of sampled respondents which is referred to as one stage constant return to scale efficiency (CRS) was 99.4% Table 4. The CRS is also known as the overall technical efficiency.

Table 4: Data Envelopment Analysis Results (n=120)

TE score	CRS	(%)
1	7	5
0.90-0.99	8	7
0.80-0.89	30	25
0.70-0.79	21	18
0.60-0.69	16	13
0.50-0.59	30	25
<0.50	8	7
Mean	0.994	
Maximum	1	
Minimum	0.423	100

Technical efficiency score (CRS) was further divided into variable returns to scale and scale efficiency to substantiate the cause for inefficiency. The results revealed that the inappropriate management of resources was due to inappropriate selection of land size as input. Farmers spent costly resources in managing a small area, hence economically inefficient.

Also, DEA gave mean results on pure technical efficiency (PTE) and scale efficiency (SE) as 70.6% and 71.2% respectively (Table 5). The measure of SE provides the ability of the management to choose the optimum size of resources, in other words, to decide on the firm size or, in other words, to choose the scale of production that could attain the expected production level. In this study, it was revealed that the inappropriate size of a firm (too small) was the cause of technical inefficiency. Table 5 shows that eight DMU were operating at scale efficiency, five at pure technical efficiency, and seven at overall technical efficiency.

Table 5: Results of input use efficiency at Madibira multidimensional

Efficiency variants	OTE	PTE	SE
No of efficient farms	7	5	8
% efficient	6	4	7
Maximum score	1	1	1
Minimum score	0.423	0.758	0.423
Mean score	0.706	0.994	0.712

Table 6 below shows that the inefficiency of Madibira smallholder farmers is due to mismanagement of farmers' inputs. Inefficiency of the farmers reflects inability of the management of the firm (farmer) to organize the inputs in the production process. It could be stated that the Madibira farmers were not properly organizing inputs in their production. SE was further disaggregated to increasing returns to scale (IRS) and decreasing returns to scale (DRS) to substantiate the nature of the scale inefficiencies. This enabled the grouping of farms into those who exhibit DRS and those who exhibit IRS. The findings showed that 107 which is equivalent to 89% famers were operating at the increasing return-to-scale (IRS) which means that the unit costs decreased as the output increased (Table 6). This implies that farmers could still increase production by hiring more land, without adding more other inputs.

The findings in Table 6 show that the reason for inefficiency of the farmers was higher cost of production in a small area (paddling) (Appendix 1). It was further revealed that the inefficiency of farmers was due to IRS as large numbers of farmers were operating at an increasing return to scale (Region one). The study confirmed that 107(88.3%) of the farmers were inefficient due to increasing returns-to-scale IRS (Table 6). In other words, farmers were operating in region one of the production function. In addition, six of the farmers showed a decreasing returns-to-scale which means that the costs of managing the farms increased as the output increased (Table 6). Seven were operating at constant return to scale. According to David (2002), six farmers exhibited DRS were operating in region three of the neo- classical productions function.

Table 6: Technical efficiency and various returns to scale for Madibira irrigation scheme (n=120)

No of farms	CRS	IRS	DRS
Efficiency firms	7	107	6
OTE	1	0.423	0.423
PTE	1	0.758	0.706
diff		O.335	0.283

Since a slack indicates excess of input, a farm can reduce its expenditure on an input by the amount of slack without reducing its output. The findings indicate that slack means were 0.805, 0.127, 0.069, and 0 for capital, labor cost, seeds and land respectively Table 7. This could imply that the inefficiency of Madibira smallholder farmers was due to overconsumption of inputs costs used per hectare. Although the results show that 35.83% were over using capital, the overconsumption of the capital was 0.805. In addition, the overconsumption of labor cost was 13% and that of seeds was 7% and none of the farmers was over consuming (over using) land (Appendix 1).

Table 7: Slacks of inputs

	Capital	Labour cost	Seed	Land
Mean	0.805	0.127	0.069	0.000

4.3 Constraints Facing Paddy Producers at Madibira Irrigation Scheme

4.3.1 Birds

Of all the constraints, the invasion of paddy farms by destructive quelea-quelea was reported by 14.2% of the paddy farmers as the major challenge (Table 8). Quelea-quelea caused significant losses to the crop. This calls for bird scaring initiatives which have cost implication as farmers have to hire labour for this activity. During the 2010/11 growing season, bird scaring for the whole period cost farmers up to TZS 80 000.

4.3.2 Price of fertilizers

Table 8 presents the summary of constraints which farmers face at Madibira irrigation scheme. Eleven percent (11.5 %) of paddy farmers mentioned high fertilizer price as one of the constraints of growing crops in the scheme. They claimed that fertilizers were so expensive that they could not afford buying them from private shops. The farmers depended mainly on subsidized fertilizers without which they could not apply the same in their farms. The study also found out that all the farmers used fertilizers, but below the recommended rates. This could be attributed to the high price of fertilizers which forced farmers to buy inadequate amounts of the fertilizers.

4.3.3 Cost of Labor

About 9.9 % of the paddy farmers indicated labour as another constraint which they faced in their efforts to increase paddy production (Table 8). The DEA analysis showed that no farmer was overusing labour, which implied that farmers could increase output by using more labour in paddy production.

4.3.4 Lack of farm implements

The scheme did not have important farm implements to facilitate farming activities in the study area. About 9.9 % of the respondents revealed that lack of farm machinery impinged on their efforts to improve paddy production and productivity (Table 8). Specifically, the farmers highlighted that lack of combined harvesters and transplanting machines was a major challenge in increasing paddy output at the scheme. The respondents explained that lack of combined harvester led to post harvest losses particularly during cutting, gathering, threshing, and winnowing of the paddy. This is supported by URT (2009) that shows that postharvest losses resulting from lack of combined harvester ranged from 15 to 50%. Thus, introducing combined harvesters at Madibira irrigation scheme would reduce postharvest losses from the field. Similarly, lack of transplanting machines made transplanting tedious and time consuming. Introducing transplanting machines at the scheme would increase efficiency of the farmers by timely transplanting paddy seedling per hectare.

4.3.5 Lack of enough plots at the irrigation scheme

Majority 9.9% of the respondents reported that land for paddy cultivation was not enough (Table 8). They asserted that the land used for cultivation was small compared to their management capacity. This argument is in line with the findings from DEA analysis which showed that there were no farmers who over used the land for paddy production since there were no slack values for land variable (Appendix1). Therefore, availing more land to paddy farmers at Madibira irrigation scheme would increase production and productivity of paddy.

4.3.6 High interest rates

The loans secured by farmers from both semiformal and informal sources were reported to have extraordinary high interest rates. This is supported by 8.8% (Table 8) of the respondents who reported that high interest rates were one of the problems facing farmers at the scheme. The situation was even worse for interest rates of informal loan sources.

4.3.7 Lack of adequate extension workers

As an occupation, farming has its principles which need to be observed by anyone intending to realize the desired level of output. These principles are expected to be shared among farmers by the help of extension staff. However, 8.6% of the farmers reported that extension services were not availed to them because there were few extension staffs (Table 8). Only a small proportion of farmers were visited by the extension officers and thus knowledge on paddy farming was not widely disseminated.

4.3.8 Corrupt village leaders

The issue of corruption among village leaders was also reported by 7.9% of the respondents (Table 8). It was learnt that these leaders demanded extra money from farmers who were supposed to obtain fertilizers at a subsidized price. The farmers reported that those who could not pay extra money to the leaders did not get subsidized fertilizers. This added extra costs which did not go directly to the production of paddy, but to the pockets of greedy village leaders.

4.3. 9 Pests and disease infestation to paddy in nurseries

Another problem which was reported by 6.6% of the respondents was paddy infestation by pests and diseases at seedling stage (Table 8). The pests and diseases caused remarkable losses of seedlings as farmers applied no agrochemicals. To overcome this problem, farmers sowed excess seed to increase the probability of remaining with enough seedlings during transplanting after other seedlings had been attacked by both diseases and pests.

4.3.10 Lack of consistent market price of harvested paddy

As shown in Table 8 5.6% of the respondents cited lack of consistency in paddy price as another constraint facing farmers in the scheme. The price varied greatly from the time of harvesting into some months of storage. For instance, the price was fluctuating between TZS 65 000 per 90 -120Kgs of paddy at harvest to TZS 120 000 at the lean period. Paddy selling price depended on the prevailing market price which was determined by businessmen who sought to maximize profit. In most cases, farmers sold their paddy at low price that is TZS 65000.

4.3.11 Poor maintenance of field canals

Paddy production at Madibira depended entirely on the gravity-fed irrigation scheme which is managed by MAMCOS. Each farmer using irrigation facilities was obliged to pay TZS 85 000 as annual membership fee. The fee was expected to, among other things, be spent on field canal maintenance. However, 4.1% of the respondents lamented that the canals were not properly maintained despite the annual payment of fee by farmers (Table 8). This leads to the problem of poor water circulation in the fields and hence increased water wastage.

4.3.12 Lack of working capital

The study found that working capital was not a constraint to most of the farmers in the study area. Only 2.7% of the respondents mentioned lack of capital as the constraint in the production of paddy. This is supported by DEA results which showed that a good proportion of farmers were overusing capital (Table 8). Also, there was a problem of misuse of the loans obtained from both formal and informal sources by some farmers. Some farmers were using working capital (loan), for paying debts, school fees and the like.

Table 8: Weighed constraints facing smallholder farmers at Madibira irrigation scheme (n=120)

Problems	(%)
Birds	14.2
Fertilizers expensive	11.5
Labour is expensive	9.9
Lack of farm implements	9.9
Lack of enough plots in the scheme	9.9
Higher interest rate of loan	8.8
Fewer extensions workers	8.6
Corruption of village leaders	7.9
Infestation of insects in the nursery	6.6
No fixed price market for paddy	5.6
Poor maintenance of field canal	4.1
Lack of capital	2.7

Number in brackets implies percent

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The first objective of this study was to identify factors that influenced input use efficiency of paddy production at Madibira irrigation scheme. It was hypothesized that socio-economic factors contribute significantly to input use efficiency in Madibira irrigation scheme. The findings indicated that land was the factor which affected input use efficiency at Madibira irrigation scheme at a significance level of $p < 0.01$. It was also revealed that age and experience were affecting positively the input use efficiency at $p < 0.01$. On the other hand, formal education and house hold size were found to improve input use efficiency at Madibira irrigation scheme. Loan applied from informal source was affecting input use efficiency negatively at $p <0.05$. Loan applied from formal sector affected efficiency negatively but not significantly. On the basis of these findings, the hypothesis that socio-economic factors did not affect the input use efficiency was not rejected.

The second objective was to determine technical input use efficiency in the irrigation scheme among farmers in the study area. In this objective, it was hypothesized that the availability of inputs at Madibira did not contribute significantly to technical input use efficiency in the scheme. The findings on this objective did not favor the rejection of the hypothesis that availability of inputs at Madibira did not contribute significantly to technical input use efficiency in the Madibira smallholder’s irrigation scheme because only 6% farmers were producing at frontier technical efficiency of one. Among other factors which contributed to inefficiency of the smallholder farmers in the schemes were lack of fertilizers, lack of processed paddy seed (recycling), and farm implements.

The third objective was to determine the constraints (problems) facing paddy producers at Madibira smallholder farmers irrigation scheme. The famers indicated birds' attack (14.2) high price of fertilizers (11.5%); labour, lack of farm implements, and enough plots (9,9%) as the main constraints facing them. There were also other factors which were mentioned by the respondents; however, their impact was insignificant.

According to the Agriculture Policy of 1997, there is need for the stakeholders of agriculture, NGOs, agency and institutions to educate farmers on using improved seeds in order to increase technical efficiency at Madibira smallholder farmers' irrigation scheme. To be in line with the government agriculture policy of (1997) and government irrigation objectives one and two, input use efficiency, which include fertilizers, land, seeds, and working capital should be improved. The management of Madibira irrigation schemes should also improve training, land rented-in; increasing (improving) irrigation infrastructure; and using recommended time for seedling transplanting, to mention a few. All these would increase the efficiency of Madibira smallholder farmers by 29% without changing the current state of technology.

5.2 Recommendations

On the basis of the study findings, the following recommendations are made;

(i) Intermediate technology: It is recommended that the government and the private sector should introduce suitable technology options for paddy preparation and value addition to local farmers at Madibira irrigation schemes. In addition, farmers should be trained on seed paddy preparations technology instead of recycling the same seeds year after year

(ii) Paddy inputs: There is need for the private sector to initiate more rural micro-finance in order to address the problem of accessibility of affordable loans.

This will create more opportunities for paddy farmers to increase their working capital for paddy production. This could make them get rid of borrowing from local lenders whose interest rates are high. In addition, frequent training of farmers on access and management of loans, mobilization of funds both within and outside their communities is highly recommended. The management of MAMCOS should discuss the interest rate with formal and semi-formal sectors offering loans to their farmers, because money is borrowed within six months. At the same time, farmers should be encouraged to engage themselves in various income generating activities to accumulate their own working capital rather than totally depending on loans.

(iii) Paddy processing and marketing technology: It is also recommended that the government and MAMCOS should provide the farmers with fuel economical processing machines. The processing of paddy by farmers is important in value addition so as to obtain good price and avoid exploitation from businessmen. This is particularly important when done in groups, associations or cooperatives. In this light, there is need for the MAMCOS to sensitize private entrepreneurs and create conducive environment for them to invest in paddy processing at the scheme. Training on issues related to cooperatives should be emphasized to farmers. Also, farmers and local processors should be trained on specific paddy related aspects and standards in order to broaden their knowledge and skills of processing paddy at their locality.

(iv) Technology: Tractors and Power tillers were the major means of tilling the land in the scheme. However, the use of these machines was one of the sources of inefficiency due to high prices of fuel. The MAMCOS should look at the alternative of buying fuel in terms of bulk purchase to reduce costs, a mechanism through which farmers could obtain fuels for the machines used in such schemes at affordable prices.

(v) Soil testing for nutrients management plan: A complete and accurate soil testing to determine soil depletion rate is important for successful nutrients management plan. Soil testing is necessary after every three years to determine the amount and type of nutrients to be replenished. The requirement can be supplied from organic or artificial nutrients at Madibira irrigation schemes.

(vi) Limitations and future studies: The study was trying to address the aspect of input use efficiency in Madibira smallholder farmer's irrigation schemes. Basically, the study was narrowed down to input use efficiency of land, working capital, fertilizers, and seeds. In this study, water was not included due to the fact that the instruments for measuring efficiency of water inlet, uptake by plants and outlet from plots, were not there in the schemes. The results obtained cannot be used to generalize to all irrigation schemes, in the country.

(vii) Further studies should be carried out to investigate the input use efficiency of the water.

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APPENDICES

Appendix 1: Results for slacks of four inputs.

Firm input:	1	2	3	4
1	0.236	0.389	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.522	0.189	0.010	0.000
4	1.085	0.000	0.067	0.000
5	1.175	0.175	0.518	0.000
6	0.428	0.389	0.000	0.000
7	0.828	0.369	0.162	0.000
8	0.000	0.000	0.000	0.000
9	1.708	0.091	0.000	0.000
10	0.000	0.000	0.111	0.000
11	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000
13	0.248	0.488	0.055	0.000
14	0.000	0.000	0.000	0.000
15	1.867	0.282	0.114	0.000
116	0.048	0.360	0.070	0.000
117	0.764	0.107	0.051	0.000
118	1.408	0.120	0.026	0.000
119	0.863	0.111	0.000	0.000
120	0.180	0.294	0.000	0.000
mean	0.805	0.127	0.069	0.000

Appendix 2: Table used to determine categorical sample study

Population	Sample size					
	Continuous data (margin of error=.03)			Categorical data (margin of error=.05)		
	p=.10 t=1.65	p=.05 t=1.96	p=.01 t=2.58	p=.50 t=1.65	p=.50 t=1.96	p=.50 t=2.58
100	46	55	68	74	80	87
200	59	75	102	116	132	154
300	65	85	123	143	169	207
400	69	92	137	162	196	250
500	72	96	147	176	218	286
600	73	100	155	187	235	316
700	75	102	161	196	249	341
800	76	104	166	203	260	363
900	76	105	170	209	270	382
1000	77	106	173	213	278	399
1500	79	110	183	230	306	461
2000	83	112	189	239	323	499
4000	83	119	198	254	351	570
6000	83	119	209	259	362	598
8000	83	119	209	262	367	613
10 000	83	119	209	264	370	623

Source: Bartlett *at al.* (2001)

1. District:
2. Division:
3. Ward:
4. Village:
5. Enumerator name ………………………..
6. Name of Household……………………..
7. Respondent name………………………..
8. Date of interview…………………………

A 1. GENERAL HOUSEHOLD INFORMATION

1.1 HOUSEHOLD MEMBERS AND OTHER HOUSEHOLD CHARACTERISTICS.

HH ID	Name	Relationship to HH code (a)	Gender (1=Male,2=Female)	Age complete years	Highest level education (b)	Primary activity (c)	Home occupancy(d)

Code (a)	Code (b)	(c)Primary activity	Home occupancy
1=Head.	0=No formal and illiterate	1= Crop farming	1=Permanent residency
2=Spouse.	1=No formal but literate	2=Trading in agricultural products not own produce	2=Residency during the farming season only.
3=Son/Daughter.	2=Primary school not completed	3=Formal salaried employee(e.g civil servant, domestic work	
4=Grandchild.	3=Completed primary school	3=Business-trade	
5=Parent of head/spouse	4=High/secondary school	4= Trading in livestock and livestock product	
6=Sister/Brother of the Head or spouse	5=College	5=Others specify	
7=Nephew/niece	6=University		
8=Servant.			
9=Divorced			
10=Non-relative.			

B. Land Ownership and Use.

2. How much land do you own? [……….]

Plot description(Distance from the main canal)	Size of the plot	Unit of land (a)	Tenure system (b)	Owner(s) (c)	What is this land mainly used for?

(a) Unit of land	(b) Tenure system	(c) Ownership of Land.	Main use of the land
1=acre	1=Owned	1=Hh head.	1=Farming activities.
2=ha	2=Public land	2=Wife	2=Renting out
3=Others specify	3=Rented-in	3=Children	3= Other uses (specify)
		4=MAMCOS	

3. In the last cropping seasons how much did you cultivate 2010/2011?

	Area	Unit
Land under paddy cultivation		
Land rented out		
Land rented in		
Land left uncultivated		

4. What is your role in the scheme?

(i) Scheme leader

(ii) A member of committee.

(iii) Famer

(iv) Otherwise.

5. How long have you been cultivating in the scheme?

6. Which problems do you face in madibila irrigation scheme?

…………………………………………………………………

…………………………………………………………………..

7. Do you transplant in line or randomly. Line /Randomly.

8. How long does it take to weed for first time after transplanting?

9. How many times do you weed to harvesting?

10. Do you use fertilizers in paddy cultivation? Yes /No.

11. If yes in Qn 9 above which type of fertilizer do you normally apply just after transplanting? (Urea, NPK, CAN, SSP, DAP, Ammonium Phosphates)

12. Which type of fertilizers do you normally apply before flowering? (Urea, NPK, CAN, SSP, DAP, Ammonium Phosphates)

13. Are inputs like fertilizers readily available? Yes/No

14. List the various crops you grown in the 2010/2011 season.

(i)……………………………………………………………………….

(ii)……………………………………………………………………..

(iii)……………………………………………………………………….

15. Do you grow the same crops every growing season?

Yes/No………….

If no which crop do you grow in which season?

16. Do you allocate the same acreage to crop you grow every growing seasons?

Yes/No……….

If no which are the influencing factors for decision of the type of crop you grow?

(i) Availability of land.

(ii) Current ppaddy of produce.

(iii) Availability of market.

(iv) Availability of rain water/water.

(v) Labour.

(vi) Capital.

(v) Other reasons.

17. What was the location of the acreage for each crop you grown in 2010/2011 seasons.

(i)……………………………………………………………………

(ii)…………………………………………………………………..

Cost of Paddy Production

18. (i) What was the total cost for paddy production?

Plot	Paddy	Size of the plot and Unit (a)	Did you use improved variety?(0=No,1 =Yes	Did you use row planting,(0=No,1 =Yes)	Seed /planting material				Production/Output				
					Quantity of planting material (b)	Unit code (b)	Source of seed/planting material(c)	If purchased amount pent(Tsh)	Quantity produced.	Unit	Quantity sold	Quantity used/Given away	Quantity remaining

A	b	c
1=acre 2=hector	1=Kg 2=bags	1=Bought 2=Saved from farmers sources

(ii) What was the cost of each of the following for paddy production?

S /n	Paddy	Land preparation and weeding					Use of fertilizers				Other s	
		Land preparation method(a)	Cost of preparation including hired labour (Tsh)	Number of times weeded.	Total cost of hired labour for weeding	Total cost for hired labour for other activities	Did you use fertilizer 0=No ,1=Yes	If yes type of fertilizers used. (b)	Source of fertilizers (c)	If purchased Total(Tsh)	Did you use pesticides/other chemicals (0=No/ 1=Yes)	If yes total cost(Tsh)

A	b	c
1=Hand hoe 2=Oxen 3=Tractor 4=Power tiller	1=NPK 2=Urea 3=CAN 4=SSP 5=DAP 6=Ammonium Phosphates	1=Purchased from private shop. 2=From Government 3=From non government organization(NGO) 4=Other specify.

(iii) Labour costs

Sn	Item/Operation	Size in acre	(i) Hired lobour		(ii) Family labour	
			Man-days	Costs per man-day	Man-days	Costs-per-man-day
1	Size of the plot.					
2	Land clearing					
3	Land preparation					
4	Ploughing					
5	Paddling.					
6	Nursery preparation					
7	Plot leveling.					
5	Planting/Transplanting					
6	Costs of weeding.					
7	Costs of fertilizers applications					
8	Insecticide application					
9	Birds scaring					
10	Harvesting.					
11	Transport from plot					
12	Other costs					
Total costs						

(iv) Family labour costs for other crops

		Size in acre	Other crops.						
Sn	Item		(i)		(ii)		(iii)		Costs.
			Man-days	Costs per man-day	Man-days	Costs-per-man-day	Man-day	Costs-per man days	
1	Size of the plot.								
2	Land preparation.								
3	Ploughing.								
4	Nursery preparation								
5	Planting/Transplanting								
6	Costs of weeding.								
7	Costs of fertilizers applications								
8	Insecticide application								
9	Harvesting.								
10	Transport from plot								
11	Other costs								

19. What was the total cost for production of other crops for 2010/2011 season?

(i)Material costs

Sn	Item	Beans	Maize	Vegetables
1	Variety			
2	Size of the plot			
3	Costs of seeds			
4	Costs of fertilizers.			
5	Insecticides cost			
6	Water fees			
7	Other relevant costs			
8	Total cost			

(ii)Cost of water and maintenance of the furrows.

Type of crop.	Do you pay fee for water use for irrigation (o=No/1= Yes)	How often do you pay this fee? 1=Annually 2=For the crop season 3=Monthly 4=It depends on how often or how much water you use. 5=Other(specify)	How much did you pay in the past 12 months? (Tsh)	Did you contribute money to maintain irrigation furrows or the irrigation scheme in the past 12 months? O=No/1=Yes

(iii) Cost of irrigation per technology

Plot	Name of crop	Did you irrigate in the last grown season 2010/2011 (O=No/1=Yes)	Through what kind of furrow does water reach this plot? 1=Traditional 2=Improved 3=Other(specify)	How do you irrigate this plot? 1=Furrow 2=Bucket 3=Treadle pump 4=Sprinkler 5=Drip
1				
2				
3				

C. Information on income

Income from own produce and Non-own produce of the respondent for the past 12 months from crops.

20. Income sources and levels should include income from all members of the household

Source of Income	Did anyone in the household earn income from source in the last 12 months? 0=No,1=Yes	Who earned	Total house hold income in the past 12 months from this source	Rank the source.
Sale of own crop and crop products				
Sale of own livestock (cattle, poultry, and all other mentioned livestock.				
Sale of own livestock products(e.g milk				
Sale of own livestock services.(Traction)				
Trading in livestock and livestock product(Not own produced)				
Trading in agriculture (not own produce)				
Working on the other farmers(Herding being inclusive)				
Other specify if not mentioned anywhere.				

21. Outputs and Income from other Non-farm activities. It relates to wages, salaries, and non-natural resources

S/n	Type of work	Amount earned last season/month	Amount earned past year.	Place of Work
				1. Nearby 2. District. 3.Town 4.City
1	Wages-seasonal			
2	Wages-Regular			
3	Salary-Gvt sector			
4	Salary-Private sector			
5	Business Income			
6	Pension Payment			
7	Other Non-Farm			
8	Remittances			
9	Rent out			

Enter earning for past month. For regular pay this should equal daily pay *number of days worked per month.

For regular earning this should be multiplied by 12.

For business ask for daily profit per day/week and then multiply by month earning and then by 12 months.

D. Information on Credit

23. Credit in the last 12 months

LoansSource of credit	Have you or any other members of your household applied for credit during the last 12 months(o=No,1=Yes)	Why did neither you nor any other member of your household apply to source? 1=No need 2=Do not know where to apply 3=Lack of collateral(security) 4=Interest too high 5=Do not like to be indebted 6=Believed we would be refused 7=Lack of sensitization 8=Other(specify)	Was a loan received from this source
Formal financial institutional(e.g Bank etc)			
Semiformal institutional" such as microfinance institutions, cooperative, non government organization			
Informal source such as friends and relatives, local money lenders, shop keepers, village level associations (rotating savings)			

(ii) Borrowing capacity

Name of borrowing source	If they wanted to,could the head or his/her spouse borrowing money from(source)o=No,1=Yes		If column 3= 1 or column 4=1:What is the maximum amount the head or his/her spouse could borrow from (source) Tsh	
	Head	Spouse	If column 3=1(Head)	If column 4=1(Spouse)
Friends/relatives				
Private money lender				
Landlord				
Employer				
Bank				
Microfinance institutions				

E. Probe questions about the Technical information on irrigation schemes at the Headquarter

1. What are the regulations governing land allocation, ownership and or transfers in the schemes?
2. Is there any specific proposed management structure of the schemes by the government?
3. What are the function of the local government (district council) to the as identified by the ministry?
4. What are the roles of the irrigations zone office to the schemes as identified by the ministry?
5. What are the problems facing the schemes?

F. Probe questions for the Irrigation Zone office

1. What are the obligations of the irrigation zone office towards improving performance of the irrigation schemes and particularly smallholder farmers' schemes?
2. What are the rule and regulation s governing the land allocations, ownership and /or transfer in the schemes?

3. If yes does it differ from schemes to schemes?
4. What kind of organization are you advising smallholder farmers to adopt?
5. Is the water right necessary in the smallholder farmer irrigation scheme?
6. Who's responsible for the water right in smallholder holder farmers' irrigation schemes?
7. Who propose the structure of smallholder farmer irrigation schemes?
8. How do you involve other displines in improving the smallholder holder farmer irrigation scheme?
9. Generally, what are the problems facing the smallholder farmers irrigation in this zonal?

G. Probe questions for the technical personnel and scheme leader.

1. When Madibira irrigation scheme was established?
2. What is the total area of the schemes?
3. What is the size of the schemes that is :

   (i) Well developed………………

   (ii) Not developed……………...

   (iii) If there area which is not well developed what is the strategies to develop the remaining area?
4. What is the main crop grown in Madibira irrigation schemes?
5. What is the total area which initially was well developed?
6. What is the actually area in Madibira irrigation smallholder farmers which can well be irrigated now?
7. What are the factors which turn from irrigable area to non-irrigable area in Madibira smallholder farmers' irrigation schemes?
8. What is the ppaddy of one acre in schemes?

9. What is the ppaddy of one acre outside the Madibira irrigation schemes?
10. How many beneficiaries of Madibira smallholder irrigation schemes?
10. How many beneficiaries of irrigations schemes are members of the farmers' organization?
11. How many are not?
12. How much do you contribute to farmers' organization as a membership fees per year?
13. What is the average rate of the farmers' payment of their dues per year or season?
14. What is the average (total) collection/income of the schemes in the last growing seasons?
15. What was the projection of the water fees collections in the last growing seasons 2010/2011?
16. What was the average expenditure of the last growing seasons in 2010/2011?
17. Do schemes (particular Madibira Irrigation schemes) have the water right?
18. In which months of the year does the scheme get enough water 2010/2011?
19. What is the management structure of Madibira irrigation schemes?
20. What are the main problems facing the schemes?
21. What are the obligations of the irrigation zone office to the schemes?
22. What are the main problems facing the schemes?