EFFICIENCY IN PRODUCTION BY SMALLHOLDER RICE FARMERS UNDER COOPERATIVE IRRIGATION SCHEMES IN PWANI AND MOROGORO REGIONS, TANZANIA

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

2015

ABSTRACT

Low price competitiveness of Tanzania produced rice driven by high production costs calls attention to developing ways of improving efficiency in production. This study was conducted to analyse production costs and factors influencing choice of inputs provider in smallholder irrigated rice production. Specifically, it focused on comparing costs of production, determining factors influencing smallholder irrigated rice farmers' choice of inputs provider and analysing production cost efficiency. Data were collected from four cooperative irrigation schemes in Pwani and Morogoro regions involving 200 farmers. Production costs were quantified using enterprise budgeting technique and differences analysed using T-test. Factors influencing choice of inputs provider were determined using Logit model. Translog stochastic cost frontier was used for cost efficiency analysis. Study findings indicate that, costs of production stands at 315.47USD/MT. Farmers purchasing inputs through irrigation scheme cooperative had lower production costs than farmers purchasing from other input providers. Factors influencing choice of production inputs provider were distance from the cooperative to nearest town, membership in other organizations, extension services, input quality satisfaction and availability of cash and credit payment mode ($p<0.05$). Rice output and prices of labour, fertilizer and irrigation water significantly affected costs of production with unit cost of production being decreasing by increasing rice output ($p<0.05$). Inefficiency in production was significantly influenced by farming experience, planting methods, frequency of weeding, degree of specialization and source of purchased inputs and accounted 82.08% of variability in costs of production ($p<0.05$). The study concludes that, there is loss of efficiency in production due to high production costs attributed by rice output produced, input prices, source of purchased inputs and other agricultural practices. It is recommended to use labour saving technologies, purchasing inputs through irrigation scheme cooperative and gaining more economies of scale by increasing specialization.

DECLARATION

I, RAJABU JOSEPH KANGILE, do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own 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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Above declaration is confirmed:

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(Supervisor)

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ACKNOWLEDGEMENTS

I wish to extend special thanks to Almighty God for protecting me, peace and all mercies throughout the study period and ever.

I express my sincere appreciation to my supervisor Dr. Zena T. Mpenda for treasurable continuous and tireless guidance and valuable comments that has led to completion of this study and Dr. Philip Damas for providing comments on the earlier drafts of this dissertation. Furthermore, my appreciation also goes to Dr. Adam M. Akyoo and Prof. Gilead I. Mlay of the Department of Agricultural Economics and Agribusiness for their constructive comments and guidance during the initial stage of my study.

I also extend my gratitude to the Department of Agricultural Economics and Agribusiness and its staff for the great support that expedited the completion of my course work at Sokoine University of Agriculture (SUA) and University of Pretoria (UP) as well. Innovative Agricultural Research Initiative (iAGRI) through Feed the Future project and the Collaborative Masters of Agricultural and Applied Economics (CMAAE) programme are also acknowledged for their financial support that made my research work accomplished.

My acknowledgement also goes to the District Executive Directors (DEDs) of Mvomero and Bagamoyo for granting access to cooperative irrigation schemes in their districts, all smallholder farmers involved in the study are highly appreciated.

Finally, I wish to thank my family (wife and children) for their emotional and material support and patience during my entire study period.

DEDICATION

This work is highly dedicated to Almighty God under whose care I was able to finish this work successfully. Secondly, to my lovely family, my wife Diana and my sons Frank and Fredrick.

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LIST OF ABBREVIATIONS AND SYMBOLS

AMCOS	Agricultural Marketing Cooperative Societies
ASA	Agricultural Seed Agency
DEA	Data Envelope Analysis
BIDP	Bagamoyo Irrigation Development Project
CET	Common External Tariff
CHAURU	*Chama cha Umwagiliaji Ruvu*
Coop	Cooperative
CUMKI	*Chama cha Wakulima Umwagiliaji Mlali Kipera*
GAPs	Good Agricultural Practices
Ha	Alternative hypothesis
Ho	Null hypothesis
LR	Likelihood Ratio
ML	Maximum Likelihood
MT	Metric tonne; which is 1 000kg
NBS	National Bureau of Statistics
NE	Neo-classical Economics
NIE	New Institutional Economics
PPS	Probability Proportional to Size
RLDC	Rural Livelihood Development Company
ROSCAs	Rotating Savings and Credit Associations
RS	Random Start
RUM	Random Utility Model
SACCOS	Savings and Credit Cooperative Societies
SAGCOT	Southern Agricultural Corridor of Tanzania
SARO	Semi Aromatic
SI	Sampling Interval
SRS	Simple Random Sampling

SQRT	Square root
TAS	Tanzanian Shillings
TXD	Tanzania Cross Dakawa
URT	United Republic of Tanzania
USD	United States of America Dollar
UWAWAKUDA	*Ushirika wa Wakulima Wadogowadogo wa Kilimo cha Mpunga Dakawa*
VICOBA	Village Community Bank
VIF	Variance Inflation Factor
WEF	World Economic Forum

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Rice in Tanzania is the second most important food crop after maize, being grown by 18% of the farming households and more marketed than maize. The quantity of marketed rice is approximately 42% of the total production while that of maize is 28%, thus being more commercialized than maize (MAFAP, 2013). The rice sub sector contributes 2.67% on the country's Gross Domestic Product (EUCORD, 2012). Rice production is predominantly dominated by smallholder farmers both under rain-fed (up-land and low-land) and irrigated (low-land) production contributing more than 90 percent in domestic production (EUCORD, 2012).

The average production in the country is lower than the actual rice demand, for example in 2009, 2010 and 2011 rice milled equivalents was lower by 39 607, 1493, 32 88 MT respectively (NBS, 2012). This is evidenced further by the decreasing rice food supplies in the country, example 36.88, 31.71 and 25.29 rice milled equivalent kg/capita/year in 2010, 2011 and 2012 respectively (MAFAP, 2013). Furthermore, the decision of the government of Tanzania in 2013 to exempt the Common External Tariff (CET) of 75% in importation of 60 000MT of rice justifies the existence of the supply gap.

The demand for rice in the country is estimated to keep increasing because, among other reasons, there is high rate of urbanization and changes in consumers' preference of rice both in urban and rural areas. For example, the rice consumption in 2011 was 1 332 078MT while in 2020 is forecasted to be 2 958 000MT (Kawamala, 2013). Rice consumption symbolizes increased status. It is the premium staple consumers aspire to move to as their incomes increase.

In irrigated rice production, smallholder farmers are the main driver with exception of few large scale producers such as the Kapunga Rice Project Limited in Mbeya and Kilombero Plantation Limited in Morogoro (SAGCOT, 2012). Smallholder irrigated rice production is done in irrigation schemes which are managed either by irrigation scheme associations or cooperatives (cooperative irrigation schemes). Farmers access land from the scheme after paying the cost of water supplies each season to the cooperative board (RLDC, 2011). Irrigation water is pumped using electrical and diesel engine pumps (pump-fed canal system). Some of the irrigation schemes are under flood recession and gravity-fed systems which does not necessarily need the pumps.

The irrigation scheme association is the group of farmers using water for irrigation in an irrigation scheme, having their own leadership and enforcing formal and informal rules such as social sanctions (URT, 2010). The irrigation scheme association is more concerned with allocation of water, operations and maintenance of the irrigation scheme with minimal or no involvement in marketing activities.

In cooperative irrigation schemes, the cooperative board manages the scheme on behalf of its members (farmers). Marketing activities are done in addition to maintenance, operation and management of the scheme. Marketing activities are usually done on the side of inputs. Available evidence indicates that, farmers rarely engage in collective marketing on the side of outputs. Farmers keep their own stocks and do private marketing (Kilimo Trust, 2014; RCT, 2015). On the side of inputs, the cooperative board purchases in bulk and sells to members or facilitates on getting suppliers of inputs to members. The inputs are made available for members of irrigation scheme cooperatives to purchase. This is done as an effort of making farmers be efficient in production cost that is; not to be high cost producers. Farmers are not forced but encouraged to purchase through the cooperatives hence are under liberty of choosing whether to purchase through the cooperative or other input providers.

Underutilization of the cooperative irrigation schemes by smallholder farmers has been a concern of the government to an extent of either privatizing some of these irrigation schemes or running them in partnership with foreign investors (BMG, 2012; EUCORD, 2012). Thus, the present study focused on these cooperative irrigation schemes in Pwani and Morogoro regions.

1.2 Problem Statement and Justification

Smallholder irrigated rice production is imperative to the rice sector and the country in general due to its low risk as the result of improved certainty to production. On the other hand, price competitiveness that is the ability of locally produced rice to compete with imported rice in the market is also important for growth of the sector and smallholder rice farmers. Low price competitiveness of produced rice in Tanzania gives room for imported rice from various countries in the World especially Asian countries reducing profit margin to smallholder farmers and market for domestic produced rice.

The low price competitiveness is due to higher production costs of domestic produced rice than imported rice. Kilimo Trust (2014) report smallholder farmers in Tanzania to incur a production cost of 289.4USD/MT along the rice value chain. This leads to smallholder farmers' farm gate prices in Tanzania being higher than other countries exporting to Tanzania. Example in Morogoro the farm gate price is 455USD/MT while in

Asian countries such as Bangladesh and India; the farm gate prices are 175 USD/MT and 169 USD/MT respectively (Kilimo Trust, 2014). Zaal *et al.* (2012) associate high production cost leading to low price competitiveness in irrigated rice production with the capital intensive nature of irrigated rice production system.

In cooperative irrigation schemes, smallholder farmers are also capital intensive in their rice production system due to high use of capital inputs (purchased inputs). This can contribute to low price competitiveness if the efficiency path of the farm production resources is not well followed. The low price competitiveness as a result of high production costs make smallholder farmers break even and sometimes experiencing loss in their rice production (MAFAP, 2013). It is under this scenario, smallholder farmers continue to remain at small scale production level without graduating to medium scale farmers (Barreiro-Hurle, 2012). Furthermore, smallholder farmers in cooperative irrigation schemes have been failing to contribute to the payments for irrigation water supply and thus left the fields to other farmers who may not necessarily be members of the irrigation scheme cooperatives. This situation among others has caused the government to privatize some of the irrigation schemes to large investors in the claim on being underutilized and poorly managed by smallholder farmers (BMG, 2012).

The government claimed underutilization of the cooperative irrigation schemes by smallholder farmers and the failure of some smallholder farmers to pay for irrigation water supply may be due to the ascertained low price competitiveness of produced rice, aversion of purchasing inputs through the irrigation scheme cooperatives by smallholder farmers or any other factors at the cooperative management or smallholder farmers level.

The present study investigated smallholder farmers' decision making level in cooperative irrigation schemes on purchase and use of production inputs. Collective purchasing of production inputs reduces unit input cost contributing to reduced cost of production enhancing price competitiveness, thus smallholder farmers avoiding purchasing inputs through the irrigation scheme cooperative needs to be investigated in addition to the efficiency use of the farm production resources. The study also ascertains the level of production costs since the reported high production costs in irrigated rice production leading to low price competitiveness is not specific for this type of irrigation scheme management.

1.3 Justification of the Study

Smallholder rice farmers' graduation to medium or large scale farmers has been a concern of policy makers in Tanzania for many years. Smallholder cooperative irrigation schemes have also been in the same blame of remaining in small scale production. Graduation of smallholder rice farmers requires reliable markets for produced rice. Under liberalized market system in Tanzania, price competitiveness of produced rice in addition to some protection by the government through CETs are important factors for the success of smallholder rice farmers and rice sector in general (RCT, 2015).

The government claimed underutilization and inefficiency in production for cooperative irrigation schemes leading to their privatization to big investors lacks empirical evidence. The sources and extent of inefficiency especially on the production cost side are not well known. This study helps policy makers and cooperatives management to have in-depth understanding of the sources of inefficiency in production on the side of smallholder farmers and be able to address them. The findings from this study generates information that can be used to strengthen the capital input sales to cooperative members in the irrigation scheme cooperatives and justifies the importance of the cooperative irrigation schemes in the rice sub sector. Furthermore, it sheds light to policy makers to formulate policies specifically for this form of irrigation scheme management.

1.4 Study Objectives

1.4.1 General objective

The general objective of this study was to analyse production costs and factors influencing choice of inputs' provider in smallholder irrigated rice production under cooperative irrigation schemes in Pwani and Morogoro regions.

1.4.2 Specific objectives

Specifically the study sought to:-

(i) Compare costs of production for smallholder irrigated rice farmers purchasing inputs through the irrigation scheme cooperative and those who do not.

(ii) Determine factors influencing smallholder irrigated rice farmers' choice of production inputs provider in cooperative irrigation schemes.

(iii) Analyse production cost efficiency by smallholder irrigated rice farmers under cooperative irrigation schemes

(iv) Examine sources of production cost inefficiency by smallholder irrigated rice farmers under cooperative irrigation schemes

1.5 Research Hypotheses

This study was guided by the following hypotheses;

(i) There is no statistical difference in costs of production between farmers purchasing inputs through the cooperative and those who do not purchase through the cooperative.

(ii) Years of experience in cooperative, membership in other organizations, credit accessibility, extension services, education, distance from the cooperative to the nearest town, input quality and input payment mode do not influence the likelihood of smallholder irrigated rice farmers to purchase production inputs through the cooperative.

(iii) Smallholder irrigated rice farmers under cooperative irrigation schemes are not cost efficient.

(iv) Source of purchased inputs, farming experience, degree of specialization, method of planting and harvesting, type of seed variety planted and frequency of weeding are not sources of cost inefficiency.

1.6 Organization of the Dissertation

This dissertation is organized in five chapters namely; introduction, literature review, methodology, results and discussion and conclusions, recommendations and areas for further research. Chapter one has provided background information on the rice sector in Tanzania and irrigated rice production, problem statement and its justification, research objectives and the associated research hypotheses. The second chapter contains review of theoretical and empirical literature of the study. Chapter three presents the study area, research design and conceptual and analytical frameworks. Furthermore, chapter four provides results discussion of which its conclusions and recommendations are well presented in chapter five.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Irrigated Rice Production

Irrigated rice production is the rice farming method involving application of specific amount of water from water sources to meet the requirement of rice plant (URT, 2010). It can be done separately during dry seasons or by supplementing rainfall to stabilize production. It is usually done in irrigation schemes using gravity, flood recession or pump-fed canal systems.

The production of irrigated rice in the World is growing in many continents. The largest area of irrigated rice production is in Asia. Irrigated rice production accounts for more than 75% of the total rice production in Asia. In Africa, irrigated rice production is highly affected by poor operations and management of the irrigation schemes. The area under irrigated rice production is low that is; only 17% of the rice growing area is irrigated (EUCORD, 2012).

2.1.1 Smallholder Irrigated Rice Production in Tanzania

Rice is the major irrigated crop in Tanzania using 75% of the irrigated land. The area under irrigation has been growing but not adequately. For example the area under irrigation in 2010, 2011 and 2012 was 310 745, 345 690 and 363 514 ha respectively against the country potential of 29.4 million hectares (NBS, 2012). The development of irrigated rice production is low in terms of re-investment. The potential area suitable for irrigation has not been utilized. This is the fact to most of the irrigation schemes. For example, Dakawa irrigation scheme in Mvomero utilizes 2000ha against the potential of

3000ha. The Ruvu irrigation scheme runs 720ha against the potential of 3 190ha (URT, 2013).

The potential rice yields in the smallholder irrigation schemes is estimated at 4-5MT/ha (URT, 2010). Unfortunately, the average yield in the majority of traditional and improved irrigation schemes is still far from the anticipated optimum. For example the study done by Nakano and Kajisa (2012) in Mbeya, Shinyanga and Morogoro showed an average yield of 3.7MT/ha. Improved yields can be realized through the use of high input agronomic practices. The study done by Kilimo Trust (2014) showed that, smallholder farmers in high input practice, their yields are twice those in areas of low input practice. Adoption of high input agronomic practices requires realization of profit margins by smallholder farmers (Zaal *et al.,* 2012). In order to realize better profit margins, gaining competitiveness in the rice market is inevitable of which can be achieved through improved efficiency in production.

Several studies (Musamba *et al.,* 2011; Barreiro-Hurle, 2012 and Zaal *et al.,* 2012) and many others have indicated that, smallholder irrigated rice production in Tanzania uses land, water, labour, fertilizer, herbicides, pesticides and some use machinery to compliment for both family and hired labour.

2.1.2 Sources of production inputs in irrigated rice production

Production inputs in irrigated rice production is obtained through/from cooperative irrigation schemes, private agricultural input shops, agricultural input voucher system, micro-credit institutions, institutions and own input materials. Irrigation scheme cooperatives provides inputs to irrigation scheme members either by selling the inputs at the irrigation scheme cooperative offices or through facilitation in which the irrigation scheme cooperative brings or contracts an input supplier to supply inputs to farmers.

Private agricultural input shops or agro-dealers are also main sources of agricultural inputs to smallholder farmers in cooperative irrigation schemes. These are shops in which smallholder farmers, purchases through their own arrangements. Agricultural input voucher system is another source to some of the irrigation scheme cooperative members. This is the government initiative in which fertilizer and/or seeds are provided to farmers through reduced price (URT, 2013).

Two institutions; micro-credit institutions and research institutions including seed agencies such as Agricultural Seed Agency (ASA) are also sources of agricultural inputs to farmers. Micro-credit institutions such as Opportunity Tanzania Limited provide input credit such as fertilizer to smallholder irrigated rice farmers. Additionally, some farmers gets inputs from their input materials that is from their fields by renewing their seeds for two, three or more seasons (Zaal *et al.,* 2012).

2.2 Theoretical Frameworks

This study relies on the synergistic relationship that exists between two paradigms of Economics; New Institution Economics (NIE) and Neo-classical Economics (NE). The study is based on neo-classical production theory in NE since the farm is the cost minimizing entity and collective action theory in NIE due to the fact that, smallholder farmers in cooperative irrigation schemes choose actions in an interdependent situation.

2.2.1 Neo-classical production theory

Neo-classical production theory puts forward one objective of the farmer, two constraints and two assumptions in agricultural production system (Besanko and Braeutigam, 2010). The objective of the farmer is to minimize cost of production subject to constraints imposed by the availability of resources. The two constraints are choice of outputs to be produced and amount to be produced, given available land, labour, machinery and equipment and allocation of resources among outputs.

The theory assumes that agricultural production has two main assumptions, assumption of pure competition and assumption of risk and uncertainty. It is hypothesized that, the farmer knows with certainty the applicable production function governing the agricultural production system. The farmer has perfect knowledge of prices both for inputs to be purchased and outputs to be sold. However, these assumptions are normally violated in many agricultural production systems (Debertin, 2012).

2.2.2 Collective action theory

The economic theory of collective action is concerned with the provision of goods and services that are collectively consumed through the collaboration of two or more individuals and involve pooled decisions (Kirsten *et al.,* 2009). Individuals under collective action choose actions in an interdependent situation (Araral, 2009). Collective action arises when people collaborate on joint action decisions to accomplish an outcome that involves their interests on well-being. This is usually accompanied by enforcing by-laws, rules and norms in the community. Collective actions are widely used in management of common pool resources. Common pool resources are such as water, community land, fisheries and forests and their management involve pooled decisions (Vanni, 2014).

The success in managing the common pool resource depends on the size of the group, homogeneity, enforcement of the agreed rules and the purpose of the group (Janssen and Anderies, 2013). Collective action helps to overcome the problem of some members who tend not to contribute to group activities because they benefit from other members activities, the problem known as free riding problem (Vanni, 2014). It also provides joint solutions for the management of common pool resources and avoiding opportunism.

2.3 Management of Smallholder Irrigation Schemes in Tanzania

Irrigation schemes are managed privately and through collective action. In Tanzania, few irrigation schemes are privately managed and these are under large scale farmers. Collective action is the common method used to manage common pool resources like water in various countries (Janssen and Anderies, 2013). Smallholder farmers in Tanzania, manage irrigation schemes in two distinct forms; through cooperatives and irrigators' associations.

A cooperative is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise (Bond *et al.,* 2009). In relation to irrigation scheme, it is any collection of individual farmers organized to supply small scale irrigation. The supreme power is under the cooperative board and is guided by existing country cooperative act (Lyimo, 2012). The current cooperative act in Tanzania which promotes cooperative activity in a liberalized system is the Cooperative Societies Act number 6 of 2013.

Many studies have identified various advantages of cooperatives to the members. According to Maghimbi, (2010) and Lu and Wang, (2012), cooperatives empower members to solve economic as well as social problems and thus achieve goals that could not have been achieved individually. This means that, costs of carrying market exchange of various services like delivery of loan, inputs, and market information and extension services are reduced. Furthermore, Janssen and Anderies (2013) outlines two collective action challenges that are solved in irrigation schemes. These are provision of infrastructure and governance structure necessary to maintain and use the resource and the asymmetric common pool resource dilemma that is the head ender user in the irrigation scheme sharing with the tail ender users.

Apart from operations and maintenances of the irrigation scheme, cooperatives may perform some other functions such as input bulk procurement for their members, facilitation in inputs purchases and output selling, selling inputs, value addition such as milling, provision of product market information and guarantee for credit to members. Contrary to cooperatives, irrigators' association has one main function which is operations and maintenance of the irrigation schemes.

Irrigators' association deals with operations and maintenances of the irrigation scheme by setting social sanctions and enforcing rules of water allocation and maintenance of the irrigation scheme. In enforcing the established rules in the irrigation schemes, various formal and informal methods are used. The informal methods such as social sanctions are common even in other countries for example; Nakano and Otsuka (2011) identified the use of social sanctions and peer supervision as common methods at Doho rice irrigation scheme in Uganda. The success of irrigators' association among other factors, requires the irrigators to be residents of the same community and to have no significant economic inequalities (Rohith and Chandrakanth, 2011).

2.4 Smallholder Farmers' Participation in Collective Action Initiatives

The realization of collective action benefits in agricultural production depends on institutional and governance structure, individuals behaviour and farm specific characteristics (Ostrom, 1990; Araral, 2009 and Rohith and Chandrakanth, 2011). These sets well the players (stakeholders) and the rules of the game. Furthermore, participation of farmers in collective action initiatives such as input markets initiated by cooperatives is imperative as it makes members utilize opportunities of economies of scale (Vanni, 2014). Thus, in situations where smallholder farmers' avoids purchasing inputs through their cooperative impedes the collective action initiatives.

Studies have identified various factors influencing decision of farmers to participate in both input and output markets, though some factors are specific to a particular farmers' group. In the case of input markets, these factors may lead to farmers choosing another input provider, apart from the cooperative. Some socio-economic factors may affect marketing choice for example; in a study by Fischer and Qaim (2012) in collective action in banana production in Kenya, identified sex, household size, farm size and members free riding behaviour to affect the participation.

Furthermore, the choice of input provider in input markets by smallholder farmers may be influenced by SEC (Search, Experience and Credence) choice factors (Kirsten *et al.,* 2009). Credence arises from the fact that, the farmer may not be able to evaluate the quality of the inputs sold through the particular input provider. It is therefore that, the decision of the farmer to purchase the input will depend on factors such as trust, assurance, management, reputation of the seller and education. Barham and Chitemi (2009) in their study in Tanzania, among other factors identified education as one of the reasons for farmers not taking part in the cooperative markets. Experience is built through repeated purchases of the inputs and influences the marketing choice (Kirui and Njiraini, 2013). The farmers may not be purchasing inputs because of bad prior experience with the input provider in terms of inputs quality or other factors. Minimal search effort also leads to choosing a particular purchasing point. The search factor can be inclined to distance from the nearest town, availability of information and the price differences among input providers.

2.5 Efficiency in Production and its Measurements

2.5.1 Efficiency concept

Kumbhakar and Lovell (2003) defines efficiency as the ability of a decision making unit to obtain the maximum output from a set of inputs (output orientation) or to produce an output using the lowest possible amount of inputs combination (input orientation**).** Dzeng and Wu (2013) recently defined efficiency as the goal oriented concept for determining the best scenario in which to use the lowest input or reach the highest output. Generally, it is the degree of achievement in the allocation of the available inputs and output produced in order to attain a high degree of efficiency in cost, revenue or profit.

2.5.2 Measurement of efficiency in production

Efficiency measurement started with the work of Farrel (1957) and proposed the term efficiency to be divided into technical and allocative efficiency. Technical efficiency represents a farm's ability to produce a maximum level of output from a given level of inputs. Allocative efficiency is the ability of a farm to use inputs in optimal proportions, given their respective prices and available technology. The combination of technical and allocative efficiency provides the level of economic efficiency. That is to say, if the farm uses resources completely allocatively and technically efficiently it is said to have achieved total economic or cost efficiency which is the ratio of minimum feasible cost to the observed expenditure.

Two approaches (parametric and non-parametric) are used in measurement of cost efficiency; however the selection of which method to use depends on theoretical and empirical considerations. The commonly used non-parametric (mathematical programming) approach is Data Envelope Analysis (DEA). This calculates efficiency of a given farm relative to the performance of other farms producing the same product or service in the industry (Morandi *et al.,* 2013). The advantage of this method relies in its statistical strength (Dzeng and Wu, 2013). It is less sensitive to misspecification errors and does not suffer multicollinearity and heteroscedasticity. However, it is more sensitive to outliers and cannot measure random errors (exogenous shocks beyond the control of the production unit) and tests hypotheses which limits its application in some studies (Ray, 2012).

Contrary to non-parametric method, parametric (econometric) approach involves specifying a technology of the producer that is, production/cost function and always takes into consideration that, deviation away from given technology is composed of two parts; randomness (misspecification and measurement errors) and inefficiency. The assumption is that inefficiencies follow a one sided distribution that is half normal, exponential or truncated and the random errors are normally distributed. The common method used is Stochastic Frontier Analysis (SFA). SFA accounts for noise (random errors) and has the ability to conduct conventional tests of hypotheses (Kumbhakar and Lovell, 2003). The disadvantage of this method is that, it imposes specific assumptions on both functional form of the frontier and distribution of error term (Gebregziabher *et al*., 2012).

2.6 Review of Analytical Techniques

2.6.1 Stochastic cost efficiency frontier analysis in agricultural production

Measurements of cost efficiency are conducted using parametric method such as DEA and non-parametric such as SFA methods. Morandi *et al.* (2013) recently compared these two methods and found that SFA gives better results than DEA. Dzeng and Wu (2013) had similar observation. SFA requires specifying a cost frontier which represents the minimum expenditure required to produce any output given input prices (Kumbhakar and Lovell, 2003).

Cost frontier is a function of output being produced by producer i; (Y_i), input prices faced by a producer (W_i) and a vector of technological parameter (β) that is, $C_i = C(Y_i, W_{i;} \beta)$ whereby C_i is the actual cost incurred by the producer in the course of production. This function should be a cost minimizing solution, non-decreasing in input prices and output, homogeneous of degree one and concave in input prices (Coelli *et al.,* 2005). The actual cost (C_i) can be greater or equal to the minimum feasible cost represented by the frontier due to external shocks within the production system (Ui) sometimes known as inefficiency. The cost frontier thus is composed of two random parts; V_i which captures statistical noise and is assumed to follow a distribution centred at zero and identically independently distributed (iid) each other and of the regressors that is, $V_i \sim iidN\left(0, \sigma_v^2\right)$ and Ui which is a non-negative variable with one sided distribution that is truncated, half normal or exponential accounting for cost inefficiency by showing how far the farmer operates above the cost frontier.

$C_i = C\left(Y_i, W_{i;} \beta\right)\exp\left(V_i + U_i\right)$ .... (1)

Using the logarithmic transformation, the model in Equation 1 can be written as flows;

$\ln C_i = \ln C\left(Y_i, W_{i;} \beta\right) + V_i + U_i$ .... (2)

It follows that, when $Ui = 0$ the producer is producing on the frontier and is 100% efficient.

The model is estimated by Maximum Likelihood (ML) after specifying the production technology using a production function. The model can be estimated by ML using a single step or two step procedures. A single step is conducted by estimating both the efficiency and inefficiency variables in a single equation. The two step procedure requires estimating the cost efficiency model and ignoring the inefficiency variables in the first stage and predicts the inefficiency effects then regress against the set of exogenous variables suspected as sources of inefficiency in the second stage. The two step procedure is biased due to misspecification of the model estimated in the first stage hence the single step provides efficient estimates (Battese and Coelli, 1995).

The production technology is commonly specified using a Cobb Douglas or Translog (transcendental logarithmic) functional form (Coelli, 1995, Kumbhakar and Lovell, 2003). The choice of either a Cobb Douglas or Translog functions depends on the assumption put forward and nature of agricultural production. Cobb Douglas functional form imposes a priori restriction on the substitution possibilities between the factor inputs (unitary elasticity of substitution) which does not hold in most of the agricultural production systems (Debertin, 2012). Translog is flexible and does not use this assumption but may sometimes run out of degree of freedom leading to multicollinearity.

Maganga *et al.* (2012), Dzeng and Wu (2013) and Morandi *et al.* (2013) used a translog in their studies due to its flexibility.

Various studies of cost efficiency in agricultural production systems such as maize, wheat, rice and rubber have received much attention in the efficiency literature (Coelli, 1995). Example, Revoredo-Giha *et al.* (2009) determined cost efficiency of farms in Scotland using translog cost efficiency frontier and found that, variations in the level of efficiency exists due to farm sizes. Ghosh and Raychaudhuri (2010) in the study of cost efficiency in West Bengal and Andhra found inefficiencies in the use of inputs in rice production. Maganga *et al.* (2012) in the study of potato production in Malawi using a translog cost efficient frontier established existence of cost inefficiency and Audu (2013) studying cost efficiency in cassava production in Nigeria also found existence of cost inefficiency.

Inefficiency is associated with the loss of productivity due to inability of farmers to use production inputs in their optimal proportions. Determinants of inefficiency are modelled using inefficiency model. Socio-economic factors and farm specific characteristics are sources of inefficiencies in agricultural production. Revoredo-Giha *et al.* (2009) associated inefficiency with farm size, small farms introduces inefficiency in production. This finding was similarly obtained in Morandi *et al.* (2013) in the study of wheat production in Iran. Maganga *et al.* (2012) identified education, credit, farming experience, household size and frequency of weeding to influence inefficiency. Furthermore, Audu (2013) also identified credit accessibility, extension services and education to be determinants of inefficiencies in cassava production.

2.6.2 Determination of Factors Influencing Choice of Two Situations

An individual choice follows the *homus economicus* assumption that, if an individual chooses a particular action or object it means the action or object maximizes the utility of that individual. Utility is the total or overall satisfaction which an individual derives from making a certain choice (Nicholson and Snyder, 2008). The choices are inferred using the Random Utility Model (RUM) framework since there is no direct measurement of how much utility a person may gain from making a particular choice. The possible way thus is to make inference from the person's behaviour.

Logit and Probit are common models using the RUM framework. The choice of which model to use depends on the assumption about the distribution of the error term though seem to give similar results in many empirical studies (Greene, 2012). Probit has a normal distribution and logit has a logistic distribution. Logit is flexible and gives better results when there is a mix of categorical and continuous variables (Kirui and Njiraini, 2013).

RUM framework guides an individual to make a choice between two alternatives by choosing the alternative which maximizes utility such that; U_{1i} is the utility that individual i gets if alternative 1 is chosen and U_{0i} is the utility that individual i gets if alternative 0 is chosen. The choice of a particular alternative by an individual is influenced by various factors (Xi) thus the regression equation 3 below (Index or latent model) could be estimated.

$$Y_i^* = \underset{\sim}{X}'_i \underset{\sim}{\beta}_k + \varepsilon_i \text{; } \varepsilon_i \approx \text{Logistic distribution for logit model} \quad \ldots\ldots (3)$$

The problem with the above model is that Y_i^* is unobservable as the utility of an individual cannot be observed, but choices made by individuals gives some information such that, if $y_i = 1$ then $Y_i^* > 0$ and If $y_i = 0$ then $Y_i^* \leq 0$. This implies that, if an individual makes choice 1 it must be the case that utility of alternative 1 is the highest. The probability of an individual making choices can be determined by combining the regression equation for the unobservable Y_i^* and the equations that links y_i and Y_i^*. An individual choses alternative 1 in such a way that, y_i=1; $Y^* > 0$ and applying probabilities gives Equation 4.

$$P[yi = 1] = P[Y^* > 0] \quad \text{...} \quad (4)$$

But from equation 3 above, $Y_i^* = \underset{\sim}{X}'_i \underset{\sim}{\beta}_k + \varepsilon_i$ thus replacing Y_i^* in equation 4 gives;

$$P[yi = 1] = P[\underset{\sim}{X}'_i \underset{\sim}{\beta}_k + \varepsilon_i > 0]$$

$$\equiv P[yi = 1] = P[\varepsilon_i > -\underset{\sim}{X}'_i \underset{\sim}{\beta}_k \;] \quad \text{...} \quad (5)$$

The logistic distribution is symmetric such that,

$$P[yi = 1] = P[\varepsilon_i > -\underset{\sim}{X}'_i \underset{\sim}{\beta}_k] \equiv P[yi = 1] = P[\varepsilon_i \leq \underset{\sim}{\beta} \underset{\sim}{X}'] = \Lambda\left(\underset{\sim}{X}'_i \underset{\sim}{\beta}_k\right) \quad \text{.............................} \quad (6)$$

The model in equation 6, $P\left[y_i{=}1\right]{=}\Lambda\left(\underset{\sim}{X}'_i \underset{\sim}{\beta}_k\right)$ which is known as logit is based on hyperbolic secant squared distribution (Sech^2) thus its cumulative density function is given in Equation 7.

$$P\left[y_i{=}1\right] = \frac{e^{\underset{\sim}{X}'i\underset{\sim}{\beta}k}}{1 + e^{\underset{\sim}{X}'i\underset{\sim}{\beta}k}} \quad \text{...} \quad (7)$$

The probability of an individual who makes choice 0 is simply the difference between 1 (probability cannot exceed 1) and the probability of making choice 1 as shown in Equation 8.

$$P\left[y_i{=}0\right]{=}1{-}P\left[y_i{=}1\right] = \frac{1}{1 + e^{\underset{\sim}{X}'i\underset{\sim}{\beta}k}} = 1 - \Lambda\left(\underset{\sim}{X}'_i \underset{\sim}{\beta}_k\right) \quad \text{...} \quad (8)$$

The ratio of making choice 1 to making choice 0 is known as odds ratio. In logarithmic form is known as log of odds ratio which is β_k as shown in equation 9.

$$\text{Ln}\left[\frac{\text{P}(y_i=1)}{\text{P}(y_i=0)}\right]=\underset{\sim}{\text{X}}'_i\underset{\sim}{\beta}_k=\beta_0+\beta_1 x_{i1}+\beta_2 x_{i2}+\ldots\ldots\ldots\beta_k x_{ik}+\varepsilon_i \quad \text{(9)}$$

The logit model in equation 7 is estimated by ML. The likelihood function is given in Equation 10.

$$\text{L}(\beta_k/\text{X}_i)=\prod_{i=1}^{n}\left[\frac{e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}{1+e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}\right]^{y_i}\left[\frac{1}{1+e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}\right]^{1-y_i} \quad \text{(10)}$$

Different software such as Stata and SPSS can be used to maximize the log of the likelihood function shown in equation 11 to get the estimates.

$$\text{Ln}\left[(\beta_k/\text{X}_i)\right]=\sum_{i=1}^{n}y_i Ln\left[\frac{e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}{1+e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}\right]+\sum_{i=1}^{n}(1-y_i)Ln\left[\frac{1}{1+e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}\right] \quad \text{(11)}$$

The results from the logit model can be interpreted using the signs of the variables, significance of the variables, odds ratio and marginal effect. Marginal effect is the change of the probability of making a choice given a change in the variable. The marginal effect is calculated using Equation 12.

$$\partial y\Big/\partial x_i=\frac{e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}{1+e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}*\frac{1}{1+e^{\underset{\sim}{\text{X}}'i\underset{\sim}{\beta}k}}*\underset{\sim}{\beta}k \quad \text{(12)}$$

The logit model can be checked for conformity of specification using various methods such as Pseudo R-Squared, percentage of correct prediction or Pearson and Hosmer-Lemeshow goodness of fit test commonly known as link test. Furthermore, unlike the probit model which is not consistent when heteroscedasticity consistent standard errors (HCE) are used, logit model can be corrected using HCE when heteroscedasticity is suspected (Greene, 2012).

2.6.3 Two group mean comparison

Two independent groups are compared using mean comparison test commonly known as independent sample T-test. This test is used when among other things; the population variance is unknown and is estimated using sample variance (through standard deviation). The test can be used when the variances are equal. In case where variances are not equal, Satterthwaite approximation is used. Levene's test for equality of variances is used to ascertain whether the variances between the two groups are equal.

The independent sample T-test requires the dependent variable to be normally distributed. Normality can be checked using graphical and statistical tests. Shapiro Wilk test is among the statistical tests which is used for the sample size of 3 to 2 000. It tests the null hypothesis that, the data fits the normal distribution. If the data are found to be not normally distributed; logarithmic transformation is performed so that the data becomes normally distributed. The other method is to use non parametric tests such as Mann-Whitney U test that does not require the assumption of normality (Razali and Wah, 2011).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Conceptual Framework

The conceptual framework for this study is based on production theory with the focus on productivity. Productivity measures how efficiently production inputs are being utilized in production to produce a given level of output (Coelli *et al.,* 2005). Thus, rice productivity is influenced by the use of production inputs (input set) in optimal proportions resulting to lower cost per unit of output. The use of inputs in optimal proportions depends on socio-economic and field management factors such as rice farming experience, production specialization, and type of seed variety planted, method of planting, frequency of weeding and method of harvesting. These factors influence production cost efficiency in addition to source of purchased inputs. Source of purchased inputs is influenced by factors such as payment mode, experience in irrigation scheme cooperative, credit accessibility, quality of inputs, distance to the nearest town, membership in other organisations, level of education and extension services (Figure 1). The situation of achieving cost efficiency in production with increased rice productivity leads to efficiency in production, enhancing rice price competitiveness.

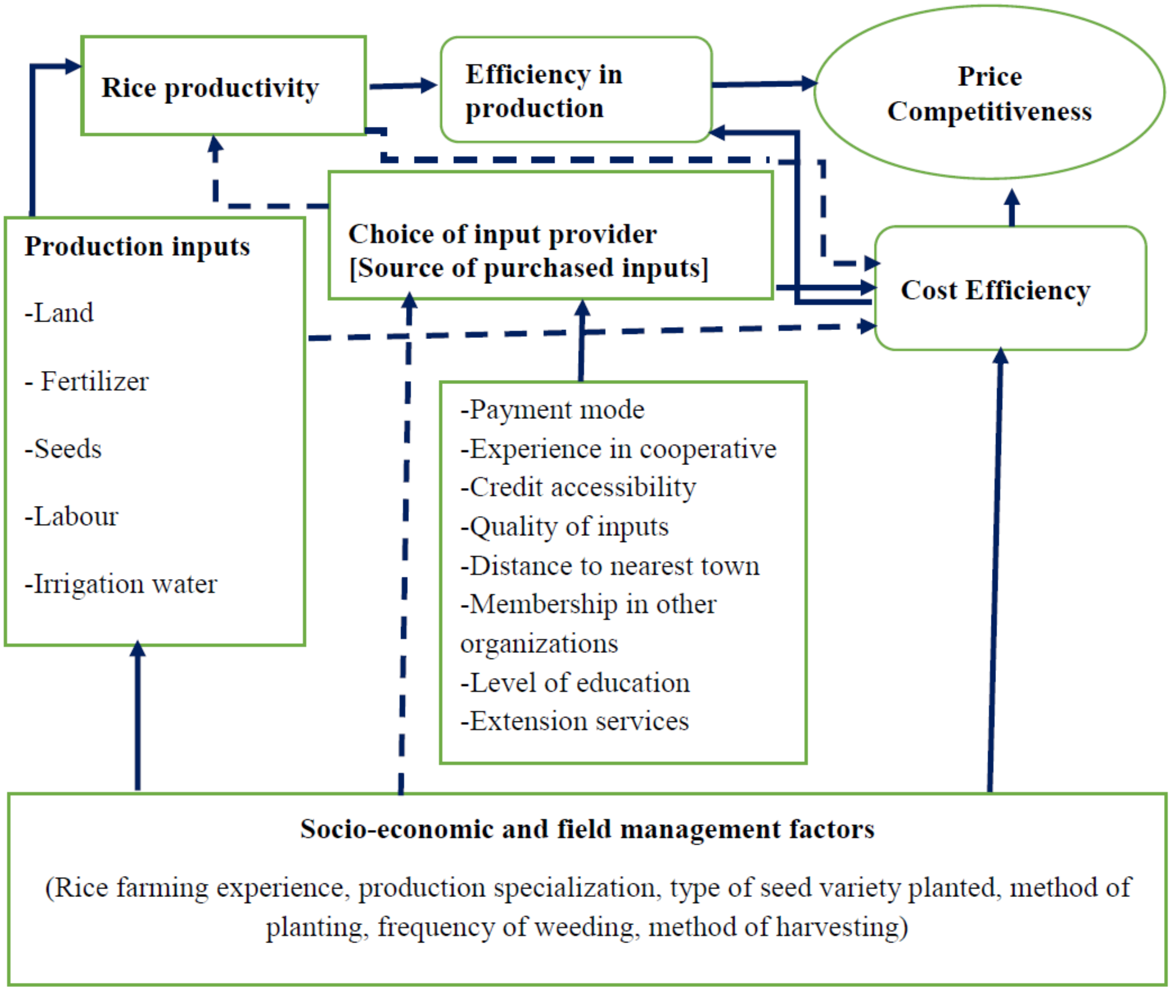

Figure 1: Conceptual framework of source of purchased inputs and production cost efficiency

3.2 Description of the Study Area

The study was conducted in Morogoro and Pwani regions focusing on cooperative managed and rice specialized irrigation schemes. In Morogoro region, it was conducted in Mvomero district under irrigation schemes found in Dakawa and Mlali wards while for Pwani region, the focus was in Bagamoyo district under irrigation schemes in Magomeni, Dunda and Vigwaza wards (Figure 2).

These regions are located in Eastern part of Tanzania. These are among priority regions for rice production in Tanzania under Southern Agricultural Growth Corridor of Tanzania (SAGCOT).

SAGCOT is the public private partnership initiative that was initiated at the World Economic Forum (WEF) Africa in 2010 to foster commercial agribusiness to benefit smallholder farmers and boost agricultural productivity. It identified Morogoro, Mbeya, Pwani, Iringa and Rukwa as priority regions for rice production in this corridor. Morogoro and Pwani regions are in similar agro-ecological zone which is suitable for irrigated rice production.

Morogoro accounts for about 18.70% of the total irrigated area and 12% of the total rice production in the country. The area under rice production is about 31% of the total area of agricultural production in this region (NBS, 2012). On the other hand, Pwani region is endowed with a large area which is potential for irrigation (128 795ha) and being getting water supplies from Wami and Ruvu rivers. Pwani region has 14 irrigation schemes of which 7 are in Bagamoyo district. Furthermore, Morogoro and Pwani regions provides reliable supply of rice due to accessibility by road network and thus serves much the Dar es Salaam rice market which makes about 60% of the national rice consumption.

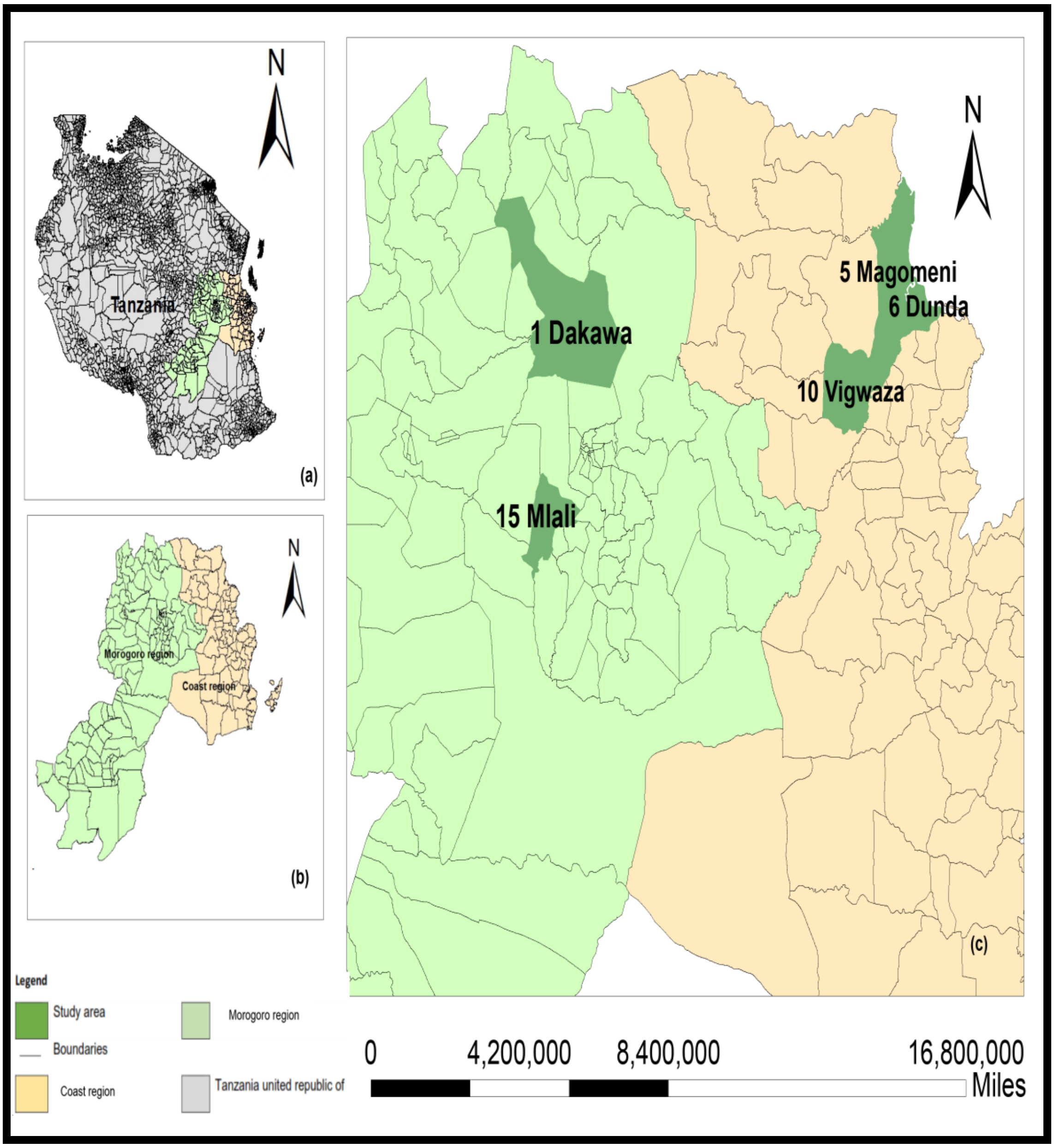

Figure 2: Map showing wards served by cooperative irrigation schemes used in the study

3.3 Research Design

3.3.1 Sampling procedure and sample size

Multi-stage sampling involving two stages was used. The first stage was selection of four out of six irrigation schemes as shown (Table 1) using probability proportional to size

(PPS). The PPS method involved listing of all rice specialized cooperative irrigation schemes, identifying the number of beneficiaries (population size), calculating the cumulative population in each irrigation scheme and calculating the sampling interval (SI) that is, ($\frac{\text{Cumulative total population}}{\text{Number of clusters}} = \frac{2311}{4} = 578$) and probability 1 and probability 2 of each irrigation scheme (Appendix 1). Probability 1 is the likelihood of selection for each sampled irrigation scheme and probability 2 being the likelihood of selection for each individual farmer in each of the sampled irrigation schemes. Four clusters (number of irrigation schemes to be studied) were used.

The last step of implementation of the PPS method was to generate random numbers and select the one which is equal or less than the SI, this is sometimes known as Random Start (RS). The random number selected was 275. The first irrigation scheme was then selected by looking for the irrigations scheme whose cumulative population size exceeds this random number in which CUMKI was selected. The second, third and the fourth irrigation schemes were selected using the same criterion by considering the SI that is; 275+578=853 for the second, 853+578=1431 for the third and 1431+578=2009 for the fourth in which UWAWAKUDA, TEGEMEO/BIDP and CHAURU irrigation schemes were respectively selected (Table 1).

Table 1: Rice specialized cooperative irrigation schemes in Pwani and Morogoro regions

Region	District	Irrigation scheme cooperative	Number of beneficiaries			Cumulative population size
			Male	Female	Total	
Morogoro	Mvomero	MKINDO/ MGONGOLA	102	78	180	180
		CUMKI	130	123	253	433*
		UWAWAKUDA	471	371	842	1275*
Pwani	Rufiji	SEGENI	38	18	56	1331
	Bagamoyo	TEGEMEO/BIDP	47	73	120	1451*
		CHAURU	516	344	860	2311*
		Total	**1304**	**1007**	**2311**	

Source: Ministry of Agriculture, Food Security and Cooperative; Eastern Zone irrigation office; * Cooperative irrigation scheme selected.

The second stage involved obtaining smallholder farmers from each irrigation scheme sampled in first stage using Systematic Random Sampling (SRS). It should be noted that, PPS requires selecting the same number of respondents from each cluster (irrigation scheme) as shown (Table 2). This second stage compensates the first stage so that, each farmer in the population of farmers in rice specialized cooperative irrigation schemes has the same probability of being sampled.

The study population (N) was 2311 (Table 1) which gives a sample size (n) of 330 using the formula in equation 13 by Kothari (2004).

$$n=\frac{Z^2.N.p.q}{e^2.(N-1)+Z^2.p.q}=\frac{(1.96)^2*2311*(0.5*0.5)}{(0.05)^2*(2311-1)+(1.96)^2**(0.5*0.5)}=329.53\approx 330 \text{.......(13)}$$

Where Z is the standard variate at 95% confidence interval, e=5% level of precision, p and q are sampling distribution of proportion of success and failure respectively. Given time and financial resources constraints, the sample size was reduced to 200.

The sample was stratified into two groups; farmers purchased inputs through the irrigation scheme cooperative and those who did not. SRS was implemented by selecting each fifth member in the list of members after reshuffling it.

Table 2: Cooperative irrigation schemes used in the study

Region	District	Irrigation scheme cooperative	Ward	Number of respondents
Morogoro	Mvomero	UWAWAKUDA	Dakawa	50
		CUMKI	Mlali	50
Pwani	Bagamoyo	CHAURU	Vigwaza	50
		TEGEMEO/BIDP	Magomeni	27
			Dunda	23
Total				**200**

3.3.2 Data collection methods and sources of data

This was a cross sectional study and involved collecting data from a single agricultural season, 2013/14. Primary data (data on production, socio-economic factors, factors influencing the source of purchased inputs and field management factors) were collected from farmers using semi-structured questionnaire (Appendix 6). Data from key informants were collected using a checklist (Appendix 7).

3.4 Analytical Framework

3.4.1 Objective I: Costs of production of smallholder irrigated rice farmers

Cost of production was quantified in order to compare costs of production for smallholder irrigated rice farmers purchasing inputs through the irrigation scheme cooperative and those who do not. Differences in costs of production were tested using independent sample T-test. Normality test is one of the requirements for implementation of T-test. The data suitable for T-test should be normally distributed. Shapiro Wilk test was used to test the normality of costs of production. It tests the null hypothesis that the observed distribution fits the normal distribution against the alternative hypothesis that the observed distribution does not fit the normal distribution.

Quantification of costs of production was conducted using enterprise budgeting technique (Appendix 2). The technique involved quantification of input costs such as irrigation water, seeds, fertilizer, herbicides, pesticides and labour. Land was not included in the quantification of the costs since farmers are given free by the irrigation scheme cooperative and the farmer has no direct decision on land thus cannot easily be allocated to an enterprise. The government land rent is paid by the cooperatives thus it is not a direct cost to farmers of the irrigation scheme cooperative. Inputs that are not easily allocated to a particular enterprise are not included in the enterprise budgeting (Debertin, 2012).

Labour costs were quantified from rice production activities of field clearing, ploughing, hallowing, planting, field water management, weeding, fertilizer application, herbicides application, and pesticides application, birds scaring, harvesting and bagging. The costs for manual harvesting were quantified from cutting, pilling, threshing and winnowing. In situations where family labour was used, equivalent wage cost of working off-farm for a wage was used. Other cost items were purchase of bagging materials and transport costs.

Number of people (labour unit) required to perform a particular amount of work was also estimated to enable the quantification of price of labour. The amount of work that can be done by one labour unit in one day is called man-day (one man day is equivalent to 8 working hours). Thus, the number of days spent on doing a particular activity in the field was estimated. The price of labour was then obtained by taking the total cost of labour divided by the number of days taken on that activity.

3.4.2 Objective II: Factors influencing smallholder irrigated rice farmers' choice of production inputs provider

Logit model was used and the dependent variable was type of inputs provider such that, $y_i=1$ if the farmer purchased inputs through the cooperative, 0 otherwise.

$$P\left[y_i=1\right]=\Lambda\left(\underset{\sim}{X}'_i\underset{\sim}{\beta}_k\right)=\frac{e^{\underset{\sim}{X}'i\underset{\sim}{\beta}k}}{1+e^{\underset{\sim}{X}'i\underset{\sim}{\beta}k}} \qquad (14)$$

Where $i=1,2......8;$ that is $X_1, X_2......X_8$ being explanatory variables as described in Table 3 below, and $k=0,1,2......8;$ that is $\beta_o, \beta_1, \beta_2......\beta_8$, as parameters to be estimated.

The expected signs of the explanatory variables for the logit model (Table 3) implies that; if the sign is positive, the explanatory variable under consideration increases the likelihood of the farmer to purchase production inputs through the irrigation scheme cooperative and vice versa. Distance from the cooperative to the nearest town is expected to increase the likelihood of the farmer to purchase inputs through the irrigation scheme cooperative due to limited number of input providers in villages that are far away from town. Experience of the farmer in the irrigation scheme cooperative is also expected to increases the likelihood of the farmer to purchase inputs through the irrigation scheme cooperative.

Availability of credit facilitated by the irrigation scheme cooperative is expected to increase the likelihood of the member of irrigation scheme cooperative to purchase inputs through the cooperative as the result of increased purchasing power on inputs. Extension services are expected to bring eager of adopting use of proper inputs. It is thus expected that, number of times the farm manager or the extension officer of the irrigation scheme cooperative visits increase the likelihood of purchasing inputs through the irrigation scheme cooperative.

On the other hand, number of organizations in which a farmer is a member is expected to reduce the likelihood of purchasing inputs through the irrigation scheme cooperative due to extended social capital that enables the farmer to get inputs from other organizations.

Satisfactory quality of inputs and education of the cooperative members are expected to increase the likelihood of purchasing inputs through the irrigation scheme cooperative. Education as measured by number of years of formal training((0 years being did not attend any formal training; less than 7 years implies that the cooperative member attended primary school but did not complete; 7 years implying attended primary education; 8 years being received training after primary school; 9-14 years being attended secondary school and 15-16 years being received training after secondary school either through technical colleges or universities) is expected to increase the awareness of farmers on the importance of collective purchases.

Lastly, input payment mode (cash only, credit only or both credit and cash) is also expected to increase the likelihood if both credit and cash payment options are available at the irrigation scheme cooperative.

Table 3: Description of explanatory variables for the choice of input provider

Variable	Description	Expected sign
X_1 = Distance	Distance from the cooperative to the nearest town in kilometres	+
X_2 = Experience	Farmer's years of experience in cooperative	+
X_3 =Credit accessibility(Dummy)	If a farmer obtained credit in a year facilitated by the irrigation scheme cooperative	+
X_4 = Membership	Number of organizations a farmer is a member	-
X_5 =Extension	Number of times visited by extension officer or farm manager from the irrigation scheme cooperative in a season	+
X_6 =Input quality (Dummy)	Input quality satisfaction	+
X_7 =Education	Years spent in formal training	+
X_8 =Input payment mode (Dummy)	Credit and cash based purchase system	+

3.4.3 Objective III: Production cost efficiency by smallholder irrigated rice farmers in cooperative irrigation schemes

Farm level cost efficiency was determined using stochastic frontier analysis given its ability to decompose deviations from the efficient frontier into two components of inefficiency and error term (Aigner *et al.,* 1977; Coelli, 1995 and Kumbhakar and Lovell, 2003). The production technology was implied by a Translog function forming a Translog stochastic cost frontier. It should be noted that, Translog stochastic cost frontier has three distinct terms; linear, quadratic and interaction terms. The stochastic cost frontier function was modelled in a four input framework (fertilizer, labour, irrigation water and seeds) as shown in equation 15 and description of the variables (Table 4).

$$lnC_i = \beta_o + \beta_1 lnY_i + \beta_{mi}\sum_{mi=1}^{4}\ln W_{mi} + 0.5\beta_5\left[\ln Y_i\right]^2 + 0.5\beta_{mn}\sum_{m=1}^{4}\sum_{n=1}^{4}\left[\ln W_{mi}\right]^2 + \beta_{mr}\sum_{mr=1}^{4}\ln W_{mr}\ln Y_i$$
$$+\beta_{mn}\sum_{m=1}^{4}\sum_{n=1}^{4}\ln W_{mi}\ln W_{ni} + Vi + Ui \quad \text{.......(15)}$$

Land was not included in the model since it is given free to all farmers (members of the irrigation scheme cooperative).

Table 4: Description of variables for the cost efficiency model

Variable	Measurement	Description
Cost of production	TAS/ha	Total cost used in the production of rice
Rice output	MT/ha	Rice output harvested in MT per hectare
Price of Fertilizer	TAS/Kg	Average price of fertilizer of both basal application and top dressing applications used in one agricultural season
Price of Seeds	TAS/Kg	Price of seeds used in either transplanting, broadcasting or direct seeding
Price of Water	TAS/ha	Price of irrigation water used in production paid to the irrigation scheme cooperative
Price of Labour	TAS/man day	Price of labour obtained by taking the total labour cost of an individual farmer divided by the total man days used in production. One man day is the amount of work that can be done by one labour unit in one day (8 working hours)

Cost efficiency frontier function is homogeneous of degree one in input prices such that $C(Y_i, \lambda W_{i;}\beta) = \lambda C(Y_i, W_{i;}\beta)$ where $\lambda > 0$. The function has to be normalized by dividing the equation except output by one of the input price (Morandi *et al.,* 2013).

The cost efficiency frontier was thus normalized using the price of seeds and the model estimated is shown in Equation 16.

$$lnC_i = \beta_o + \beta_1 \ln Y_i + \beta_2 \ln P\_fert + \beta_3 \ln P\_lab + \beta_4 \ln P\_water + 0.5\beta_5(\ln Y_i)^2 + 0.5\beta_6(\ln P\_fert)^2$$
$$+0.5\beta_7(\ln P\_lab)^2 + 0.5\beta_8(\ln P\_water)^2 + \beta_9 \ln Y * \ln P\_fert + \beta_{10}\ln Y * \ln P\_lab + \beta_{11}\ln Y * \ln P\_water$$
$$+\beta_{12}\ln P\_fert * \ln P\_lab + \beta_{13}\ln P\_fert * \ln P\_water + \beta_{14}\ln P\_lab * \ln P\_water \quad \text{.......(16)}$$

where; ln is natural logarithm; C_i is normalized total production cost incurred by a farmer; Y_i is rice output obtained by a farmer; P_fert is the normalized price of fertilizer; P_lab is the normalized price of labour; P_water is the normalized price of irrigation water and β_s are parameters to be estimated.

The above model was estimated by single step procedure using Frontier version 4.1. The single step procedure was used in order to avoid bias as the result of misspecification that is always brought by the use of two step procedure. Single step procedure estimates in a single equation the parameters for the efficiency model, cost efficiency scores, value of gamma and sources of inefficiency in the production system.

Cost efficiency scores ranges from 1 to infinity in a cost efficiency frontier model. However, in case there is interest of showing cost efficiency ranging from 0 to 1, the approach is to take the reciprocal of the cost efficiency in cost frontier.

The value of Gamma (γ) indicates the level of inefficiency such that; γ=0 implies that, deviations from the frontier are entirely due to noise as there is no evidence for presence of inefficiency effects. The value of γ=1 would mean that, all deviations from the frontier are due to inefficiency (inefficiency effects are highly significant in the production system). Furthermore, the likelihood ratio test (LR test) is used to compare the fitted model which includes inefficiency factors, to a corresponding model without inefficiency factors. The hypotheses being tested are; there is no inefficiency implying that smallholder farmers are 100% efficient (Null hypothesis) and there is inefficiency implying that smallholder farmers are not 100% efficient (alternative hypothesis).

3.4.4 Objective IV: Sources of production cost inefficiency by smallholder irrigated rice farmers in cooperative irrigation schemes

Sources of inefficiency were determined through assumption on the inefficiency error component. The inefficiency error component U_i was assumed to follow a truncated normal distribution with a mean as a function of the hypothesized sources of inefficiency in production (Battese and Coelli, 1995).

$$U_i = \delta_o + \sum_{t=1}^{n} \delta_t Z_t + \varepsilon_t \qquad (17)$$

The value of $\delta_0 ...... \delta_7 = 0$ implies that there is no inefficiency in the production system.

Empirically, the inefficiency model used was specified as follows;

$$U_i = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 \qquad (18)$$

The variables $Z_1 .... Z_7$ are given in Table 5 below and $\delta_0 ... \delta_7$ were the parameters to be estimated.

Table 5: Description of variables for inefficiency model

Variable	Description	Expected sign
Z_1 =Farming experience	Years of rice farming experience	-
Z_2 =Harvesting methods (Dummy)	Combine harvester/motorized thresher	-
	Manual	+
Z_3 =Planting methods (Dummy)	Transplanting	-
	Broadcasting and dibbling	+
Z_4 =Frequency of weeding	Number of times weeding is done from planting to harvesting	-
Z_5 =Seed variety planted(Dummy)	Improved variety	-
	Local variety	+
Z_6 =Degree of production specialization	Measure of economies of scale(ratio of total rice acreage to total crop acreage)	-
Z_7 =Source of purchased inputs	Purchasing inputs through the cooperative	-

(Dummy)	Purchasing inputs from other input providers	+

The negative expected sign shows a decrease of inefficiency (increasing cost efficiency) and the positive expected sign implies that a particular factor increases inefficiency (decreasing cost efficiency). Farming experience as measured by years of rice farming experience is expected to reduce the level of inefficiency in smallholder farmers' production system. The more years a farmer spends in irrigated rice production the more skills are acquired in managing the production inputs hence increasing efficiency.

Good Agricultural Practices (GAPs) are important in ensuring efficiency in any agricultural production system. Proper ways of harvesting, planting, weeding and use of quality seeds are imperative in smallholder irrigated rice production in cooperative irrigation schemes. The use of combine harvester or motorized rice thresher as mechanization method in harvesting activity is expected to reduce inefficiency in harvesting activity thus improving the cost efficiency. Manual harvesting is expected to be inefficient in terms of cost, quality of rice and time hence can lead to inefficiency in the harvesting activity.

There are three main methods of planting rice; transplanting, broadcasting and direct seeding (dibbling). Transplanting method of planting allows the farmer to plan apriori the spacing, reduces weeds and leads to high yields. It is expected that, as farmers in irrigated rice production use transplanting method of planting, their efficiency increases through yield increase and reduced weeds. The increase in frequency of weeding (number of times weeding is done from planting to harvesting) increases cost efficiency due to reduced weed infestation in rice. Improved seeds also increase efficiency in production.

Degree of specialization $\left[\frac{\text{Total rice acreage}}{\text{Total acreage of all crops}} * 100\% \right]$ is the measure of economies of scale. Debertin (2012) defines economies of scale as what happens to per unit costs of production when output is changed but input levels do not necessarily increase in the same proportionate amounts. In other words, it is what happens when all input categories are increased proportionately. Specialization allows farmers to enter into bulk markets as the average cost of production falls. Additionally, source of purchased inputs (whether a farmer purchases inputs through the cooperative or from other input providers) is expected to have influence on cost efficiency of the smallholder irrigated rice farmers in cooperative irrigation schemes. It is hypothesized that, purchasing inputs through the irrigation scheme cooperative increases cost efficiency in their production system.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of the Cooperatives Surveyed

Gender, experience, education and primary occupation as shown (Table 6) are important socio-economic characteristics for cohesion in collective action initiatives such as cooperative. Results revealed that, no significant variation in the distribution of male and female exist in the cooperatives surveyed according to the Chi-square test. This indicates that, male and female are closely involved in collective actions. The disproportionate of gender was observed in CHAURU irrigation scheme in which female were only 38% compared to 62% male.

Level of experience varied across the irrigation schemes ($p<0.05$). CUMKI irrigation scheme found in Mlali/Kipera had a slightly higher percentage of farmers with less than 5 years of experience in the cooperative. On the other hand, TEGEMEO irrigation scheme which is sometimes known as Bagamoyo Irrigation Development Project (BIDP) had the lowest percentage of farmers with high level experience.

Level of education was measured by number of years spent in formal training by the cooperative members. Results indicate that, there were variations in the level of education in the irrigation schemes surveyed. There were no farmers who did not get formal training in UWAWAKUDA and TEGEMEO irrigation schemes.

Crop production, wage employment, business and other self-employments were the primary occupations of cooperative members. Variations in primary occupations exist with few (48%) members in UWAWAKUDA being primarily involved in crop production. UWAWAKUDA was found to have a significant number of members who are primarily involved in wage employment, business and self-employment occupations.

Table 6: Socio-economic characteristics of the cooperatives surveyed

Variable name		Irrigation scheme cooperative UWAWAKUDA	CHAURU	CUMKI	TEGEMEO	χ^2 value (n=200)
Gender (%)	Male	48	62	46	64	
	Female	52	38	54	36	
						5.253
Years of experience (%)	Low level experience (<5 years)	4	2	32	14	
	Experienced (5-10 years)	44	40	28	54	
	High level experience (>10yeras)	52	58	40	32	
						30.390*
Level of education (%)	No any formal training	0	4	4	0	
	Primary education	72	56	76	72	
	Secondary education	12	40	20	14	
	Training after secondary education	16	0	0	14	
						32.262*
Primary occupation (%)	Crop production	48	96	84	88	
	Wage employment	28	2	2	6	
	Business and other self-employment	24	2	14	6	
						46.693*

*significant at 1% level

4.2 Socio-economic Characteristics and Participation in Input Purchases

Participation in input purchases was found to be independent of gender of the irrigation scheme cooperative members. The study found more male to have not purchased inputs through the irrigation scheme cooperative than female but the difference was not significant. This indicates that, level of female participation is higher than that of male.

This result is similar to the one obtained by Kirui and Njiraini (2013) who reported female to have high participation in collective actions.

Experience was found to influence the participation of members of the irrigation scheme cooperative in input purchases ($p<0.05$). Results show that, more members with high level of experience purchased inputs through irrigation scheme cooperative than members with low level of experience. This finding is similar to the one obtained by Vanni (2014) who found experience in collective action to improve participation and devotion to voluntary action of those shared interests. It was also found by Nugussie (2013) in the study of membership in agricultural cooperative in Ethiopia that, experience influences the level of participation in the cooperatives.

Level of education in cooperative irrigation schemes was found not to influence participation of members in input purchases. There was no direct association between participation in input purchases and level of education. This could be due to the availability of extension services that are usually offered at the time of purchase of the agricultural inputs through the irrigation scheme cooperative. Furthermore, participation in input purchases was found to vary with the primary occupation of the farmer in which, more farmers with crop production as their primary occupation did not participate in input purchases than farmers with wage employment, business or self-employment as their primary occupation.

Table 7: Socio-economic characteristics and participation in input purchases

Variable name		Participation in input purchases: Purchased through cooperative	Purchased from other providers	χ^2 value (n=200)
Gender (%)	Male	52.8	57.6	0.468
	Female	47.2	42.4	
Years of experience (%)	Low level experience (<5 years)	6.5	20.7	8.824**
	Experienced (5-10 years)	44.4	38	
	High level experience (>10yeras)	49.1	41.3	
Level of education (%)	No any formal training	1.9	2.2	0.232
	Primary education	70.4	67.4	
	Secondary education	20.4	22.8	
	Training after secondary education	7.3	7.6	
Primary occupation (%)	Crop production	72.2	87	6.509**
	Wage employment	12.1	5.4	
	Business and other self-employment	15.7	7.6	

**significant at 5% level

4.3 Characteristics of Cooperative Members' Production System

4.3.1 Rice farming experience and economies of scale

Economies of scale as measured by the level of specialization in a particular crop production such as rice and farming experience are important in agricultural cooperatives (Cechin *et al.,* 2013). Results as shown (Table 8) indicate an association between the level of specialization and years of rice farming experience ($p<0.05$). Highly experienced cooperative members have high level of specialization allowing them to enjoy economies of scale. It shows that, 16% of the cooperative members use more than 50% of their land for rice production with 40% being 100% producing rice only.

Table 8: Rice farming experience and economies of scale

Rice farming experience in years	Economies of scale (Level of specialization)				Total
	<25%	25-50%	>50%	100%	
<5	1	9	2	3	15
5-10	7	23	9	39	78
11-16	9	19	12	29	69
>16	9	11	9	9	38
Total	26 (13)	62 (31)	32 (16)	80 (40)	200
Statistical test	**χ^2 (9, n=200) =17.791**; p=0.038**				

**significant at 5% level; values in brackets are percentages

4.3.2 Input purchases and economies of scale

All farmers in irrigation scheme cooperatives were found to have purchased fertilizers, either through the irrigation scheme cooperative or from other input providers. Results show further that, input purchases are not independent of level of specialization in irrigated rice production. Purchased input combination varied with the level of specialization as more specialized farmers purchased input combinations than farmers who are less specialized. It can be concluded that, economies of scale as measured by the level of specialization improves the decision of farmers towards purchase of agricultural inputs. The situation of more specialized farmers to purchase inputs increases their participation in collective actions especially when the inputs are purchased through the cooperative. Studies such as Kirui and Njiraini, (2013) have also shown that, level of specialization improves participation in smallholder farmers' collective activities.

Table 9: Input purchases and economies of scale

Purchased inputs combination	Economies of scale (Level of specialization)				Total
	<25%	25-50%	>50%	100%	
Fertilizer, seeds	11	31	12	43	97
Fertilizer, seeds, herbicides	2	14	13	15	44
Fertilizer, seeds, pesticides	4	4	0	10	18
Fertilizer, seeds, herbicides,	9	13	7	12	41

pesticides					
Total	26 (13)	62 (31)	32 (16)	80 (40)	200
Statistical test	**χ^2 (9, n=200) =18.683**; p=0.028**				

**significant at 5% level; values in brackets are percentages

4.3.3 Level of agricultural practices

The use of improved seeds, proper weeding, harvesting and planting methods are worthy indicators of good agricultural practices. Results indicate no existence of variations in the use of seeds across the cooperatives. It shows that, an average of 94.5% of smallholder rice farmers in cooperative irrigation schemes uses improved seeds. Most of the farmers were found to use TXD 306 famously known as SARO 5. TXD 306 was released in 2002 by Chollima Agro-Scientific Research Centre in Morogoro by cross breeding of Super and an improved variety from Korea known as KM 67. TXD 306 is semi-aromatic, high yielding and has a short growing season (110-125 days) contrary to other varieties which has a longer growing season (125-140days).

Weeding was found to be not fully mechanized as an average of 65.5% of farmers does it manually. Weeding methods varied across irrigation schemes (p<0.01). The highest number of farmers doing manual weeding in their irrigated rice production systems (96%) was found in TEGEMEO irrigation scheme. There were no farmers in this irrigation scheme using chemical weeding only. Few (4%) supplemented manual weeding with chemical weeding through the use of herbicides. UWAWAKUDA had a better number of farmers (50%) who are supplementing manual weeding with chemical weeding. These farmers can easily fully mechanize weeding activity once are exposed to better herbicides and extension services related to the use of herbicides.

Harvesting was investigated on the basis of either doing it manually or using labour saving technologies. Variations in use of harvesting methods existed across irrigation schemes surveyed ($p<0.01$). CUMKI irrigation scheme in Mvomero district is completely not mechanized in harvesting activity. This is due to the nature of their fields. It was observed during field survey that, their fields are in sloping areas making difficulties of combine harvesters to be used. This is because most of the combine harvesters available are bigger in size, requiring slightly flat fields. It's thus important to provide small combine harvesters that can work in these fields. Furthermore, transplanting as the method of planting varied across cooperatives with UWAWAKUDA irrigation scheme having the lowest (58%) number of farmers doing transplanting (Table 10).

Table 10: Level of agricultural practices in cooperative irrigation schemes

Agricultural practice (%)	**Irrigation scheme cooperative**				**Total**	**χ^2 value (n=200)**
	UWAWAKUDA	CHAURU	CUMKI	TEGEMEO		
Use of seeds						
Improved seeds	98	98	90	92	94.5	
Local seeds	2	2	10	8	5.5	4.906
Weeding methods						
Manual weeding	48	50	68	96	65.5	
Chemical weeding	2	6	10	0	4.5	
Manual weeding supplemented with chemical weeding	50	44	22	4	30	40.143*
Harvesting methods						
Manual harvesting	2	12	100	18	33	
Mechanized harvesting	98	88	0	82	67	138.308*
Planting methods						
Transplanting	58	92	94	88	83	
Broadcasting and direct seeding	42	8	6	12	17	30.191*

*significant at 1% level

4.3.4 Cooperative members' credit accessibility and level of specialization

Level of specialization was found to influence credit accessibility in cooperative irrigation schemes. Results indicate that, more farmers with high level of specialization accessed credit from different sources than farmers with low level of specialization. Low credit accessibility of less specialized farmers can be due to the reason by Bond *et al.* (2009) who found that, more diversified farmers (less specialized farmers), gets difficulties in obtaining information related to input and output markets and agricultural innovations. It's thus plausible to conclude from this finding (Table 11) that, as farmers become more specialized their ability to access credit increases.

Table 11: Credit accessibility and level of specialization

	Economies of scale (Level of specialization)				
Credit accessibility (%)	<25%	25-50%	>50%	100%	**Total**
Obtained credit	38.5	37.1	40.6	41.3	39.5
Did not obtain credit	61.5	62.9	59.4	58.8	60.5
Statistical test	**χ^2 (3, n=200) =16.281**; p=0.0496**				

**significant at 5% level

4.3.5 Source and type of credit in cooperative irrigation schemes

Farmers obtained credit from bank, SACCOS, VICOBA, microfinance institutions, ROSCAs and moneylenders (Table 12). The types of credit obtained from these sources were cash, credit and a combination of both credit and cash. Source of credit was found to influence the type of credit obtained ($p<0.01$). Microfinance institutions were the only source of credit found to provide both cash and input credit to the cooperative members. VICOBA (24.1%) and SACCOS (21.5%) were the two sources being used by many cooperative members. Moneylenders still exist in the credit market as 15.2% of the members of irrigation scheme cooperative obtained credit from moneylenders. Moneylenders are known for charging high interest rates due to their high cost of acquiring capital, risk of default and administrative costs (Mallick, 2012). It is therefore important to enhance credit sources that have social credit enforcement mechanisms and low interest rates such SACCOS, VICOBA and ROSCAs.

Table 12: Source and type of credit in cooperative irrigation schemes

Source of credit (%)	Type of credit accessed: Cash credit	Input credit	Cash and input credit	Total
Bank	3.4	0.0	0.0	2.5
SACCOS	29.3	0.0	0.0	21.5
VICOBA	32.8	0.0	0.0	24.1
Microfinance institution	12.1	23.5	100	19.0
ROSCAs	76.5	1.7	0.0	17.7
Moneylenders	20.7	0.0	0.0	15.2
Statistical test	**χ^2 (10, n=79) =75.770*; p<0.01**			

*significant at 1% level

4.4 Production Activities and Cost

Activities in irrigated rice production utilizing labour start from field clearing or ploughing to bagging as shown (Figure 3). Costs of different activities were obtained using enterprise budgeting technique (Appendix 2). Activities in which the farmer is incurring high average costs in descending order were weeding, harvesting, planting and bird scaring. The high cost on weeding is due to low level of mechanization of the weeding activity. Smallholder farmers using herbicides for weeding were 34.5% but as a supplement to manual weeding. The use of mechanized labour saving technologies in weeding is low. Similar result was obtained by Mdemu and Francis (2013) in their study in Kapunga irrigation scheme in Mbeya, Tanzania where weeding was the highest labour intensive activity due to low level of mechanization of this activity. Harvesting high average cost is due to 33% of smallholder farmers being using manual harvesting. Smallholder farmers using manual harvesting were 115 458.49TAS/ha higher than those using mechanical harvesting. Planting and bird scaring were 100% not mechanized.

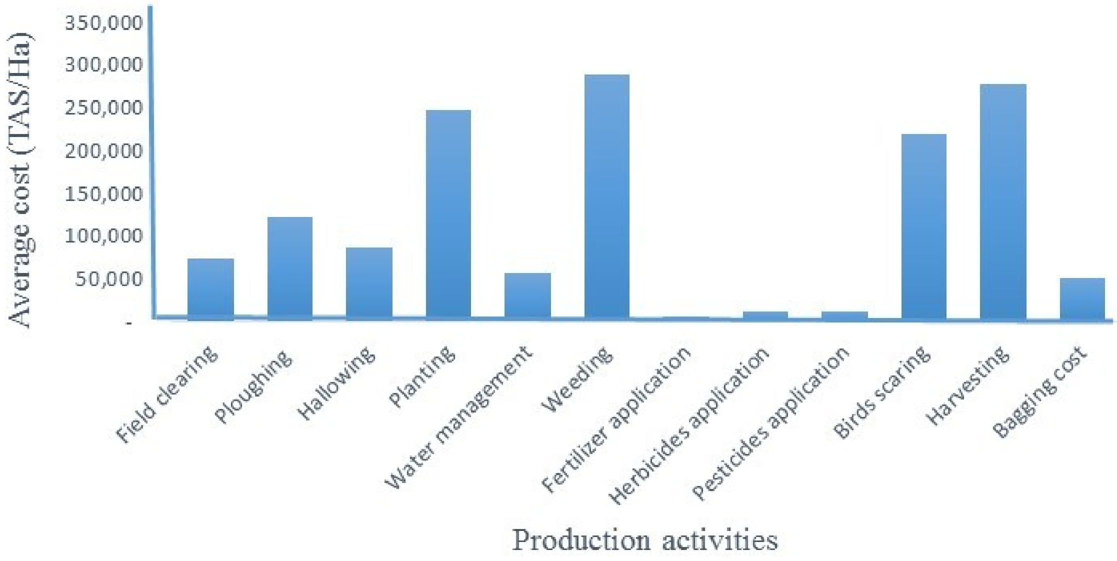

Figure 3: Irrigated rice production activities and their associated average costs

Unit production cost was calculated by dividing the total production cost to the total rice output produced. Unit production cost depends on the level of output being produced, thus the high unit production cost may be a result of rice output or generally high costs on inputs, labour and other production items. The highest average production cost per unit of rice output was found in CHAURU irrigation scheme as shown (Table 11). According to Bank of Tanzania (BOT), the 2013 annual exchange rate was 1599 TAS/USD thus using this rate, the average production cost of 504.43TAS/Kg is equivalent to 315.47 USD/MT. This production cost is even higher than the farm gate prices from some of the countries that exports rice to Tanzania. Asian countries such Bangladesh and India, the farm gate prices are 175 USD/MT and 169 USD/MT respectively (Kilimo Trust, 2014). Therefore, high production cost may be one of the factors contributing to low price competitiveness of rice produced in these irrigation schemes.

Table 13: Comparison on unit production costs across cooperatives

Name of irrigation scheme	Cost in TAS/kg		
	Average	Minimum	Maximum
UWAWAKUDA	495.27	270.98	979.32

CHAURU	580.92	297.35	895.68
CUMKI	504.21	205.32	1478.57
TEGEMEO/BIDP	437.32	230.64	1429.10
Grand mean	**504.43**		

4.5 Differences in Production Costs Across the Cooperatives

Normality test for the production costs was conducted using Shapiro Wilk test on the null hypothesis that the observed distribution fits the normal distribution against the alternative hypothesis that the observed distribution does not fit the normal distribution. The test confirmed the data on production costs to be normally distributed as the null hypothesis was not rejected ($P>0.05$) as shown (Appendix 3).

Furthermore, Levene's test for equality of variance was conducted and found that, variations of production costs were equal in each group and between the two groups; farmers purchasing inputs through the cooperative and farmers who do not purchase inputs through the cooperative. These tests confirmed the suitability of the independent samples T-test for group mean comparison of the production costs.

The results on the T-test revealed that, the costs of production in Tanzanian Shillings per hectare of farmers purchasing inputs through the cooperative are lower than that of farmers who purchased inputs from other input providers. Thus the hypothesis of no statistical difference in costs of production between farmers purchasing inputs through the cooperative and those who do not purchase through the cooperative was rejected (two tailed $p\text{-value}<0.05$) as shown (Table 14).

Table 14: Mean comparison on production cost between farmers purchased input through cooperative and farmers purchased from other input providers

Group	Obs	Mean (TAS/Ha)	Std. Err.	Std. Dev.	95% confidence interval

Purchased from other input providers	92	2256284	29919.68	286979.5	2196852	2315716
Purchased input through cooperative	108	2145531	24394.87	253519	2097171	2193891
Combined	200	2196477	19401.2	274374.5	2158219	2234735
Diff.		110753.4*	38223.38		35376.23	186130.6
t=2.8975, df. 198		**Ho: Diff=0;**	**Ha: Diff≠0**		**Pr.(|T|>|t|)=0.0042**	

*Significant at 1% and 5%.

4.6 Factors Influencing Choice of Production Inputs Provider

Collinearity diagnostics was conducted prior to estimation of the logit model. The results gave the allowable Variance Inflation Factor (VIF) which is tolerable (VIF<5) as shown (Appendix 4), indicating no multicollinearity issues. Furthermore, the square root (SQRT) of variance which tells how much larger the standard error is, compared with what it would be if that variable were uncorrelated with the other predictor variable in the model were also low. The logit model fitted well the data as it was confirmed by Person's goodness of fit test. The null hypothesis of the model being fitting the data was not rejected, P>0.05 as shown (Appendix 5).

The ML estimate of the logit model was obtained with the HCE correcting for any heteroscedasticity. Results revealed that; the choice of production input provider by smallholder irrigated rice farmers in cooperative irrigation schemes is influenced by distance from the cooperative to the nearest town, number of organizations in which a farmer is a member, extension services, input quality satisfaction and payments mode available at the cooperative. These were the variables found significant (P<0.05). Years of experience in the cooperative, credit accessibility and education were not significant as shown (Table 15).

Distance from the cooperative to the nearest town, input quality and payment modes had their expected signs that are positive. It should be noted that, all irrigation scheme cooperatives are closer to the farms hence the increase of the distance from the cooperative to the nearest town increases the likelihood of the farmer to purchase inputs through the cooperative. This implies that if the distance between the cooperative and the nearest town is short and there happen to be issues on inputs quality and price differences, the farmer would prefer to purchase in town where there are many input providers. Input quality being satisfactory and the availability of both credit and cash as payment mode increase the possibility of farmers to purchase inputs through the cooperative.

Number of organizations in which a farmer is a member and extension services had unexpected signs. It was expected that, the increase in number of organizations in which a farmer is a member such as ROSCAs, VICOBA, Agricultural Marketing Cooperatives (AMCOs) and SACCOS would reduce the possibility of purchasing inputs through the cooperative as a result of networking and the fact that, some organizations offer input credit to farmers. The results indicate that, as a farmer becomes a member in many organizations, the likelihood to purchase inputs through the cooperative increases. This is due to the fact that, many organizations provide access to credit which is the component that enhances the purchase of inputs through the cooperative.

It was also expected that, increase in number of times a farmer is visited by extension officer increases the possibility of purchasing inputs through cooperative but results showed the opposite. This is because there are quality issues with the inputs purchased through the cooperative and extension services that created awareness on quality and GAPs hence reducing possibility of farmers to purchase through the cooperative. Information on poor quality of inputs available through irrigation scheme cooperatives were reported by farmers in CHAURU, CUMKI and TEGEMEO/BIDP irrigation schemes.

In terms of the ratio of making choices between two options; purchasing inputs through the cooperative and purchasing from other input providers (odds ratio), a one kilometre increase in distance from the cooperative to the nearest town where farmers could access many input providers and a unit increase in number of organizations in which a farmer is a member, the chance (odds) in favour of purchasing inputs through the cooperative increases by 1.2324 or (1.2324-1)*100% which is 23.24% and 1.8483 or (1.8483-1)*100% which is 84.83% respectively.

This signifies that, networking which creates social capital is essential for the farmers to take part in collective action initiatives. However, a unit increase in number of extension visit to the farmer, the odds in favour of purchasing inputs through the cooperative decreases by 12.95% *ceteris paribus.*

Input quality and payment mode are also essential for the farmers to purchase inputs through the cooperative. Input quality being satisfactory, the farmer is 3.6957 times more likely to purchase inputs through the cooperative than if the input is not satisfactory. Availability of both credit and cash based payment mode at the cooperative are 23.506 times more likely to make a farmer purchase inputs through the cooperative than if only one mode of payment (cash or credit) is available provided that, all other things remains constant.

Similarly, the marginal effect ($\partial y / \partial x$) shows the extent on which the factors change the probability of the farmer to purchase inputs through the cooperative as shown (Table 15). Example the scheme distance factor implies that, a one kilometre increase in distance from the cooperative to the nearest town will produce a 0.0507 increase in the probability of the farmer to purchase inputs through the cooperative. In case of the discrete change in dummy variables, it shows how much more or less likely a situation coded 1 would increase or reduce the probability of the farmer to purchase inputs through the cooperative. It is the means of comparison between two situations of the factor.

The payment mode factor implies that, the predicted probability of a farmer to purchase inputs through the cooperative is 0.5465 greater for both cash and credit payment mode being available than for cash or credit based only, other things remains constant. Fischer and Qaim (2012) using payment timing to measure payment mode had similar observation in the study of marketing of banana in Kenya. Likewise, the predicted probability of a farmer to purchase inputs through the cooperative is 0.3141 greater if the input quality is satisfactory to the farmer than being not satisfactory.

Table 15: Odds ratio and marginal effect of the logit model

Variable	**Odds ratio**	**Robust Std. Err.**	**Z**	**P>|z|**	$\partial y / \partial x$
Constant		0.8234	-2.07	0.038	
Scheme distance	1.2324*	0.0823	2.54	0.011	0.05069*
Coop experience	1.0004	0.2936	0.01	0.988	0.00011
Credit accessibility	1.4088	0.4571	0.75	0.453	0.8242d
Membership	1.8483*	0.2502	2.45	0.014	0.1490*
Extension visit	0.8705**	0.5101	-2.72	0.007	-0.03365**
Input quality	3.6957*	0.6372	2.05	0.040	0.3141*d
Education	0.9066	0.0615	-1.59	0.111	-0.02377
Input payment mode	23.506**	0.6888	4.58	0.000	0.5465** d
Number of observations =200; Wald $chi^2(8)$= 49.69; prob> chi^2 =0.0000; log pseudo likelihood= -94.4496; McFadden's Pseudo R^2=0.3155					

**Significant at 1% probability level; * Significant at 5% probability level; (d) $\partial y / \partial x$ is for discrete change of dummy variable from 0 to 1.

4.7 Production Cost Efficiency

4.7.1 Maximum likelihood estimates of the cost efficiency model

Cost efficiency frontier function was estimated through single step procedure and the results are as shown (Table 16). All linear terms (normalized rice output, normalized fertilizer price, normalized price of labour, and normalized price of water) were significant ($p<0.05$) and positive indicating that increasing these variables in irrigated rice production will increase the total cost of production of the smallholder farmers. This implies that, costs of production in smallholder farming system under cooperative irrigation scheme are more sensitive to changes in input prices $\partial(LnC_i) / \partial(\text{Ln}\, Fertilizer\ \text{Pr}ice)$ for price of fertilizer, $\partial(LnC_i) / \partial(LnWater\ \text{Pr}ice)$ for price of irrigation water, $\partial(LnC_i) / \partial(LnLabour\ \text{Pr}ice)$ for price of labour and rice output $\partial(LnC_i) / \partial(\text{Ln}Rice\ Output)$.

Price of fertilizer was the most sensitive variable influencing the total cost of production followed by price of irrigation water charged by the irrigation scheme cooperative. A 1% increase in prices of fertilizer and irrigation water was found to increase 2.216% and 1.996% of the total production cost respectively. Price of labour was the least variable in terms of sensitivity as a 1% increase in price of labour was found to increase 1.159% of the total production cost. Interestingly, the unit cost of production was found to decrease by increasing rice output. This is because the cost elasticity of rice output evaluated at the mean, was 0.917 implying that, a 1% increase in production in terms of rice output will increase 0.917% of the total production cost that is, increase in production are higher than increase in cost of production.

In quadratic (squared) terms, only normalized rice output was significant and positive, showing evidence of some economies of scale. All interaction terms were not significant but some were positive. Positive interaction coefficients terms show complementarity of the variables. Results reveal that, rice output and labour, rice output and irrigation water and fertilizer and irrigation water are complements in smallholder irrigated rice production system under cooperative irrigation schemes, implying to have zero elasticity of substitution.

The constant term was 8.444, positive and significant ($p<0.05$) implying that the expense on fixed factors of production are incurred regardless of whether the production takes place or not. This includes all production fixed inputs especially farm implements as their costs are spread over a long period of time and contributions to the irrigation scheme cooperative for maintaining the membership status. This is in agreement with Ghosh and Raychaudhuri (2010) and Hidayah *et al.* (2013) in their study of cost efficiency in rice in India and Indonesia respectively.

Results of stochastic cost frontier indicated that, $\gamma=0.8208$ (Table 16) implying that, 82.08% of the variability in the total cost of production that is not accounted by the function is influenced by inefficiency factors in irrigated rice production under cooperative irrigation schemes and only 17.92% being due to random factors that are beyond or outside smallholder farmers' control. Furthermore, the Likelihood Ratio (LR) test for one sided error testing the hypothesis that, smallholder farmers are not 100% efficient was supported (The test statistic LR chi-square [χ^2] was 27.63 which is greater than the critical LR χ^2 of 3.84 read from statistical tables), indicating that smallholder farmers in cooperative irrigation schemes are not cost efficient.

Table 16: Maximum likelihood estimates of the cost efficiency model

Variable	Coefficient	Standard error	t-ratio
Constant	8.4442**	3.18536	2.65094
LnRice Output	0.7811*	0.31268	2.498081
LnFertilizer Price	0.8802*	0.357296	2.463589
LnLabour Price	1.6869*	0.747669	2.25619
LnWater Price	0.49697*	0.25036	1.98505
$(\text{LnRice Output})^2$	0.06563**	0.024787	2.64785
$(\text{LnFertilizer Price})^2$	-0.037516	0.084911	-0.44183
$(\text{LnLabour Price})^2$	0.054087	0.11559	0.467917
$(\text{LnWater Price})^2$	-0.051839	0.059028	-0.878209
LnRice Output* LnFertilizer Price	-0.12789	0.042229	-3.02855
LnRice Output* LnLabour Price	0.080302	0.042555	1.88701
LnRice Output* LnWater Price	0.022939	0.015985	1.43504
LnFertilizer Price* Labour Price	-0.11635	0.097657	-0.11914
LnFertilizer Price* LnWater Price	0.66532	0.046151	1.44162
LnLabour Price * LnWater Price	-0.33225	0.047316	-0.70219
Sigma-squared(σ^2)	0.0053557*	0.0026994	1.98403
Gamma (γ)	0.820768**	0.1173288	6.995452
Number of observations=200; Log likelihood function=363.427; LR test =27.625			

**Significant at 1% and * Significant at 5% probability level; Ln is Natural Logarithm

4.7.2 Production cost efficiency distribution

All farmers had efficiency levels above 1 indicating that, they are operating above the cost frontier and are less efficient. Results indicate that, 64% of all farmers were below the mean cost efficiency level and 36% above the mean (Table 17). The average efficiency level was found to be 1.139 indicating that, 13.9% of costs of production in irrigated rice production can be avoided without affecting the level of rice output. The mean efficiency level of 1.139 can be expressed in percentage through reciprocation giving an equivalent mean efficiency level of 87.80%. This mean efficiency level is high (87.80%) which is in agreement with Hidayah *et al.* (2013) who also obtained a high mean efficiency level (86.6%). The high mean efficiency level is due to high level of specialization allowing farmers to enjoy economies of scale as 56% of smallholder farmers in cooperative irrigation schemes use more than 50% of their land for rice production within which 40% are 100% farming rice only. Morandi *et al.* (2013) had similar reason of existence of economies of scale when found high cost efficiency levels for wheat production in Iran.

In other words, the mean cost efficiency of 1.139 implies farmers to experience a cost saving of 13.9% if they happen to achieve cost efficiency. Likewise, cost saving by attaining the average cost efficiency level is 10.31% that is, $\left[1-\frac{\text{Mean}}{\text{Max}}\right]$*100% and for attaining the minimum efficiency level smallholder farmers will save 12.76% of the production cost that is, $\left[1-\frac{\text{Min}}{\text{Max}}\right]$*100% respectively. It's therefore plausible to improve management of production inputs in irrigated rice production to achieve the minimum cost efficiency.

Table 17: Cost efficiency distribution of smallholder irrigated rice farmers

Efficiency range	Frequency	Percentage	Efficiency level	
<1.139	128	64.0	Mean	1.139
1.139-1.177	55	27.5	Minimum (Min)	1.108
1.178-1.216	10	5.0	Maximum (Max)	1.270
>1.216	7	3.5	Standard deviation	0.030
Total	**200**	**100.0**		

4.8 Inefficiencies in Rice Production under Cooperative Irrigation Schemes

The inefficiency model results indicated that, farming experience, planting methods, frequency of weeding, degree of specialization and source of purchased inputs are significant. This implies that, they have a significant influence on cost efficiency. Type of rice seed variety planted and harvesting methods are not significant as shown (Table 18). All other variables except harvesting method variable had their expected signs. The positive sign indicate that, the variable under consideration increases the cost inefficiency in the production system while the negative sign shows decrease in cost inefficiency (increasing cost efficiency).

Farming experience has a negative influence on farmers' cost inefficiency. It is true that, as smallholder irrigated rice farmers spend more years in rice farming their expertise in combining resources increase thus minimizing the wastage on the use of production inputs which increases production cost efficiency. Maganga *et al.* (2012) in his study of cost efficiency of Irish potato farmers in Malawi found farming experience to be highly influencing the cost efficiency of the farmers. Likewise, Audu *et al.* (2013) obtained the same results in the study of cost efficiency in cassava production in Nigeria.

Planting and weeding are important GAPs in smallholder irrigated rice production under irrigation schemes. Planting methods, transplanting in particular and more frequency of weeding done by farmers, reduces inefficiency since has negative influence on cost inefficiency. The result on frequency of weeding being influencing cost efficiency, contradicts the result by Maganga *et al.* (2012) in his study of cost efficiency in Irish potato production in Malawi who found increase in weeding frequency not significantly influencing cost efficiency. This can be due to the nature of the rice production system being more susceptible to weeds.

Degree of specialization as the measure of economies of scale had a negative influence on cost efficiency. Specialization permit producers to enter into big markets through expansion of the level of output, spreading fixed costs which lead to reduced average cost per unit of output. Therefore, specialization in rice production increases cost efficiency of smallholder irrigated rice farmers. This is in agreement with Maganga *et al.* (2012) and Dzeng and Wu (2013). Maganga *et al.* (2012) found that, more specialized Irish potato farmers were more cost efficiency than their counterparts who were less specialized. Similarly, Dzeng and Wu (2013) in the study of construction industry in Taiwan found cost efficiency to be higher to firms focusing in building construction only than those are involved in civil and building construction.

Table 18: Sources of inefficiencies in production

Variable	Coefficient	Standard error	t-ratio
Constant	0.099955*	0.050915	1.96318
Farming experience	-0.0038275**	0.00090364	4.2357
Harvesting methods	0.024451	0.022724	1.076028
Planting methods	-0.084136*	0.033741	-2.49356
Frequency of weeding	-0.04152*	0.0161656	-2.568433
Seed variety planted	-0.027295	0.033684	0.810324
Degree of specialization	-0.046121*	0.022607	-2.040153
Source of purchased inputs	-0.10134027**	0.032792	-3.090425

**Significant at 1% probability level; * Significant at 5% probability level

Furthermore, source of purchased inputs was found to influence cost inefficiency negatively. The situation of a cooperative member to purchase inputs through the irrigation scheme cooperative contributes to increasing efficiency in production that spurs cost efficiency due to reduced unit cost of input and accessibility of after purchase services offered through the irrigation scheme cooperative.

4.9 Summary of Results on Hypotheses

This study was guided by four hypotheses as per specific objectives. The first hypothesis of no statistical difference in costs of production between farmers purchasing inputs through the cooperative and those who do not purchase through the cooperative was rejected. It was found that, farmers purchasing inputs through the irrigation scheme cooperative had lower production costs than farmers purchasing from other input providers. The second hypothesis revealed that, not all hypothesized variables had influence on the likelihood of smallholder irrigated rice farmers to purchase production inputs through the cooperative. Factors influenced choice of production inputs provider were distance from the cooperative to nearest town, membership in other organizations, extension services, input quality satisfaction and availability of cash and credit payment mode. The hypothesis on smallholder irrigated rice farmers under cooperative irrigation schemes being not cost efficient was not rejected. The LR test indicated smallholder rice farmers to be not 100% cost efficient. Lastly, it was shown that inefficiency in production was significantly influenced by farming experience, planting methods, frequency of weeding, degree of specialization and source of purchased inputs.

CHAPTER FIVE

5.0 CONCLUSIONS, RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH

5.1 Conclusions

This study aimed at analysing production costs and factors influencing choice of inputs provider in smallholder irrigated rice production under cooperative irrigation schemes in Pwani and Morogoro regions. Specifically, it focused on comparing costs of production for smallholder irrigated rice farmers purchasing inputs through the irrigation scheme cooperative and those who do not, determining factors influencing smallholder irrigated rice farmers' choice of inputs provider, analysing production cost efficiency and identifying sources of production cost inefficiency by smallholder irrigated rice farmers under cooperative irrigation schemes.

Study hypotheses were tested based on the analytical method used. The hypothesis of no statistical difference in costs of production between farmers purchasing inputs through irrigation scheme cooperative and those who do not purchase through the irrigation scheme cooperative was tested using independent sample T-test while the hypothesis on smallholder irrigated rice farmers under cooperative irrigation schemes being cost inefficient was conducted using stochastic trans log cost frontier. Furthermore, hypothesized factors influencing smallholder irrigated rice farmers' choice of inputs provider and those influencing production cost inefficiency were tested using logit model and inefficiency model respectively.

Study findings on socio-economic characteristics of the cooperatives surveyed indicated no significant variation on gender across the cooperatives. Level of experience in cooperatives and education varied across the cooperatives with no farmers never attended formal training in UWAWAKUDA and TEGEMEO/BIDP irrigation schemes.

Primary occupation also varied across the cooperatives in which UWAWAKUDA had the lowest percentage (48%) of farmers primarily involved in crop production. Furthermore, experience and primary occupation influenced the level of participation in input purchases. Experience increased participation in input purchases. Primary occupation results showed that, farmers primarily involved in crop production less participated than wage employed, business or self-employed farmers.

Production system of smallholder farmers indicated high level of specialization whereby 40% of farmers use 100% of their land for rice production only with weeding being the highest costing activity in irrigated rice production due to low level of mechanization of this activity. The level of specialization also influenced the purchase of inputs and credit accessibility. Additionally, source of credit was found to influence the type of credit obtained by smallholder farmers in cooperative irrigation schemes.

Quantification of costs of production indicated that, smallholder farmers' costs of production stands at 315.47USD/MT which is higher than the farm gate prices of rice in other countries especially Asian countries. Comparison between farmers purchasing inputs through irrigation scheme cooperative and those who do not purchase through the irrigation scheme cooperative showed that, farmers purchasing inputs through the irrigation scheme cooperative has lower production costs than farmers who do not purchase inputs through the irrigation scheme cooperative.

The study found that, factors influencing smallholder irrigated rice farmers' choice of production inputs provider in cooperative irrigation schemes are distance from the cooperative to the nearest town, number of organizations in which a farmer is a member, extension services, input quality satisfaction and availability of cash and credit as payment mode at the irrigation scheme cooperative. The study found further that, under *ceteris paribus* entering in only one other organization increases the likelihood of purchasing inputs through the irrigation scheme cooperative by about 85% and input quality increase the likelihood of farmers to purchase inputs through the irrigation scheme cooperative to about 4 times if there is input quality satisfaction.

With regard to analysis of production cost efficiency, the study findings indicate costs of production being more sensitive to changes in prices of inputs and outputs but with unit cost of production being decreasing by increasing rice output. All farmers have efficiency levels above 1 indicating that are operating above the cost frontier. The LR test rejected the hypothesis of smallholder farmers being 100% cost efficient. It was further found that, the mean efficiency level was high due to high level of specialization enabling farmers to enjoy economies of scale.

Five factors influencing efficiency in smallholder irrigated rice production under cooperative irrigation schemes were identified. Farming experience, the use of transplanting method in planting, increased frequency of weeding, degree of specialization and purchasing inputs through the irrigation scheme cooperative. Evidence indicates also that, these factors accounts 82.08% of the variability in the costs of production.

5.2 Recommendations

The study recommends improving efficiency in irrigated rice production under cooperative irrigation schemes to foster rice price competitiveness. The cooperative management and other stakeholders need to encourage farmers with low experience in cooperative and in rice farming to learn through experienced farmers. This will improve participation in cooperative initiatives and gaining more skills of the rice production system hence increasing efficiency in their production.

Encouraging farmers to specialize in rice production will facilitate in making farmers enjoy economies of scale through lowering input price per unit, spread fixed costs over a large output and easing the access of agricultural information such as market information. Specialization will also enhance credit access and production input purchases.

Weeding, harvesting, transplanting and birds scaring are activities highly costing the farmers. Thus, it is important to use labour saving technologies in weeding, harvesting, transplanting and bird scaring to lower the costs of these activities and make them efficient. This can be done through the use of herbicides in weeding (chemical weeding); use of motorized rice thresher or combine harvester in harvesting; use of transplanter in rice transplanting and helicopter spraying to curb for individual farmers' bird scaring costs.

Comparison between farmers purchasing inputs through irrigation scheme cooperative and those who do not showed that, farmers purchasing inputs through the irrigation scheme cooperative have lower production costs than farmers purchasing from other input providers. It is therefore plausible to encourage farmers to purchase inputs through the irrigation scheme cooperative of which will contribute to reduction of their production costs. This can be enhanced through ensuring that, inputs provided are of satisfactory quality and both cash and credit payment methods are used.

In encouraging farmers to purchase inputs through the irrigation scheme cooperative, it is important to provide price incentive in the purchase of inputs by ensuring that there is significant price difference between the inputs purchased through irrigation scheme cooperative and from other input providers in nearby towns. Farmers need also to be encouraged to form or enter into other organisations such as AMCOS, SACCOS and ROSCAs to improve networking, credit access and create social capital that can make them benefit from sharing agricultural information.

Lastly, there is a need to increase rice output to reduce the unit production cost by improving management through good agricultural practices especially the use of transplanting, proper weeding, fertilizer and reliable rice seeds.

5.3 Areas for Further Research

The present study investigated smallholder farmers' decision making level in cooperative irrigation schemes on purchase and use of production inputs. It is thus plausible to conduct further study especially on the cooperatives' management decision making level so as to ascertain whether the inefficiencies especially on collective marketing of both inputs and outputs is coming from the farmers or the management of the irrigation scheme cooperative. Furthermore, there is a need to compare the two management options of irrigation schemes in Tanzania that is irrigators' association management and cooperative management option. This will enable policy makers to foster in supporting one of the management options of the irrigation schemes.

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APPENDICES

Appendix 1: Probabilities from implementation of the PPS

Irrigation scheme cooperative (Cluster)	Population size	Cumulative sum	Prob.1	Farmers per cluster	Prob. 2	Weight
MKINDO/ MGONGOLA	180	180	0.08	50	0.28	46.22
CUMKI	253	433	0.11	50	0.20	46.22
UWAWAKUDA	842	1275	0.36	50	0.06	46.22
SEGENI	56	1331	0.02	50	0.89	46.22
TEGEMEO/BIDP	120	1451	0.05	50	0.42	46.22
CHAURU	860	2311	0.37	50	0.06	46.22

Appendix 2: An enterprise budgeting template for an acre of rice

Item	Value
1. GROSS RETURNS	
Yield(MT/acre)	
Price (TAS/MT)	
Total Gross Revenue	
2. VARIABLE COSTS OF PRODUCTION	
Cost of production inputs	
Irrigation water charge (TAS/acre)	
Amount of seeds used (Kgs/acre)	
Average price of seeds (TAS/Kg)	
Cost of Seeds used (TAS/ha)	
Amount of fertilizer used (Kgs/acre)	
Average price of fertilizer (TAS/Kg)	
Cost of fertilizer used (TAS/ha)	
Cost of chemicals (herbicides and pesticides)	
Cost on labour activities	
Field clearing	
Ploughing	
Hallowing	
Planting	
Field water management	
Weeding	
Fertilizer application	
Chemical application (herbicides and pesticides)	
Birds scaring	
Harvesting	
Bagging	
Total cost of labour	
Other cost items	
Bagging material cost	
Transport cost	
Total production cost	
NET RETURNS	

Appendix 3: Shapiro-Wilk W test for normal data on costs of production

Variable	Observations	W	V	Z	Prob>z
Production cost per hectare	200	0.99510	0.732	-0.719	0.76392

Appendix 4: Collinearity of factors influencing choice of input provider

Variable	VIF	SQRT VIF	Tolerance	R-Squared	Eigen values	Condition Index
Scheme distance	1.59	1.26	0.6293	0.3707	2.3068	1.0000
Coop experience	1.04	1.02	0.9642	0.0358	1.2260	1.3717
Credit accessibility	1.40	1.19	0.7118	0.2882	1.0781	1.4628
Membership	1.35	1.16	0.7392	0.2608	1.0236	1.5012
Extension visit	1.56	1.25	0.6398	0.3602	0.9227	1.5811
Input quality	1.13	1.06	0.8846	0.1154	0.5635	2.0233
Education	1.11	1.05	0.9024	0.0976	0.4897	2.1703
Input payment mode	1.44	1.20	0.6964	0.3036	0.3894	2.4339
Mean VIF	**1.33**				**Condition number**	**2.4339**

Appendix 5: Goodness of fit test of logistic model for choice of input provider

Logistic model for choice of input provider; goodness of fit test	
Number of observations	200
Number of covariate patterns	181
Pearson $Chi^2(172)$	171.98
Prob> Chi^2	0.4860
Ho: The model fits the data well; Ha: The model does not fit the data well	

Appendix 6: Questionnaire for smallholder irrigated rice farmers in cooperative irrigation schemes

QUESTIONNAIRE ADMINISTERED TO SMALLHOLDER IRRIGATED RICE FARMERS IN COOPERATIVES

Efficiency in Production by Smallholder Rice Farmers under Cooperative Irrigation Schemes in Pwani and Morogoro Regions

Name of enumerator………………………….Date of interview………………..…

Name of the Respondent……………………………………………………………

SECTION A: General information

Name of irrigation scheme cooperative……………..……Village………..…………

Ward……………………………….…District…………………..…...Region…………

1. Gender of the respondent[Circle]… 1=Male 2=Female
2. Experience in the irrigation scheme cooperative (enter years of experience)…………..
3. Level of education attained by the irrigation scheme cooperative member (enter years of schooling) ………………………….

   0= none 1= standard one… 7= standard seven 8= training after primary 9=form one… 12=form four 13= form five 14=form six 15=training after secondary education 16= university & tertiary education [Otherwise specify where appropriate]……
4. Primary occupation [circle]….1=Crop production 2=Livestock production 3=Wage employment 4=Business 5=other, specify……………………………..

SECTION B: Farm characteristics and Management

1. Experience in irrigated rice farming (state the actual years)…………………………..

2. What was the total land area under crop production last season (2013/2014), in acres…………...
3. Of the total land area under crop production, how much was under rice production, in acres..
4. What was the rice seed variety that you planted last agricultural season, 2013/2014? [Circle one] 1=Improved variety, mention the name of the variety(s)………………
   2= Local variety, mention the name of the variety(s)………………….
5. Which method of weeding did you use in your farm?[circle]
   1=Manual weeding 2=Chemical weeding 3=Manual weeding supplemented with chemical weeding 4=other, specify………………………………
6. How many times did you weed from planting to harvesting in a season? ………
7. Which method of rice harvesting did you use in your farm? [circle]
   1=Manual/hand harvesting 2=Combine harvester
   3=Motorized rice thresher 4=other, specify………………………………
8. Did you get a visit by the extension officer to your field during the 2013/2014 agricultural season? [circle] 1=Yes 2=No
9. If the answer in question **8** is YES, how many times? ....

SECTION C: Irrigation scheme cooperative and production inputs

1. When did you join the irrigation scheme cooperative? [Enter year or years example, 2005 or 10 years ago]…………………………………………………
2. Mention the criteria that were used for you to join the irrigation scheme cooperative (circle all that applies)
   1=Entrance fees 2=Annual payments 3=Proximity (Living around the irrigation scheme area) or within the community 4=others (mention)

…………………………………………………………………………………………

………………………………………………………………………………

3. Do you have membership in other organisations such as SACCOS, ROSCAs etc.?[circle] 1=YES 2=NO

4. If the answer in question **3** is YES, how many? ....

Mention them,

…………………………………………………………………………………………

………………………………………………………………………………

5. What are other direct costs paid/contributed to the irrigation scheme cooperative apart from irrigation water cost?

S/N	Item	During joining-Tsh	After joining-Tsh
1	Entrance in the cooperative		
2	Annual contribution (membership fee)		
3	Other (specify)………………..		
4	Other (specify)………………..		

6. Did you get credit during the 2013/2014 agricultural season? [circle] 1=YES 2=NO

7. How many times did you get credit last season, 2013/2014? ....

8. Mention the type and source of credit.

S/N	Type of credit [Cash credit or Input credit]	Source [Bank, SACCOS etc.]
1		
2		
3		
4		

9. What are the purchased inputs that you used in irrigated rice production? [Circle all that applies] 1=Fertilizer 2=Seeds 3=Herbicides 4=Pesticides 5=Farm implements (mention)……………………………………………

10. Mention the source and mode of payments of the inputs that you used in irrigated rice production[Fill the table below]

S/N	**Purchased inputs**	**Source**	**Mode of payment** 1=Purchase/cash, 2=Credit, 3=Gift, 4=Exchange, 5=Other(Please specify)
1	Fertilizer		
2	Seeds		
3	Herbicides		
4	Pesticides		
5	Farm implements		

11. Why did you prefer the chosen sources to get the needed inputs?

S/N	**Purchased inputs**	**Source**	**Reason(s)**
1	Fertilizer		
2	Seeds		
3	Herbicides		
4	Pesticides		
5	Farm implements		

12. What are the purchased inputs available at/through the irrigation scheme cooperative? [Circle all that applies] …. 1=Fertilizer 2=Seeds 3=Herbicides 4=Pesticides 5. Farm implements 6. Others, mention……………………………………………………

13. Did you purchase the inputs through the irrigation scheme cooperative? [circle]

1= Yes 2= No

14. If the answer in question **12** is YES, mention the inputs that you purchased through the cooperative……………………………………………………

15. If the answer in question **12** is No where did you purchase the inputs? ....

16. What is your view in terms of quality of the inputs provided by the cooperative? [circle]

1= satisfactory quality   2= Quality is not satisfactory

17. What are the methods of payment options available at the cooperative? [circle]

1 =Cash only 2= Credit only 3=both cash and credit 3=other, specify……………………

18. Approximate distances[enter the distances in Kilometres and walking hours]

a. From the irrigation scheme cooperative to the nearest town….…km……….hrs
b. From the home village to the nearest town………………km………………hrs
c. From the main water supply/pump station to your field…………km………hrs

SECTION D: Irrigated rice production

1. What quantity of paddy did you harvest last agricultural season (2013/2014)?

Item	**Unit of measurement**	**Amount**
Total acreage	Acre or Hectare? ……………	
Total quantity harvested	Kg or bags?	
Selling price	Tsh/bag or Tsh/kg……………	

***Note**: If unit of measurement is in bags, state the approximate kg per bag*

2. What was the cost of irrigation water during the last agricultural season?

Unit of measurement[lump sum or Tsh/acre]	Amount

3. What is the maximum and minimum wage for farm hired worker in your place?

Unit of measurement[1=Tsh per day, 2=Tsh per month]	Minimum	Maximum

4. What was the average rental cost of an irrigated land during the last agricultural season(2013/2014)?...Tsh/acre

5. Provide information on labour used in different rice production operations in 2013/2014 agricultural season in terms of man-days [acre labour equivalent**.**

Labour item		Number of people	Days worked		Total labour days	Daily wage rate per person	Total cost
			Family	Hired			
Field clearing							
Ploughing							
Hallowing							
Planting							
Field water management							
1st Weeding							
2nd Weeding							
3rd Weeding							
Fertilizer application							
Herbicides application							
Pesticides application							
Birds scaring							
Mechanical harvesting							
Manual harvesting	Cutting						
	Pilling						
	Threshing						
	Winnowing						
Bagging							
Transporting from field to home							

6. Please provide information on the use of fertilizer in 2013/2014 agricultural season

Type of fertilizer	**Amount of fertilizer used per acre**	**Price[Tsh/50kg bag]**
Basal application fertilizer		
Top dressing fertilizer		

7. Please provide information on the use of seeds in the previous agricultural season (2013/2014)

Method of planting	**Amount of seeds used per acre**	**Price[Tsh/kg]**
Transplanting		
Broadcasting		
Dibbling		
Other [specify]………………..		

8. What were the types of labour used and the costs of activities in rice production?

Activity item		Type of labour [1=Hired labour, 2=Family labour, 3=Hired tractor/power tiller/combine harvester/motorized rice thresher, truck 4=Community help]	Cost per acre
Field clearing			
Ploughing			
Hallowing			
Planting			
Field water management			
Weeding	1st		
	`2nd		
	3rd		
Fertilizer application			
Herbicides application cost and purchase			
Pesticides application cost and purchase			
Birds scaring			
Mechanical harvesting			
Manual harvesting	Cutting		
	Pilling		
	Threshing		
	Winnowing		
Bagging and cost of bagging materials			
Transporting from field to home			

9. Give the challenges facing your rice irrigation scheme cooperative. ………………………………………………………………………………………………

10. What are your general comment(s) regarding your irrigation scheme cooperative?

....

“THANK YOU FOR YOUR COOPERATION”

Appendix 7: Checklist for key informants

For Rice irrigation scheme cooperative stakeholders/Cooperative board members/government officials

SECTION A: General Information

1. Name of the respondent
2. Organization(where working)
3. Job title
4. Region

SECTION B: Issues on rice irrigation scheme cooperatives

5. What is the total number of beneficiaries of the irrigation scheme cooperative?
6. What are the criteria used to register members in the irrigation scheme cooperative?
7. What are the costs associated with joining in the irrigation scheme cooperative?
8. What are the key issues considered during the preparation of the irrigation scheme cooperative budget?
9. How does the irrigation scheme cooperative facilitate the availability of production inputs?
10. What are the benefits of the irrigation scheme cooperative to its members?
11. What are the factors considered in deciding on the cost of irrigation water per year?
12. Some members of irrigation scheme cooperative are reported to lend the fields to non-members, what are the reasons for this situation?

"THANK YOU FOR YOUR COOPERATION"