IMPORTANCE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN RICE PRODUCTION AMONG SMALL SCALE FARMERS IN MOROGORO REGION, TANZANIA

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ABSTRACT

In many sub-Saharan African countries including Tanzania, farmers face hardship to access better agricultural information. Consequently farmers lack adequate knowledge on farm management skills like correct land preparation, timely planting, pest and diseases and their control, timely weed control to bypass the critical period of weed competition, and low price of their product since they depend mostly to get information from extension officers and middlemen. But number of extension officers does not match with number of farmers who are in need of agricultural services and middlemen tend to give farmers low price and sell at high price to the trader for their own advantage hence farmers incur loss. Though the rapid development in ICTs have a huge potential to address challenges facing small scale farmers in accessing agricultural information and hence farm profitability, empirical evidence to that effect is lacking in Morogoro Region . Therefore the present study aims at bridging that knowledge gap. The present study used descriptive statistics, Probit model and Gross margin analysis to analyze the data from a randomly selected sample of 399 rice farmers from four districts of Morogoro region. The descriptive results show that 57.3% of these farmers were adopters of ICT's while 42.7% being non-adopters, whereby among the adopters most farmers used mobile phones and radios to access information on agronomy advice and weather forecast compared to market information. Television was used by few farmers to access weather forecast information.Probit analysis shows that the use of ICT's in communicating agriculture information is influenced by age, gender, education level, total farm size, awareness of ICT's and use of advanced technology during production were. Gross margin analysis results shows that the adopters of ICT's had a high gross margin compared to non- adopters at 0.05 level of significant. Through these results it is seen that still many of the rice farmers in Morogoro have not

adopted the use of these ICT tools in assessing the agricultural information hence most of these farmers end up obtaining low yields and among the users of ICT many of them access very limited information with limited ICT tools. Therefore the Government should encourage policies that will emphasize farmers using the ICT tools by ensuring maximum support from other stakeholders' example from mobile service provider companies, ensuring affordable prices of these ICT tools and prices of acquiring information so as to support rice farmers in ensuring that they obtain higher yields that will boost the sector in the country.

DECLARATION

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

_____ _____

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(MSc. Candidate)

The declaration above is confirmed by;

_____ _____

Dr. Damas Philip Date

(Supervisor)

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DEDICATION

With special feeling of gratitude, I dedicate my dissertation work to my loving parents Phineas and Leticia Kalema for being there for me, with their words of encouragement and support throughout the entire master's program, and Dr.GaudioseMujawamariya for her kindness, devotion and her endless support throughout the process.

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LIST OF ABBREVIATIONS AND ACRONYMS

CDs	Compact Disc
ε	Error term
Fig.	Figure
ICT's	Information and Communication Technologies
IDT	Innovation Diffusion Theory
KACE	Kenya Agricultural Commodity Exchange
OECD	Organization for Economic Cooperation and Development
RLDC	Regional Leadership Development Conference
β	Beta
δ	Delta

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Information is among the key drivers for agriculture development if it's relevant, right and timely delivered. Agricultural information plays a vital role in empowering farmers toimprove their livelihoods by providing important agricultural information such as sowing, improving soils, seeking the best price for theirproduce and ways to combat pests and diseases (Armstrong and Gandhi, 2012).

According to RLDC (2009), most of rice farmers lack agricultural information in mostly in farming practices and market price; hence farmers end up using their experience and traditional ways of farming practices. That results to low yields since they are hardly change ways of farming and incur low prices because of less information about market price. In African counties most farmers lack access to day to day agricultural information, which is needed to assist farmers in making decisions regards farming practices and market price (Matovelo, 2008).

Each stage of agricultural production requires specific decision from farmers. Farmer's need latest information on seeds, pest and diseases, weed management, agronomy practice and market price, quantity and quality needed to the market, agricultural credit/loan and storage method to help them in decision making (Mittal *et al.*, 2010).

Generation and application of agricultural knowledge is increasing, especially for small and marginal farmers, who need relevant information in order to improve, sustain and

diversify their farm enterprises. Agriculture require substantial knowledge transfer to farmers, among farmers and other agricultural actors about better farming practice, new technology in controlling pest and diseases outbreak and new market (OECD,2001).

Early at 19th century, farmers used to obtain their information from middlemen, extension officers, market boards, farmers groups and family/relatives (Klueskens, 2013). At the end of 19th century television and radio and mobile phone emerged, radio and television were the main electronic broadcast technologies, that provides information to the farmers and most of its communication is one way communication manner, and mobile phone provides information in two ways communication manners (Westland, 2016).

The use of mobile phone, radio and television, increase communication among farmers, market and traders without involving middlemen and extension officers because, through information communication technologies, information can be easily accessed and provide day to day information through message, calls and broadcasting (Mtega andMsungu,2013).

In Tanzania, almost all radio and television stations provide agricultural information like TBC and star TV. Mobile phone technology provide information through mobile phone operators, that support the flow of agricultural information are TIGO through TIGO KILIMO and VODACOM through KILIMO CLUB and enable farmers to communicate among themselves in agricultural matters.

1.2 Statement of the Problem

African agriculture is largely traditional and practiced by small scale farmers and pastoralists. Such agriculture is predominantly rain-fed, lack access to information on farm

management skills, marketing, and financial intermediation services (ICT in AgricultureTransformation, Africa 2012).

In many sub-Saharan African countries including Tanzania, farmers face hardship to access better agricultural information. Consequently farmers lack adequate knowledge on farm management skills like correct land preparation, timely planting, pest and diseases and their control, timely weed control to bypass the critical period of weed competition, knowledge on nutrient deficiency symptoms and how to correct them and keeping farm records (Thomas,2013).

Also in marketing, farmers do not have much of a choice in selling their product; they can only sell their product through traders who travel between villages and markets or transporting their products to the nearest markets by themselves. This is because of communities' remoteness and poor communication with market place (Subervie and Courtois, 2013).

Recently communication between farmers/ agricultural stakeholders in Tanzania is top down Information is passed through extension officers, but it's clear that the ratio of extension officers doesn't match with the ratio of farmers who are in need of agricultural services (Nyamba, 2012). In addition toinsufficient number of extension officer, extension officers lack strong supervision in guiding farmers based on their agricultural needs and low involvement of the private sector on delivery of extension services because of small number of extension officers (Thomas, 2013). For the available extension officers, farmers still struggle to get assistance from them because it becomescostful since farmers have to pay transportation fee for extension officer because of remoteness of the areas where these farmers live.

Farmers rely on word of mouth, family/relatives and farmers group as local information system, but most of their information is based on their experience. For example on weather forecast information, they use annual experience and farming practices which are unreliable.

Traders may take advantage of farmer's ignorance of market price and cutting a rental from them by offering very low price for their product. Rice farmers negotiate on price of their product based on information provided by traders, which limits their bargaining power, and since farmers depends on middlemen to deliver market price which favors middlemen and others participants but not farmers. Well informed farmers manage to bargain higher farm-gate prices on their production compared to non- informed farmers (Svesson and Yanagizawa, 2008).

Most Farmers believed that technologies bring about social economic development to farmers (Svensson and Yanagaziwa, 2008). Farmers believe on technologies because they increase efficiency in terms of high yield, less pest, though agronomy advice, weather forecast, community, increase sales with better price so as to make more profit and increase their income through market information and solve multiple agricultural problems (Chi and Yamada, 2002). But other rice farmers doesn't adopt the use of ICT's since they do not believe that the use of ICT's will increase their profit and high income, so they choose not to adopt the use of ICT's, even if they have access to it.

Since farmers believe that the use of ICT's to access agricultural information can bring high income to the farmers through information provided by ICT's on market price and better farming practice that will bring high and better quality, yield, hence social economic

development among small scale rice farmers. But the use of ICT's to rice farmers is subjected to different factors , that will cause farmer to engage themselves on the use of ICT's based on the information needed by farmers in a given agricultural problem.

Though the rapid development in ICTs having a huge potential of improving farmers' information access and hence yields and profitability through the adoption of productivity enhancing technologies and improved access to market information, yet empirical evidence on their adoption rate, effectiveness, challenges addressed facing small scale farmers in accessing agricultural information and their profitability is lacking in Morogoro region. Therefore the present study aims at bridging that knowledge gap.

Holding other factors constant, this study aims to show how ICT's can shift farmers in Morogoro region from subsistence farming to more commercial farming subject to different factors that lead to use of ICT's in accessing agricultural information needed by rice farmers from early stage of production up to marketing .

1.3 Objectives of the Study

1.3.1 Overall objective

The overall objective is to analyze the contribution of ICTs to the improvement of agricultural information access among small rice farmersand its influence on profitability in Morogoro region, Tanzania.

1.3.2 Specific objectives

i. To analyze contribution of ICT's to small scale rice farmers in accessing agriculture information.

ii. To determine the rate of adoption of ICT's among rice farmers.

iii. To identify factors influencing the use of ICT's in communicating Agriculture information.

iv. To compare the profit margin for adopters and non-adopters of ICT's.

1.4 Hypotheses

i. HO: Factors such as age, gender, education level, farm size, household size, and experience, aim of engaging in rice production, use of modern equipment during production, awareness and income have no significant influence on the use of ICT's.

ii. HO: There is no significant difference in farmer's profit margin between adopters and non-adopters of small scale rice farmers.

1.5 Research Question(s)

i. How do ICT's contribute in accessing agricultural information to small scale rice farmers in Morogoro region?

ii. What proportion of farmers has adopted ICT's in accessing agriculture information?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definitions of the Key Terms

Information is described as data that have been put into a meaningful and useful context which is communicated to recipient who uses it to make decisions (Asogwa*et al.*, 2012).According toKantumaya (1992) Information is described as the power which anyone can have access to where by Buccola (1984) explained that information has an economic value if it helps estimate the value of something.

Information technology can be defined as the diverse set of technological tools and resources used to communicate, disseminate, store, and manage information. These technologies include computers, internet, and network hardware and software, satellite systems, broadcasting technologies (radio and television), and telephony (land lines and cellular). As well as the various services and applications associated with them, such as web portals, email, SMS, video-conferencing (Sharma, 2001). According toInformation technology is

Samuel (2001) defined agricultural information as the data for decision-making and a resource that must be attained and used in order to make an informed decision.

ICTs refer to an intensifying assembly of technologies that are used to handle information and aid information it includes hardware, software, media for collection, storage, processing, transmission and presentation of information. (Mekonnen and Asenso-Okyere, 2012). ICT comprises of radio, mobile phone, television, emails, E-book reader and instant message (Bangkok, 2012).

According to Kundishora (nd) ICTs is the collection of media technologies that are used for collecting, storing, editing and passing on (communicating) information in various forms to the once who access it.

According to Knight (1921) uncertainty is when the probability of occurrence is unknown and cannot be quantified. Uncertainty is when the likelihood of future events is indefinite or incalculable (Knight, 2001).

2.2 Defining Adoption

According to Hall and Khan (2002), adoption of technology as the choice to acquire and use a new invention or innovation. The definitions of an adoption vary widely across studies; each study has its own meaning of adoption depends on type of technology that study is emphasizing to adopt. When defining "adoption," it can either be a discrete state with binary variables (a farmer either is using the technology, or is not using the technology, an "adopter") or whether adoption is a continuous measure (Doss, 2003). OgunyemiandOjo, 2014, argued that when at least one of the advanced technologies is used for at least one season, then can be defined as an adoption.

If either farmer's is using the technology or not using the technology, is seen in different ways, according to Doss, 2003, as longer as farmers is involved with one of the any advanced technology, let say mobile phone to access agricultural technology, that's is adoption. When a farmer use both local and advanced technology let say word of mouth and mobile phone to access agricultural technology, that's is adoption And when farmer use completely advanced technology in accessing information that's is an adoption too. In this study, adoption of ICT's cooperates with(Doss, 2003) (OgunyemiandOjo,2014) and

(Das, 2014), that's if farmer use at least one of advanced information technology, for at least one rice season along with local information technology and completely advanced information technology to access agricultural information that termed as an adoption.

2.3 Importance of Information and Communication Technology in Accessing Agriculture Information

Mekonnen and Asenso-Okyere (2012) did the study on the importance of ICT's in the provision of Information for Improving Agricultural Productivity and Rural Incomes in Africa. They argued that with almost one billion small-scale farmers worldwide, extension is urgently seeking for the best ways to support these farmers in terms of information, technology, advice, and empowerment among the best ways to do agricultural extension to reach large number of farmers is using information communication technologies (ICTs) through mobile telephony, innovative community radio and television programs, mobile phones in combination with radio, video shows, information kiosks, web portals, rural tele-centers, farmer call centers, video-conference, offline multimedia CDs, open distance learning.

Radio television, mobile phones helps farmers to understand what to produce, how to produce, where to sell, how much to sell with increase production, access to input, sell at reasonable price and increase income (Sanga*etal*.,2015).

ICT's help to meet farmers needs information that will help them to obtain high yield, better market price , communication among farmers and other agricultural actors(Iortima, 2012).

ICT-based agricultural extension brings incredible opportunities and has the potential of enabling the empowerment of farming communities. With the availability of ICTs the problem of few extension officers proposition for an increasing number of extension staff may no longer be wholly valid. Moreover, the use of ICTs to improve information flow and to connect people within the rural areas has proved that illiteracy of farming communities may no longer be an excuse to deny some form of extension system (Saravanana, 2010).

With ICT's based extension services, farmers are able to obtain knowledge and obtain social and economic development (Sanga*et al.*, 2007). Availability of markets and market information gives farmers the potential to bargain and improve their incomes (Okyereand Makonnen, 2012).

2.4 Contribution of ICT's to Farmers in Accessing Agriculture Information

According to Mittal and Mehar (2012), did a study on role of mobile phone enabled climate information services in gender-inclusive agriculture. They argued that ICT's bring positive contribution to rice farmers on sustainable development and poverty reduction. 77% of farmers argued that ICT's contributed in increase of accurate price information (Rashid and Elder, 2009). According to Muto (2008) contribution of ICT's to rice farmers reduce agricultural transaction costs, making agricultural extension activities more effective that increase market efficient that would benefit both producer and consumer. ICT's connects farmers and agricultural actors like traders and agronomist. It gives direction during production on the use of better seeds, fertilizer, use of mechanization and searching for market that will gives high price.

Svensson and Yanagaziwa (2008), argued that ICT's contribute to social economic development. In particular it suggests that information dissemination through FM radio may be powerful tool to increase both efficiency and relative income of small scale farmers.

2.5 Theoretical Framework

2.5.1 Innovation diffusion theory

Innovation diffusion model explains the adoption of technology is through initiation and implementation stage. It's capable to explain the adoption of information technology in organization and to individual as well (Jeyaraj, Rottman and Lacity, 2006). The actual decision to adopt ICT's in organization/firm occurs between initiation and implementation phases (Paul*et al.*, 2008). IDT has a relative advantage to the farmers for instance innovation economic Profitability, Low initial Cost, reduced discomfort, time saving, fast return and reduce effort input (Fotoh,2006).

2.5.2 Innovation decision process theory

According to Roger (1995), on micro level of innovation, innovation decision process model can be best explained through five stages in the diffusion process of technological adoption, which are knowledge, persuasion, decision, implementation and confirmation. From the first stage of knowledge adopters during adoption must learn and understand about innovation, on persuasion adopter must know the value innovation on decision, adopter must decide to adopt it, as for implementation, after adoption, individual must implement and put innovation into use, even though decision of adoption had been made already but individual will have certain degree of uncertainty about the expected consequences of the innovation and finally the decision must be confirmed on

weatherindividual can adopt or reject the innovation, if individual reject to adopt the use of innovation, decision can be reversed (Roger,1982).

According to Roger (1982) there are factors that affect the decision to adopt any technology that include different external and internal characteristics. These factors are grouped into socio-economic, institutional and technology characteristics. Some of these they include age, gender, experience of the farmers, income level, extension availability, credit facilities, household size, market availability and perception of what these people (farmers) have on a certain innovation.

2.5.3 Perceived attributes theory

It's argued that, there is five attributes upon which an innovation is judged, in micro level which are trialability, observability, relative advantage, complex and compatibility (Carr 2009: Roger, 1995). Where from the first step of judging innovation is trialability, innovation can be tried out by individual on whether to adopt it or not to adopt it, after observation innovation must be judged if it has advantage compared other innovation of the same field, or same circumstance, economic profitability, social prestige, and saving of time and effort,. So that an individual/adopter should know which innovation is worth for adoption compared to other.

Holloway (1977), Moore and Bendasat (1990) and Tonnatikand Klein (1982), found relative advantage is the best predictors of an innovation's rate of adoption, because it's indicate the benefits and the costs resulting from adoption of an innovation and have positive significant rate of adoption. Also innovation should not be overly complex for adopter to learn and use, should be average in use in a way that any individual with training can be able to adopt and l it should fit with circumstance that individual needs to

apply it, if it became innovation become complex, the adopter has negatively related to its rate of adoption (Roger, 1995).

Lastly innovation should be certain, as more compatibility of innovation should be less uncertain, since it's perceived to be consistent with the existing values, past experiences, and needs of adopters so as helps the adopter to give meaning.to the new idea/innovation.

2.5.4 Theory of the firm

Also study based on the theory of the firm in micro level, where the behavior of a particular business entity is said to be driven by profit maximization subject to budget constraint. When adopt new technology, simplification and less cost, is highly expected by farmers so as to generate more profit from minimization of cost of production with high yield from that technology. As for adoption of ICT's, (farmers who decide to adopt the use of ICT's), farmers incurred less cost to access agricultural information compared to local ways of obtaining information and will get high yield through obtaining information on agronomy advice, community and weather forecast and market information will gives high price and will make high gross margin compared to those who didn't adopt the use of ICT's. Hence farmers who adopt the use of ICT's will maximize profit subject to budget constraint. Theory interacts with market to determine price and demand and then resources allocation and decision making (Nicholson and Snyder, 2008), since it governs decision making in resource allocation i.e. income of the rice producer to access market information from services providers (TIGO KILIMO and KILIMO CLUB).

2.6 Review of Empirical Studies

2.6.1 Significance of ICT's to agricultural based decision making

According to Reddy (2004) market information is of great importance to the farmers and merchants. Price information is very vital for farmers in their decision of timing the sales.

Merchants require market information to carry on their routine transactions and strategic planning. Mobile technologies deliver effectively agricultural information and assist farmers to make better decisions about their agricultural activities (Armstrong &Gandhi, 2012).

According to Mekonnen and Asenso-Okyere (2012), argued that information communication believed to bring about social and economic development by creating and enabling environment. Among the benefit of mobile phone reach even those who do not themselves have first-hand access to them.

2.6.2 Descriptive analysis to analyze contribution of ICT's to rice farmers in accessing agricultural information

According to Barakabitze*et al.* (2017), on the use of participatory approaches in developing ICT-based systems for disseminating agricultural knowledge and information for farmers in developing countries, argued that 90.2% agreed that ICT's contributes to the increase of agriculture productivity to small scale rice farmers.

Olaninyi and Ismaili, (2016) used descriptive analysis to analyze on contribution of ICT's to access agricultural information. Farmers used 92.5% of mobile phone, 86.3% of radio and 69.9% of television to access agricultural information. Contribution derived from the use of ICT's by Yarm farmers was analyzed through descriptive analysis, where ICT's contribute 52.4% on production analysis and 49.6% on marketing(Chavula, 2013).

2.6.3 Probit model to identify factors influencing rate factors influencing the use of ICT's in communicating Agriculture information

Based on the study done by Okello (2013) used probit model to analyze drivers of use of ICT's in communicating Agriculture information. Logistic regression model used to

analyze socio-demographic, farm and market related factors, if they influence the use of ICT's on accessing agricultural information. According to Van der Elstraeten (2015), on assessment of factors influencing the use of ICT's in maize marketing in North Central Nigeria. The results showed that age, education, regulatory bodies, market channel and market cost affect maize marketing. Mehar and Mittal (2015) argued that multivariate probit model, used to identify socio-economic factors affecting adoption of modern ICT's by farmer in India. The results showed that age, education level and farm size influence farmer's behavior in selecting different sources of information.

According to lopes (2010), probit analysis used to estimate factors associated with households' adoption decisions, where the study identify factors such as socio-demographical characteristics such as household size, household' head age, household' head gender and household' head education, institutional characteristics such as access to extension officer, price information from market, and membership in agricultural association and risk and economic attributes such as drought and floods.

2.6.4 Rate of adoption

Most literatures used descriptive statistic to analyze rate of adoption to identify frequency and percentages of farmers who adopt the use of advanced technology or didn't adopt the use of advanced technology. Example Lopes (2010), used descriptive statistic to estimate rate of adoption and through probit model, factors that influence the use of ICT's were identified. Nkiru*et al*. (2012) also used descriptive statistics to evaluate rate of adoption and to identity factors that determine weather or weather not farmer adopt the use of ICT's in a given area through probit model. After estimating frequency with percentage of adopters and non-adopters, through descriptive analysis, next was to identify factors

affecting adoption through probit model and determination of the intensity in the use of technology was estimated through logitmodel (Feder*et al.*, 1988: Place and Hazell, 1933: Shiferawand Holden, 1998). Meharand Mittal (2015) used descriptive analysis and multivariate probit model to analyze factors that affect the farmer's adoption of different agriculture-related information sources. The study highlighted farmer's age, education level and farm size influence farmer's behavior in selecting different sources of information.

2.6.5 Model for profitability

According to Churi*et al.* (nd), gross margin analysis can be used to provide descriptive evidence of enterprises profitability. Gross margin analysis was used as a proxy for profitability of an enterprise (Samboko, 2011). Gross margin analysis was used to identify on profitability of farmer for the adoption of new beans varieties, (Katungi*et al.* 2011). Mgeni and Temu (2010) use gross margin analysis to examine the profitability of fresh fruits and vegetable export marketing channel of small-scale farmers in Tanzania.

2.7Conceptual Framework

It's anticipated that access to market information through information communication technology, have impact on farmers' development thought increase in income and profit making. ICT's can be used and supposed to be used by every rice farmers because each farmer needs information to have better farming system and for search for market. But the use of ICT's is influence by different factors such as age, gender, education level, farm size, aim of engaging in rice production, technology used in rice production , awareness ,household size, income ,and experience for farmer to use ICT's. Though ICT's farmers can be able to access different kind of information like agronomy advice, community, weather forecast and marketing information, where though those information farmer will

be able to get high yield, quality product, high pricing, trading quantities, new and profitable crop and high incomes. The use of ICT's has direct impact to the development of farmers on their farming system and marketing. Fig. 1 represents a conceptual framework for using information communication technology (ICT's), to access agricultural information that's reduce poverty and bring impact to the rice farmers (Mwakaje, 2010).

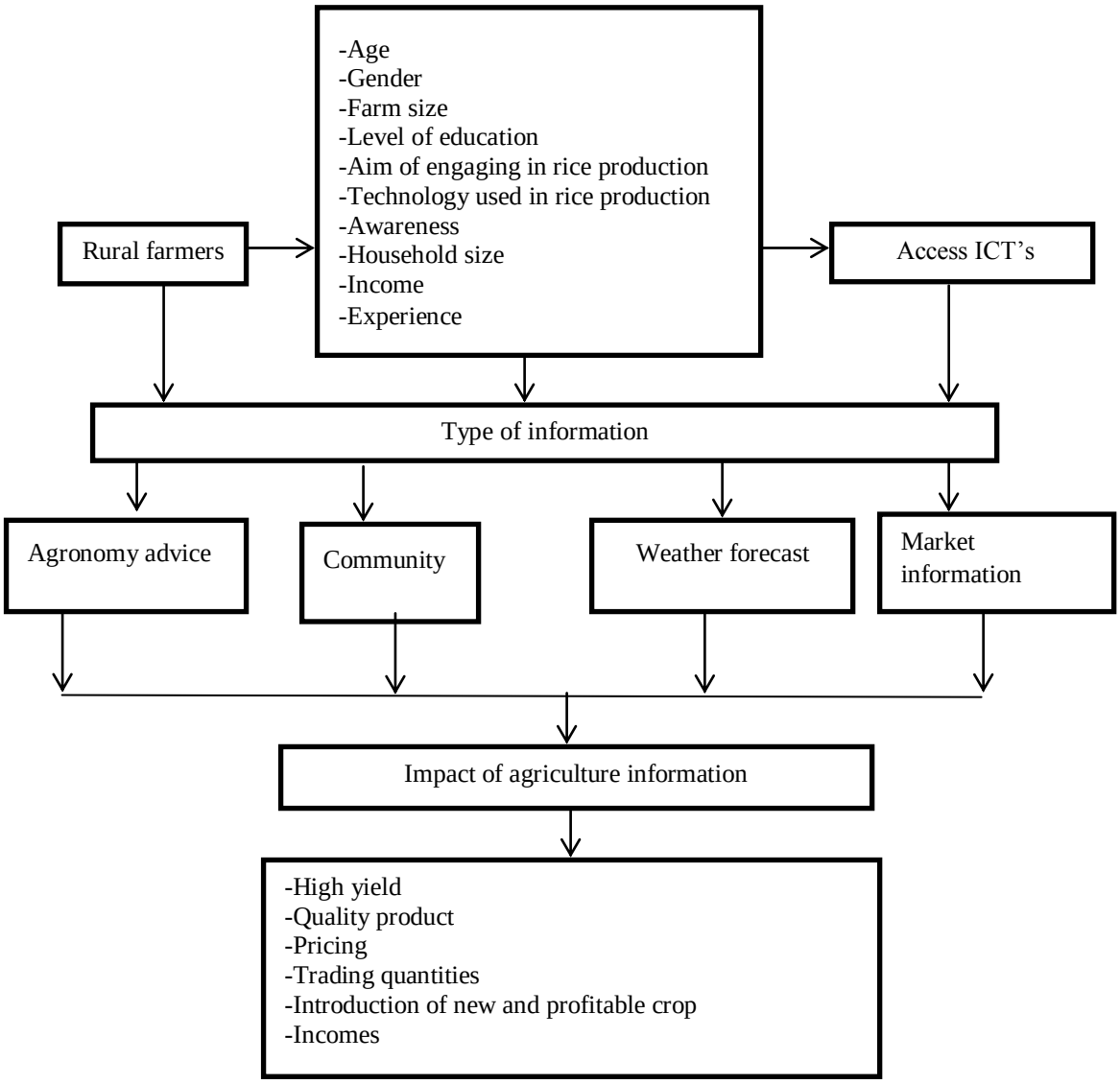

Figure 1: Conceptual Framework

Source: Modified from Mwakaje (2010)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area

The study was conducted in Morogoro region, at Kilombero, Mvomero, Morogoro urban and Morogoro rural districts. Morogoro region was selected because of its suitability for production of paddy, it provide average yields of paddy 1.95 tonnes/ha, with annual average production of paddy 1 301 000 tonnes approximately 933 000 tonnes of rice (Kilimo, Tanzania, (nd)). According to Mligo and Msuya (2015), Morogoro region is important in rice production and it's among the region where the country mainly depends on, for the supplying food grains mainly rice. Also the region which has much awareness on advance technology adaption mainly production technology since are mostly used compared to other regions.

3.2 Research Design

Cross - sectional research design was used in order to capture the information at a given point in Morogoro region. Cross-sectional research design allows collection of information at a single point in time from a selected sample to represent the large population (Creswell, 1994: Babbie, 2010).

3.2.1 Sources of data, collection methods and types of data

The research study used both primary and secondary data sources through the use of a structured questionnaire: checklist, interview and observation during field survey and secondary data was obtained through the record kept by mobile operators through questionnaires, publications and official reports.

3.2.2 Sampling technique

The study population was small scale rice farmers, and random sampling was applied to the farmers through sampling frame using village registers. According to Solvin's formula:

$n=N / (1+Ne^2)$ and A sample interval will be determined by: $i=N/n$……(1)

The formula is reliable to 95%, Population in Morogoro region is 2218492 (census 2012)

n=2 218 492 / (1+ 2 218 492 (0.0025)

Sample size will be 399

i= 321611/399

The interval per section will be the 806^{th} household

Where; n = sample size, N = population size, e= Deviation of sampling

3.3 Analytical Techniques

The analytical tools were categorized based on their objectives:

3.3.1 Descriptive analysis

Based on the study, specific objective one and specific objective two were analysed through descriptive analysis, which used to describe and summarize collected data based on the objective. In identifying contribution of ICT's to small scale rice farmers in accessing agricultural information, descriptive statistics was used to analyse contribution of ICT's to small scale rice farmers in accessing agricultural information based information needed by farmers i.e. agronomy advice, community, weather forecast and market price.

Prior to the analysis of the probit model to identify rice farmers' decision of whether to adopt or not to adopt the use of ICT's, a sequence of descriptive statistics were estimated

using SPSS statistical software to explore percentages and frequencies of farms who adopt the use of ICT's or didn't adopt the use of ICT's. The descriptive statistical analysis describes and summarizes the use of ICT's at Morogoro region by age, gender, education level, household size, farm size, farming experience, farm ownership, and aim of engaging in rice production, use of advanced technology during production, awareness and income.

3.3.2 Probit model

After using descriptive statistic to summarize number of adopters and non- adopters, probit model was used to analyze specific objective three, to identify factor factors influencing the use of ICT's in communicating agricultural information. Probit model was employed by the study because of normality distribution of data. Where every farmer uses at least one of the advanced information communication (radio, television and mobile phone) is termed as an adopter. Dependent variables of the model are 0, 1 dummy variables, which indicate one , if rice farmer in Morogoro region adopt the use of ICT's in accessing agricultural technology, and zero if rice farmers in Morogoro region didn't adopt the use of ICT's in accessing agricultural technology. This study uses the probit adoption model to identify rice farmers' adoption decision, based on gender, age, education, total farm size, household farm size, farm ownership, experience, aim in engaging in rice production, use of advanced technology, awareness and income because it is an appropriate econometric model for the binary dependent variable and the error term is assumed to be normally distributed (Gujarati, 2004).

Probit model: $Y = F(X^{I}\beta) + \varepsilon_i$ .....(2)

$$Y_i = \begin{cases} 1 \ if, adopted \\ 0 \ otherwise \end{cases}$$

Where; $\varepsilon \sim N(0, 1)$

β - Maximum likehood

i - Cumulative distribution functions of standard normal distribution.

ε - Error term

x - Set of independent variable

Independent variables included in the model are age, gender, household size, farm size, income, farm ownership, experience, awareness, aim of engaging in rice production and technology used in rice production.

After using probit model which used to provide coefficient estimation that gives direction of the effect of the independent variable on the dependent variables so as to obtain the actual magnitude of the change of probabilities through marginal effect.

Marginal effect used to reflect the change in probability of independent variablewhich are age, sex, level of education, awareness, technology used during rice production, aim of engaging in production, farming experiences, farm size ,household size and income in a given change of dependent variable i.e. ICT's.

$$\frac{\delta E(\frac{Yi}{Xi})}{\delta Xi} \quad \text{.....(3)}$$

Where; Yi = dependent variable, that is use of ICT's

Xi= independent variables which are age, sex, level of education, awareness, technology used during rice production, aim of engaging in production, farming experiences, farm size ,household size and income.

δ = show change in probability of independent variable in a given change of dependent variable.

Table 1: Explanatory variables of the probit model

Variable		Measurement	Description	Expected sign
X_1	Sex (Dummy)	Dummy(0= Female ,1= Male)	Male farmers are more likely to adopt the use of ICT's compared to female farmers	+
X_2	Age	In years (continuous)	Younger farmers are more likely to adopt than older farmers.	+
X_3	Education level (Dummy)	Dummy(1= informal education 2= primary education, 3= secondary education, 4=above secondary education	Formal educated farmers are more likely to adopt than those with informal education levels	+
X_4	Awareness	Dummy (0= not aware , 1=aware	Awareness among farmers, influence the use of ICT's compared to farmers who have less awareness.	+
X_5	Technology used during rice production	Dummy (0= local technology, 1= advanced technology)	Farmers who use modern equipment in rice production are more likely to adopt ICT's compared to others.	+/−
X_6	Aim of engaging in production	Dummy(0= consumption purpose, 1= commercial purpose)	Farmers, who do farming for commercial purpose are more likely to adopt the use of ICT's compared to farmers who do farming for consumption purpose	+/−
X_7	Farming experience	In years (continuous)	The high the experience, more likely to adopt ICT's	+
X_8	Farm size	In acres (continuous)	Large farm size owners are more likely to adopt the use of ICT's compared to small farm size owners	+
X_9	Household size	Household member (continuous)	Large household size are likely to adopt than small household size	+
X_{10}	Income	In Tanzania shillings currency (continuous)	High income earners are likely to adopt compared to low income earners	+

3.3.3 Gross margin

It was hypothesized that there is no significant difference in farmer's profit margin between adopters and non-adopters of small scale rice farmers. This hypothesis was tested through gross margin analysis (GM), and was used to compare the gross margin between adopters and non-adopters on the forth specific objective, were single assumption was made. It assumes that the fixed costs are small, that hardly affect sustainability of enterprise such fixed cost are cost of acquiring land, cost of acquiring farming equipment such as hand hoe, knife and stick and cost of obtaining communication devices like mobile phone, radio and television that they do not affect sustainability of enterprises.

$$\left.\begin{array}{l} GM_i = \Sigma TR_i - \Sigma TVC_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{i)} \\ GM = Q_j P_i - X_i P_{xi} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{ii)} \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where;

GM_i – Gross Margin per acre of i_{th} ,adopters/non- adopters, ΣTR_i- total revenue from sales of i_{th} .ΣTVC_i- total variable cost spenton one acre due to i_{th}production and marketing information acquired. Q_j-output .P_i- price of output produced .X_i- input .P_{xi}- cost of input.

Consequently t- test was carried out to compare the gross margin of ICT adopters and ICT non-adopters per acres for market information acquired, and determined through their mean differences, on whether the means of adopters and non-adopters are statistically indifferent from each other.

$$t = \frac{M_x - M_y}{\sqrt{\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where; M_X = Mean of adopters, M_y = Mean of non- adopters,S_x= Standard deviation of adopters, S_y = Standard deviation of non-adopters, n_x= Total number of adopters, n_y= Total number of non-adopters.

$$S^2 = \frac{\sum (x - M)^2}{n - 1} \quad \text{.....(6)}$$

Where; x = individual values, M = mean, n= total number of farmers (adopter or non-adopters)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Social Economic Characteristics for Rice Farmers in Morogoro Region

4.1.1 Sex of respondents

Based in the analysis, the results indicate that most of respondents in Morogoro region were male compared to female. Male were 59.6% of total respondent and female were 40.4% of total respondent, this is because men have access to resources compared to female.So male farmers are more likely to adopt the use of ICT's compared to female farmers. Example most of land are owned by male farmers, male farmers have access to credit compared to female (Okonya and Kroschel, 2014).

4.1.2 Age

Results show that most of the rice farmers were from 19-40 years of age which have 58.8% of total respondent, followed by farmers from 41-60 years of age which have 31.8% of total respondent, and 61 and above years of age have 5.1% and 0- 18years have 4.4 years of age. This shows that rice farmers with mid aged farmers are many compared to other groups of age, young farmers are ease and capable to adopt changes compared to other groups. According to Adeogun*et al*. (2010) argued that younger farmers are most likely and willing to spend more time to obtain information on improved technology compared to other age groups. Also younger farmers are less resistant to changes than older farmers and they accept and adopt innovations and new technologies readily and quickly (Crusan*et al.,* 1982).

4.1.3 Education level

More than half of respondent attendant formal education, compared to those who didn't attended formal education. Almost half (49.1%) of rice farmers had attended secondary

education, 3.4% attended primary education and 4.1% attended above secondary education, this shows that many farmers are literacy compared to illiteracy farmers (43.2%). This shows literacy rate is high hence easy to influence the use of ICT's with programme or training to emphasize the adoption of ICT's since educated farmers have favorable attitudes towards adoption and use of advanced information technology(Hassan, 1991 and Habib*et al.*, 2007). Therefore the more rice farmers are literacy, increase, adoption of ICT's in accessing agricultural information.

4.1.4 Rice farming experience

Results on Table 2, shows that, 56.2% of rice farmers had less than 10 years of rice farming experience, followed by 41.3 years of experience who have 11 to 30 years of experience. This shows that most of rice farmers have less experience in rice farming so, they need more information about rice farming and market situation to guide them in farming practice, communication among farmers and searching for market.

4.1.5 Total farm size

As its indicated in Table 2, most of rice farmers (49.8%) own less than 5 acres, and 32.6% or rice farmers own 6-13 acres, with few (17.6%) rice farmers who owns more than 14 acres, this means most of rice farmers in Morogoro region are small scale rice farmers since their farms are less than 4.92 acres (Lowder*at el.*, 2016). Hence small scale rice farmers are more likely to adopt the use of ICT's.

4.1.6 Farm ownership

Results indicates that majority of farms are owned individually, that accounted for 54.5%, followed by family ownership of farm and renting which have 20.4% of rice farms.

Individually owned farms happened to a majority of other groups of ownership because rice farming most of owner are not indigenous from Morogoro region and engaging in rice farming mostly for commercial purpose.

4.1.7 Aim of engaging in rice production

Farmers engaging in rice production for different objective, 89.7% of farmers are engaging in rice production for both commercial and consumption purpose, 21% of rice farmers involve themselves in rice production for commercial purpose and 19% of rice farmers do rice farming for consumption purpose. Therefore rice farmers who engage in rice production for both consumption and commercial purpose are more likely to adopt the use of ICT's.

Table 2: Socio-economic characteristics of rice farmers in Morogoro Region

Variables	Frequency	Percentages
Sex		
Male	145	37.4
Female	241	62.4
Total	**386**	**100**
Age		
0-18	17	4.4
19-40	227	58.8
41-60	120	31.1
61 and above	22	5.1
Total	**386**	**100**
Education level		
Informal education	167	43.2
Primary education	13	3.4
Secondary education	190	49.1
Above secondary education	16	4.1
Total	**386**	**100**
Rice farming experience		
> 10 years	217	56.2
10- 30 years	160	41.3
<30 years	9	2.3
Total	**386**	**100**
Rice farm size(acre)		
>5	192	49.8
5-13	126	32.6
<13	68	17.6
Total	**386**	**100**
Farm ownership		
Individually owned	211	54.5
Family owned	79	20.4
Renting	79	20.4
Institutional owned	12	3.1
Jointly owned	5	1.3
Total	**386**	**100**
Aim of engaging in rice production		
Commercial purpose	21	5.4
Consumption purpose	19	4.9
Both commercial and consumption purpose	346	89.7
Total	**386**	**100**

4.2 Empirical Results

4.2.1 ICT's and agricultural information

From the first objective of identifying contribution of ICT's to small scale rice farmers in Morogoro region in accessing agricultural information to rice farmers in Morogoro region descriptive statistics was employed, which used to describes and summarizes the contribution of ICT's based on the information needed by farmers from the beginning of production up to the market through percentages and frequencies of farmers. Farmers have different ways of acquiring information based on cost, network coverage, type of information needed which are influenced by age, education level, sex , household size, aim of engaging in rice production, farm ownership, and experience. Early in the season, ICT's are used to inquire information about time of planting, source and availability of seeds and other inputs. During mid-season, most farmers use ICT's to inquire information about availability of pesticides for pest and disease management. Later in the season during harvesting, ICT's used to inquire about the prevailing market prices for agricultural commodities (Tukahira*et al.,* 2000). Table 3 present type of agriculture information accessed by rice farmers through information communication technology.

4.2.1.1 ICT and market information

Mobile phone, radio, and television provide market information, but differ on how easy on deliverance of information to the farmers. Farmers in the study area argued that the use of radio and television to access market information is less preferred compared to the use of mobile phone as it's presented in Table 3.And this is becauseradio and television delivers market information with general prices, which is mostly one way communication. The use of mobile phone gives farmers direct two ways communication either between farmer and mobile operator or among farmers. Farmers doesn't only use mobile phone to access

market information from mobile phone operators but also exchanging market information with markets, brokers and near cities for selling their produce (Ilahiane, 2007). Mobile phone has been able to connect farmers to market information on the specific time and deliver accurate information. Also adoption of mobile phones might influence farmers' decision to travel to market rather than to sell at farm-gate.

4.2.1.2 ICT's and agronomy advice

Before provision of agricultural information through mobile phones mostly farmers were depend on broadcasting media such as radio and television to get knowledge and information about farming practice (Hassan and Chhachhar, 2013). Slightly famers shift from radio and television to mobile phone as it's presented on Table 3, because mobile phone gives farmer exactly what they are looking for like input to use, improved seeds, fertilizer, and other agro-chemical, machinery, and irrigation unlike radio, they broadcast what they have and not what farmers want since they broadcast what they wants and not what farmers wants to know about their farm situations. Even when they could broadcast what farmers want, farmers have different need regards their farms. With mobile phone each farmers can access agronomy information based on farmer needs, that's why farmers prefer mobile phone.

4.2.1.3 ICT's and weather forecast

Since farmers depends on nature, Weather forecasting information is the most important information to the farmers .Based on the results, presented on Table 3, due to its daily broadcasting, rice farmers use mostly radio to access weather information. It helps farmers to know when to start farming based on the weather information but also through mobile phone farmers can get weather information through phone operators, metrological people

and among farmers. Nowadays many farmers contact with metrological department to get information about weather before start a pesticides in their crop (Duncombe, 2011).

4.2.1.4 ICT's and community

With community information, farmers prefer to access through mobile phone. Community information helps farmers to link with fellow farmers from different places, traders and farming expertise, which help them to exchange ideas. Unlike the use of radio and television it's impossible for farmers to link up and exchange ideas as presented in Table 3.

Table 3: ICT's and agriculture information

	Percentage (n=399)			
Variables	**Weather forecast**	**Community**	**Agronomy advice**	**Market price**
Mobile phone	6.1	36.4	51.4	6.1
Television	0.1	0	0	0
Radio	63.1	20.1	16.1	0.7

4.2.2 Non ICT's and agriculture information

Word of mouth, family, middlemen, farmers group, extension officers and institutions provide all kind of information, but other sources are specialized at giving a certain kind of information and farmers have their specific source to obtain certain kind of information, as it's presented in Table 4. Farmers mostly access market price through middlemen, despite that middlemen set price on their advantage, but still farmers preferred middlemen price other than other sources of information. Farmers complain about selling paddy to the middlemen because of low price received from middlemen. Farmers might have an idea of prevailing price and wants to sell their paddy on that price, only traders or market place will buy from that price. But farmers don't have much of a choice, but to sell them to middlemen because it hard for them to sell paddy direct to traders and for that reason they

end up sell their paddy to middlemen. Farmers prefer community information and agronomy advice from institutions. Institutions do provide agronomy advice and farmers tend to believe most on what they see because institutional information came with practice and that's what make farmers believe and use most institutional information on agronomy advice because of demonstration. Example Africa rice assist rice farmers of Kilombero District with agronomy advice either with new seed variety or new farming practice through demonstrations and take them from step to step. Also extension offices assist farmers by visiting on their farms and show them practically. It can be either farmer needs personal assistance or extension officer wants to train farmers on new farming practice / technology.

Extension officers also help to provide information on weather forecasting on when farmers should expect to start another season of production so that farmers will start to prepare their farms. Family and farmers group also provide weather forecasting information, and the information provided by them, is the collection of information from different source.

Table 4: Non- ICT's with agriculture information

	Percentage (n=399)			
Variables	**Weather forecast**	**Community**	**Agronomy advice**	**Market price**
Word of mouth	24	26.7	25	24.3
Family	25.1	23.9	27.3	23.7
Farmers group	25.5	23.9	26.9	23.7
Middlemen	3.2	3.2	0	92.4
Market board	0	0	0	0
Extension officer	31.2	29.9	30.7	8.2
Institutes	33.4	58.3	8.3	0

4.2.3 Rate of adoption

The second objective of analyzing rate of adoption of ICT's to rice farmers in Morogoro region descriptive statistics was employed , which used to describes and summarizes the use of ICT's though percentages and frequencies of farmers who adopt the use of ICT's or didn't adopt the use of ICT's at Morogoro region by age, sex , education level, household size, farm size, farming experience, farm ownership, aim of engaging in rice production, use of advanced technology during production, awareness and income.

Based on Table 5, 56.6% of rice farmers in Morogoro region who adopt at least one source of ICTs, to access agricultural information, and 43.4% of rice farmers didn't adopt the use ICT's in access agricultural information. The results shows that male rice farmers adopt more the use ICT's compared to female rice farmers. Female rice farmers adopt less the use ICT's because, female were not allowed to own any kind of ICT's since male are the once involves in selling product while female involved a lot in production.

The younger the farmer, more likely to adopt ICT's, younger farmers adopt more ICT's compared to other groups of age, because younger farmers are capable of learning and have higher ability to accept changes for development, unlike older farmers who are less likely to embrace changes. Rice farmers who at least attended secondary education seem to adopt more the use of ICT's compared to illiteracy farmers. Farmers with education have ability to adopt easy due to their understanding, and use ICT's to help them make decision on production and marketing (Ali, 2013).

Small scale farmers size tend to adopt more the use of ICT's compared to medium and large scale farmers as presented in Table 6. According to Das (2014), small scale rice

farmers are < 2 ha, middle scale rice farmers > 2 ha but < 10 ha and large scale farmers > 10 ha. Small scale rice farmers adopt more the use of ICT's because they want to increase their production level and selling their product at high price though agronomy advice, community, weather forecast and market price.

Farmers who aim to engaging in rice production for consumption and commercial purpose are more likely to adopt the use of ICT's compared to farmers who aim for consumption and commercial purpose only. Farms who are owned in individual wise adopt more the use of ICT's compared to others, because when it's easy to make decisions on adoption of technology when it's individually owned compared to other farm ownership. Similar finding was obtained by Roger (1983), who argued that when an innovation-decision is made by a system, rather than by an individual, the decision process is usually much more complicated. Most of ICT's adopters happen to use both local and advanced technology during rice production. When farmers use both technologies for production as in advanced technology as the main technology and local technology as supportive technology, it's likely to understand the benefit of using ICT's to access information for their production.

Table 5: Descriptive analysis on the rate of adoption

Variables	Frequency	Percentage (%)
Adopters	226	56.6
Non adopters	173	43.4

Table 6: Descriptive analysis on rate of adoption regarding socio-economic factors

Variables	Adopter (n=226)		Non adopters (n=173)	
	Frequency	Percentage	Frequency	Percentage
Sex				
Male	211	52.85	32	6.74
Female	17	4.40	139	36.01
Age				
0-18	12	3	7	1.7
19-40	138	34.59	98	24.56
41-60	66	16.54	56	14.04
61 and above	12	3	10	2.51
Education level				
Informal	8	2.07	161	40.35
Primary education	13	3.25	5	1.25
Secondary education	191	47.86	5	1.25
Above secondary education	16	4.01	0	0
Total farm size(acres)				
< 5	105	25.91	93	23.83
5-20	78	19.68	53	13.21
> 21	43	11.14	27	6.48
Experience(years)				
< 10	117	30.31	100	25.91
10-30	95	24.87	64	16.58
> 30	6	1.55	3	0.78
Aim of engaging in rice production				
Consumption purpose	10	2.59	9	2.33
Commercial purpose	9	2.33	18	3.12
Both consumption and commercial purpose	209	52.33	144	37.30
Farm ownership				
Individually owned	124	30.31	34	8.81
Family owned	50	12.95	104	25.39
Institutional owned	10	2.59	6	1.55
Jointly owned	3	0.78	4	1.03
Renting	42	10.88	22	5.71
Technology used during production				
Advanced technology	3	0.78	2	0.52
Local technology	2	0.52	16	2.59
Both advanced and local technology	223	55.96	153	39.64

4.2.4 Reason(s) for not adopting the use of ICT's

Based on the analysis, 43.4% of rice farmers didn't adopt the use of ICT's .Non adopters had different reasons on why they are not involving themselves on the use of ICT's to obtain agricultural information. The important reason was ranked first, followed by other reasons as ranked as it's presented in Table 7. Non adopters argued that the use of ICT's does not seem beneficial to them, from what they observe from those who use ICT's. Most

of them are satisfied with their local ways of obtaining information from local extension officers, middlemen, farmers group and word of mouth. Farmers find it costful to incur 250Tsh for single information, even other farmers are not aware on the existence of ICT's to access agriculture information.

Table 7: Reasons for not adopting the use if ICT's

Variables	Score (%)	Overall Rank
Doesn't find it beneficial	18	1st
Satisfied with traditional ways of obtaining agriculture information	32.6	2nd
Costly	25.9	3rd
Had no idea if its existed	22.8	4th

4.2.5 Reason(s) for stopping using ICT's

From the first objective of analyzing rate of adoption, 56.6%adopt the use ICT's and 43.4% didn't adopt the use of ICT's to access agricultural information. Among 43.3 % who don't use ICT, 5% used to use ICT but they stop from using it because they face some difficulties and challenges at the time of adoption. Table 8 presents the results of ranking of the reason for farmers who stopped using ICT's. Irreverent information was ranked as the first reason because, they shifted from traditional ways of obtaining information to ICT's so as to get accurate and assured information but instead they get information which are not relevant to their problems and other information are too general. Farmers argued that Information provided by ICT's are outdated mostly information provided by radio, and become useless at the moment. With network problem and electricity problem in the study area to access information through mobile phone and radio/ television respectively, makes it harder for farmers to access agriculture information.

Table 8: Reasons for stopping using ICT's

Variables	Score (%)	Overall rank
Irreverent information	45.6	1st
Outdated information	33.6	2nd
Hard to access	5.7	3rd
Cost	15.1	4th

4.2.6 Factors influencing the use of ICT's in communicating agriculture information

After using descriptive statistics in the second objective to describe and summarizes rate of adoption of ICT's though percentages and frequencies of small scale rice farmers who adopt the use of ICT's or didn't adopt the use of ICT's at Morogoro region by age, gender, education level, household size, farm size, farming experience, farm ownership, aim of engaging in rice production, use of advanced technology during production, awareness and income. Probit model was used to identify factors influencing the use/adoption of ICT's in communicating Agriculture information and to explain a choice decision of using ICT's among rice farmers and identify factors influencing the use of ICT's in communicating agricultural. Before employing probit model multicollinearity problem was check where tolerance was greater than 0.2 and VIF was less than 10, hence there was no multicollinearity problem. In this study, adopters are farmers that used at least one of advanced information technology along with local information technology.

Probit model provide coefficient estimation as estimated in Table 9 that gives direction of the effect of the independent variable on the dependent variables so as to obtain the actual magnitude of the change of probabilities through marginal effect.

The likelihood estimation of the probit model indicate that the chi-square (X^2) statistic of 483.09 was highly significant (P=0.0000) suggesting that the model has strong explanatory power. Overall rate of correct classification is estimated to be 97.93%, with

97.59% of the normal weight group correctly classified (specificity) and only 98.18% of the low weight group correctly classified (sensitivity). Probit analysis suggest that the dummy variables on age is significant but has negative impact on the adoption of ICT's, as age increase, the probability of adopting the use of ICT's decreases because younger farmers are more likely to adopt the use of ICT's compared to older farmers since older farmers are hardly accept changes because they believe on their experience. Gender has positive significant effect on the rate of adoption; where male have greater proportion of adoption compared to female, as male increase, and probability of adopting ICT's increases. Male farmers have access to ICT's tools compared to female because most of male farmers were household head. Well educated farmers are more likely to adopt the use of ICT's compared to less educated farmers. Increase in farmers, education lead to increase in probability of adoption of ICTs. This shows that education has positive significant to the adoption of ICT's. Educated farmers have ability to understand importance of using ICT's and some of them didn't need training on the use of ICT's compared to uneducated farmers. Similar findings were obtained in a study by Mittal and Kumar (2000) who examined that education help farmers to creates conditions that enable farmers to acquire and use knowledge for decision making regarding allocative and technical matters effectively on the use of ICT's.

Farm size has negative effect on the adoption of ICT's, whereas farm size increase probability of adopting ICT's decreases as presented in Table 10. Farmers with large farm size have their selling point; they don't depend on ICT's to connect them with market, compared to farmers who own small size farms. Farmers who adopt the use of mechanization during rice production are more likely to adopt the use of ICT's, because when famers who advanced technology during production understand the importance of

using advanced technology due to its on simplification save time and efficiency, therefore more use of mechanization, increase the probability of adopting the use of ICT's. Awareness has positive effect on the adoption of ICT's whereas farmers who had awareness on the use of ICT's are more likely to adopt the use of ICT's, because having awareness help farmers to know and understand the use of ICT's, hence increase in awareness on the use of ICT's, increase the probability of adoption of ICT's as its presented on Table 9.

Table 9: Probit results of factors influencing the use of ICT's in communicating agriculture information

Probit model		**Robust**		**Marginal effect**		
Variables						
Use of ICT						
	Coef.	**Std.Err**	**P>|z|**	**dy/dx**	**Std.Err**	**P>|z|**
Sex(Male)	2.077	0.558	0.000	0.066	0.016	0.000*
Age (19-40 years)	-0.067	0.028	0.018	-0.002	0.001	0.011**
Education level(secondary education)	4.138	0.820	0.000	0.132	0.019	0.000*
Total farm size	-0.135	0.065	0.038	-0.004	0.002	0.030**
Household size	0.009	0.108	0.931			
Farm ownership	0.995	0.636	0.118			
Experience	-0.001	0.002	-0.524			
Aim of engaging in production (commercial purpose)	0.704	0.564	0.212			
Advanced technology during production (advanced technology)	1.290	0.733	0.078	0.041	0.023	0.070***
Awareness (Yes)	2.976	1.108	0.007	0.095	0.033	0.003**
Income	-1.560	3.540	0.659			
Observation	399					
LR chi2(11)	483.09					
Prob>chi2	0.0000					
Pseudo R2	0.916					
Log likelihood	-22.218					

*Significant at 1%, ** Significant at 5%, *** Significant at 10%

4.2.7 Gross margin for ICT's adopters and ICT's non adopters among small scale rice farmers

Forth objective of comparing profit margin for adopters and non-adopters, gross margin (GM) analysis was done to compare profit and to test the hypothesis which state that" adopters and non-adopters have the same profit margin among small scale rice farmers. And t- test was used to test if there is there significant different in GM per acre for acquiring agricultural information. These were done among small scale rice farmers who adopted information communication technology and those who did not adopt the use information communication technology to acquire market information.

Gross margin analysis show that the average variable cost per acre for adopters was274 958.69Tsh per acre and gross revenue 924 723.76 Tsh per acre, with gross margin of 649 765.07 Tsh. On the other hand average variable cost per acre for non-adopters was 243 316.26 Tsh per acre and gross revenue 560 784.40 Tsh per acre, with gross margin of 317 474.62 Tsh per acre (Table 10). This shows that gross margin for small scale rice farmers who adopt the use of ICT's to access agriculture information is higher than that of small scale rice farmers who does not use ICT's to access market information.

Cost and revenue analysis show that rice farmers who adopt the use of ICT happens to incur high cost of production compared to farmers who does not use ICT, due to the fact that high cost is attributed to the high yields, associated with the use of improved production technologies. And since adopters of ICT's have high yields compared to non-adopters, it's likely that they incur high cost of production because its translated that high yields lead to high operations operation cost such as harvesting, transport due to fact that most of ICT's adopters use modern equipment during production like tractor, power tillers

and combine harvesters. Also ICT's adopters incur less cost compared to ICT's non-adopters in accessing agricultural information because through mobile phone specifically TIGO KILIMO, farmers incur no cost accessing agricultural information i.e. weather forecast, agronomy advice and community expect for market information which incur cost of 250 Tsh/information, through radio and television, famers incur no cost in accessing agriculture information unless, farmer needs more clarification in a certain agricultural information that's needs to call back, and incur cost of average 800 Tsh/information, but the use of other source of information like extension officers services, farmers incur more cost for transportation fee for extension officer to reach/visit their farms, if they needs assistants/advice based on the farm problem, due to remoteness among farms and poor road network. Extension officer services are quite expensive and face some obstacles. Field extension officers have difficulties reaching some areas due to poor road networks (Afiman, 2014). Also for farmers groups, farmers incur monthly cost of average 1300Tsh/month to pay for membership fee every month, regardless if they provide information that month or not. And for farmers who had groups under certain organization/institution, like KATRIN, ARI, ILONGA, they receive agricultural information after sometimes which can be either early or late and be useless at a time.

Gross revenue obtained by ICT's adopters is relative high compared to ICT's non adopters 924 723.76Tsh per acre and 560 784.40 Tsh per acre respectively. Even if both have difficulties to sell their paddy, ICT's adopters happens to sell their paddy at high price compared to ICT's non adopters. Adopters tend to wait and take their paddy to the highest bidder because they are aware of the price, which help them to negotiate for better price in a transparent manner, and also reduce the need for middlemen and sell their products directly to consumers or traders and not middlemen.

Compared to non-adopters, who are not so much aware of the prevailing price, they sell their products based on their capacity of bargaining without knowing the prevailing price, which cause them to end up with low price, hence low gross revenue (Table 10).

Based on t- test results as presented in Table 10, the test statistics under the assumption of equal variances not assumed was 2.31 having a significant level of 0.051 being significant (0.005). Therefore it is likely to reject null hypothesis that adopters and non-adopters have the same profit margin, and assumes there is no significant difference in farmer's gross margin per acres for acquiring marketing information between adopters and non-adopters of small scale rice farmers.

Therefore there is significant difference in farmer's gross margin per acres for acquiring agricultural information between adopters and non-adopters. Based on the analysis adopters accure more profit than non-adopters with mean difference of about 2.192 per acre for acquiring information communication technology (Table 10). This is because of high and almost stable price of paddy acquired by small scale rice farmers by accessing information through ICT's.

Table 10: Cost and return result of adopters and non-adopters of ICT's in accessing agricultural information

Variables	Adopters (n=226)		Non –adopters (n=173)	
	Units/Acres	Amount(Tsh)	Units/Acres	Amount (Tsh)
A: Gross revenue				
Average Yields(Kg)	1 065.08		886.71	
Average price per Kg (Tshs)	868.22		632.44	
Total revenue		924 723.76		**560784.40**
B:Variable costs				
Cost of Production				
Hired land	I acre	58 333.33	1 acre	**49200.00**
Cultivation and plantation	1 acre	47 175.93	1 acre	**46366.46**
Seeds	23.96 kg	32 362.86	23.96 kg	**30320.75**
Weeding (Herbicides)	1.5 liters	33 040.46	1.5 litres	**31150.54**
Harvesting	1 acre	60 588.24	1 acre	**64390.24**
Threshing	1 acre	37 000.00	1 acre	**16272.73**
Total cost of production		268 500.81		**237700.72**
Transaction cost				
Transportation cost	1 bag	4 357.87	1bag	**4315.53**
Information cost (ICT)		2 100.45		**1300.00**
Total cost of transaction		6 457.87		**5615.53**
Total variable cost per acre		274 958.69		**243316.26**
C: Gross margin per acre =Gross income -Total variable cost		649 765.07		**317474.62**
Mean	**1 acre**	**8.854**	**1 acre**	**4.662**
t-test		**2.31**		
P(T<=t)		**0.050***		

*Significant at 0.05

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on analysis, rice farmers in Morogoro region ICT's was highly contributing in accessing agricultural information based on the information needed by farmers. Most farmers use mobile phone to access agronomy advice and market price, Weather forecast is most accessed through radio and television. About 57.3% of farmers adopt the use of ICT's to access agricultural information 42.7% of farmers didn't adopt the use of ICT's to access agricultural information. where male farmers, 19 – 40 years of age farmers, farmers with secondary education, farmers who own less than 5 acres with less than 10 years of experience of growing paddy who aim for commercial purpose and farmers who use advanced technology in production are more likely to use ICT's compared to other groups . Age, gender education level, use of advanced technology during production and awareness were the significant factors that influence the use of ICT's to access agricultural information. The probability of using ICT's to access agricultural information increases with increasing of educational level, gender, use of advanced technology during production and awareness of ICT's, decrease in age and farm size increase the probability of using ICT's to access agricultural information and that's lead to the rejection of null hypothesis which stated that "Factors such as age, gender, education level, farm size, household size, and experience, aim of engaging in rice production, use of modern equipment during production, awareness and income have no influences on the use of ICT's".

Also there were significant differences in farmer's profit margin between adopters and non- adopters, with mean difference of 1.3854, that's cooperate to reject null hypothesis

which stated that “there is no significant difference in farmer’s profit margin between adopters and non-adopters of small scale rice farmers”.

Using ICT’s doesn’t mean other means of acquiring information doesn’t provide accuracy information but through ICT’s information can be obtained easily, reliable, more accuracy and updated. The use of information communication technology like radio, mobile phone and television help farmers to obtain information regardless of the distance problem.Rice farmers in Morogoro region appreciate information communication technology as easy, fast and convenient way to communicate and get prompt answers of respective problems. Also it generated an opportunity for the farmers especially to get the information about marketing information, weather forecast, and community and agronomy advice.

In the terms of community development ICT’s has played a positive impact to small scale farmers and their communities and use of ICT’s strengthen their position in the production and market chain.

Farmers in Morogoro believe that, the use of ICT’s will help to improve their agricultural practices by getting high yield with good quality, market information, communication among farmers and other agricultural participant .Information are need by all kind of farmers but mostly by farmers who live in remote regions since remoteness cause less flow of information and its where middlemen takes advantage of their ignorance on information, lack of assistance during rice production. Increasing ICT’s and ICT’s based services improves the availability of knowledge and information and will further help in improving awareness, education, better adoption of technology, better health and

efficiency, reduced transaction costs and better market efficiencies these will increase rural sector development and economic growth.

5.2 Recommendations

Government and agricultural stakeholders should encourage a liberal policy for affordable prices for modern ICT's product, especially mobile telephones and as they provide subsidies to fertilizer and other agriculture input, they should also assist farmers to acquire modern ICT's at low price and share costs with these rice farmers during accessing agricultural information so that many farmers can adopt the use of ICT's.

Non-governmental agricultural institutions should provide guidance to extension systems for designing ICT based information system to better serve the farming communities based on their needs.

ICT's has great potential in improving farmers' yields, profitability and livelihood and therefore educating farmers especially in the villages is among the necessary criteria for linking them to easily accessing agriculture information in a timely and accurate manner.

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APPENDIX

Appendix 1: Rice Farmers Questionnaire

1. Village……..
2. District…….
3. Region……..
4. Name of respondent…….……
5. Basic social economics information
    i. Gender
        i. Male ( )
        ii. Female
    ii. Level of Education
        i. Formal Education ( )
        ii. Informal Education
    iii. Total farm size……
    iv. Household size ……..
    v. Age of respondent
        i. 0- 18 years
        ii. 19-40 years ( )
        iii. 41-60 years
        iv. 61- and above
    vi. Distance from the market…….
    vii. Household income
        i. 50 000 – 250 000 TSH
        ii. 260 000- 500 000 TSH
        iii. 510 000- 750 000 TSH ( )

iv. 760 000- 1 000 000TSH

v. More than 1 000 000TSH

6. Rice production

   a. Rice farm size …….

   b. Ownership of the farm

      i. Individually owned

      ii. Family owned

      iii. Institutional owned ( )

      iv. Jointly owned

      v. Renting

   c. Name of the farm owner

      ……

   d. Acquisition of land……. When ……

   e. When did you engage yourself in rice production……

   f. Aim of engaging in rice production

      i. Consumption purpose

      ii. Commercial purpose ( )

      iii. Both consumption and commercial purpose

7. When did you engage yourself in rice production……..

8. Type technology used of farming practice

   i. Advanced technology

   ii. Local technology ( )

   iii. Both local and advanced technology

9. If Advanced technology used in farming practice

Variables	Advanced technology on Farming practice used	Number of units used in 2016	Ownership 1.Owned 2.Hired	Cost
Tractors				
Power tiller				
Combine harvester				
Milling machine				
Push weeder				
Seeds varieties				

10. If local technology used in farming practice

Name of local technology used	Number of units used in 2016	Ownership 1.Owned 2.Hired	Cost

11. Cost of transaction

Means of transportation	Weight carried in (KG)	Ownership 1.Owned 2.Hired	Cost
Car			
Motorbike			
Bicycle			
Other means specifically			

12. Number of labour used…….

13. What is the average price for paddy per KG?

Variables	Last week	Last month
what is the average price for paddy per KG		

14. Rice production in 2016……

ICT USAGE

15. Are you aware on the use of information communication technology?

i. Yes

ii. No ( )

16. Do you use any information communication technology?

i. Yes

ii. No ( )

17. If YES, put a tick(√) where appropriate

Variables	ICT	Mass media		popular			Agricultural agents		Agricultural system	
	Mobile phone	Radio	TV	Word of mouth	Family	Farmer's group	Market board	Middlemen	Extension officers	Institutes
When did you start to use it										
Cost of acquisition										
Where do you get your information from?										
Which program /market if it's from mass media and Agricultural agent										
Cost of usage										
Ways of communication										
Regularity (how often do use)										
Type of information										
Reliability (how true the information's are)										
If Market information? What kind of market information										

Code:

When did you start to use it 1.Ten years ago2.Three years ago 3.Now (2017)

Ways of communication: 1. One way communication 2. Two way communication

3. Both one way and two ways communication

Regularity: 1. more often 2. Often 3. Less often

*less often – 5 times per week (less than 1 per day)

*often – 7 times per week (1 time per day)

*more often – 8 times and more per week (more than 1 time per day)

Type of information: 1. Market information 2. Community 3.Weather forecast

4. Agronomy advice **Reliability**: 1 .Not true at all 2. Somehow true 3. Definitely true

Market information: 1. Price 2. Quality needed 3. Quantity needed

18. What kinds of information do you mostly looking for? Put tick (√) where appropriate.

Variables	ICT	mass media		Popular			Market agent		Agricultural system	
	Mobile phone	Radio	TV	Family	Word of mouth	Farmer's group	Market board	Middlemen	Extension officer	Institute
Weather forecast										
Community										
Agronomy advice										
Market price										

19. Mobile phone technology

Variables	TIGO	VODACOM
How many SIM card do you own?		
How much does it cost, in accessing information per SMS? i. Weather forecast		
ii. Community		
iii. Agronomy advice		
iv. Market price		
Regularity		
How much do you use per day to access market information?		
How much do you use per week to access market information?		
Which kind of information is more reliable compared to others?(rank them from 1 to 4) i. weather forecast		
ii. community		
iii. Agronomy advice		
iv. Market price		

Code

Regularity: 1. more often 2. Often 3. Less often

*less often – 5 times per week (less than 1 per day)

*often – 7 times per week (1 time per day)

*more often – 8 times and more per week (more than 1 time per day)

20. If "NO" why (Put (√) where appropriate)

i. Doesn't find it beneficial ( )

ii. Doesn't provide accuracy information ( )

iii. Costly( )

iv. Others……..

21. Where do you get your information from?.....

22. Do you find it beneficial? (The use of mobile phone to access market information)

i. Yes

ii. No ( )

23. Advanced technology used in your farming practice

Variables	Advanced technology on Farming practice used	Number of units used in 2016	Ownership 1.Owned 2.Hired	Cost	
Tractors					
Power tiller					
Combine harvester					
Milling machine					
Push weeder					
Seeds varieties					

24. Why choosing a certain kind of information communication technology (reason for preference), put a tick(√) where appropriate

Variables	ICT	Mass media		Popular			Market agent		Agricultural institute	
	Mobile phone	Radio	TV	Family	Word of mouth	Farmer's group	middle men	Market board	Extension officer	Institutes
Rank (scale of preference) 1-9										
Time used to obtain information										
Accuracy										
Accessibility										
Reliability										
Cost										
Awareness										
Market size										
Farm size										

25. Do you still use ICT?

i. Yes

ii. No

26. If No, why did you stop using it? Put a tick (√) where appropriate

Variables	ICT	Mass media		Popular			Market agent		Agricultural institute	
	Mobile phone	Radio	TV	Family	Word of mouth	Farmer's group	middle men	Market board	Extension officer	Institutes
Cost										
Doesn't meet your needs of information										
Outdated										

information										
Irreverent information										
Hard to access										

27. What challenges do you face when accessing marketing information? Put tick (√) where appropriate

Variables	ICT	Mass media		Popular			Market agent		Agricultural system	
	Mobile phone	Radio	TV	family	Word of mouth	Farmer's group	Middlemen	Market board	Extension officer	Institutes
Outdated information										
Language barrier										
Lack of awareness on the existences of different market source										
Lack of funds to acquire information										
Incomplete information										
Limited accessibility of source of information										
Poor reliability										

28. What are the advantages of using information communication technology in accessing marketing information?

i. ……

ii. ……

iii. ……

iv. ……