DETERMINANTS OF ADOPTION OF EARLY MATURING MAIZE VARIETIES IN NZEGA DISTRICT, TABORA REGION

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

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ABSTRACT

Nzega is among the district located in semi-arid areas of Tanzania where drought is a limiting factor for agriculture. In the district farmers are advised to use early maturing maize varieties (EMMV). In contrary the adoption of EMMV in Nzega District is still low. Increase in use of EMMV is possible if factors which influence adoption are addressed. The present study aimed at identifying factors which influence adoption of EMMV. The main objective was to analyze challenges facing efforts to improve maize production through the promotion of adoption of EMMV. The specific objectives were to compare profitability of EMMV and the traditional maize varieties, to identify determinants of adoption of EMMV and to determine factors affecting the level of adoption of EMMV. A total of 150 maize farmers consisting of adopters and non-adopters of EMMV were involved. Multistage random sampling technique was used to select maize farmers from 10 villages. Data were collected through structured questionnaire. Gross margin was used to compare the profitability of EMMV and the traditional maize varieties. Cragg's double hurdle model was used in determining factors affecting adoption decision and the level of adoption. The results show that the gross margin for EMMV is higher than the traditional maize varieties. Results also show that extension services, education level of the household and size of the farm owned by the farmer were significant in affecting both the adoption decision and the level of adoption. Factors like family labour, family dependency ratio, number livestock units owned by the farmer and distance to the nearest market were significant in explaining adoption decision only. The present study concludes that low adoption of EMMV can be attributed to institutional and socio-economic factors. Therefore the Government should put more effort in improving extension services, markets and provision of input subsidies for maize farmers.

DECLARATION

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

_____ _____

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The above declaration is confirmed

_____ _____

Dr. Damas Philip Date
(Supervisor)

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This work is dedicated first to the ALMIGHTY GOD, secondly to my late Father Mr. Raphael Dunda, my lovely Mother Maria Mgoba who built the foundation for my education. May the soul of my Father rest in eternal peace. Amen.

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LIST OF ABBREVIATIONS

CBT	Consumer Behaviour Theory
CIMMYT	*Centro Internacional de Mejoramiento de Maíz y Trigo* [International Maize and Wheat Improvement Centre]
DAP	Di-Ammonium Phosphate
EMMV	Early Maturing Maize Varieties
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
GM	Gross Margin
IMV	Improved Maize Varieties
MSV	Maize Streak Virus
Mt	Metric tones
NMRP	National Maize Research Programme
OPV	Open Pollinated Varieties
QPM	Quality Protein Maize
REPOA	Research on Poverty Alleviation
SPSS	Statistical Package for Social Sciences
TMV	Tanzania Maize Variety
TOSCA	Tanzania Official Seed Certification Agency
TR	Total Revenue
TVC	Total Variable Cost
URT	United Republic of Tanzania
USDA	United States Department of Agriculture

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Maize is a cereal crop which is produced on nearly 100 million hectares in developing countries, with almost 70% of the total maize production in the developing world coming from lower and middle income countries (FAOSTAT, 2010). In the western countries maize production is highly mechanized while in many developing countries the crop is still grown by smallholder and medium scale farmers using traditional and low input cultivation techniques (Verheye, n.d).

In Sub-Saharan Africa maize is a staple food for more than 300 million people. According to FAOSTAT (2012) maize account for an average of one fifth of the total consumed calories per day and about 17 to 60% of the daily protein. In recent years, rainfall patterns have become erratic and unpredictable. Erratic rainfalls pose a big challenge for farmers growing maize because most of them practice rain-fed agriculture. On the other hand, high population growth demands for an increase in maize productivity in marginal and drought-prone areas. From year 2002 to 2012 population and maize demand increased by 30% and 44.6% respectively (NBS, 2012). Under this condition there is a need to promote varieties which can do well in drought prone areas like early maturing maize varieties.

1.1.1 Place of maize in the economy of Tanzania

In Tanzania, maize is the major staple food. The crop is grown in almost every region in Tanzania mainland. On land basis, it occupies more than 80% of the land planted to cereals and is grown by over 80% of the farming community as food

(Matata *et al*., 2011). Major maize producing regions are Iringa, Mbeya, Rukwa, Arusha, Kilimanjaro, Morogoro, Kigoma, Mwanza and Tabora (Lyimo *et al*., 2014). It is estimated that the annual per capita consumption of maize in Tanzania is 112.5kg. Maize contributes about 60% of dietary calories to Tanzanians (Manyong *et al*., 2009). Maize is not only a staple crop in surplus regions; it is also a cash crop (Ramadhani *et al.*, 2002). Most of the crop is produced by small scale farmers who are resource poor, with land holdings of about 1-3ha and such farmers accounts for about 85% of the total crop production (Temu *et al*., 2011). The other group of maize farmers is composed of public and private farmers with farm sizes of over 100 hectares and contributing about 5% of the total National maize production.

1.1.2 Challenges facing maize production

Despite its importance, the average maize yields for small-holder farmers is only about 1.2 metric tons per hectare compared to the estimated potential yield of 4- 5 metric tons per hectare (Aquino *et al*., 2001; Makurira *et al*., 2007; Bucheyeki, 2012). Poor yield is due to a range of factors, the major ones include the following;

i. Inadequate use of inputs such as fertilizer, improved maize seed and crop protection chemicals. The inputs are either not available or too expensive for the farmers to afford.

ii. Drought. This is a major threat to maize production in many parts of Tanzania because maize farmers practice rain-fed agriculture (Mbwaga and Masawe, 2002).

iii. Biotic stresses like insect pests e.g. army worms, cutworms stalk borers, *Sitophilus spp*, and large grain borer.

Table 1 shows trends of maize production in Tanzania from 2002 to 2012 and the demand required. Approximately all of the years there was maize deficit except for 2002, 2007 and 2011. The deficit was covered through importation of maize. Table 1 also shows the amount of maize imported to cover the deficit in each year.

Table 1: Maize production trends and consumption required in Tanzania from 2002- 2012

Year	Area harvested (ha)	Production(Mt)	Demand (Mt)	Deficit/excess	Import (Mt)
2002	845 950	2 500	2450	-11	11
2003	1 718 200	2 700	2 735	-35	35
2004	3 462 540	2 320	2 396	-76	76
2005	3 173 070	3 230	3 271	-41	41
2006	3 109 590	3 300	3 463	-163	163
2007	2 570 150	3 373	3 344	29	0
2008	2 600 340	3 660	3 610	50	0
2009	2 578 000	3 634	3 674	-40	40
2010	2 570 000	3 326	3 326	0	0
2011	2 765 000	3 600	3 580	20	0
2012	2 765 000	3 600	3 550	-5	5

Source: USDA (2011).

1.1.3 Efforts for improving maize production

The Government of Tanzania has demonstrated commitment to enhance maize production for several decades. Research has been going on under the National Maize Research Programme (NMRP) which started in 1974 to coordinate key aspects of maize research including varietal development and maize management research (Katinila, 1998). Improved maize cultivars have been stressed in strategic documents as an important means for achieving reductions in hunger and poverty (REPOA, 1994; Vision, 2025). However, despite considerable efforts by several programs and organizations, the adoption of improved agriculture technologies is low. For instance while from 1950's to 2011, about 100 maize varieties have been released in Tanzania, but farmers plant only 6- 12% of the improved varieties (Mafuru *et al.,* 1999). Majority of farmers still grow landraces and OPVs with low production potential (Mafuru *et al.,* 1999). The reasons

behind such low usage of improved maize varieties are difficulties in accessing improved seed, unavailability of seed and high cost of key inputs like fertilizer (Mbwaga and Masawe, 2002).

Table 2 shows the rate of use of improved maize varieties for three seasons from 2007 to 2010. The Table shows that in the year 2010 only 26% of the area was planted with improved maize varieties.

Table 2: Percentage of the area planted with improved maize varieties

Year	Area (Ha)	Production(Tones)	Area with IMV	% of area with IMV
2007/08	2 570 000	3 373 000	523 850	20.4
2008/09	3 168 000	5 446 000	826 250	26.1
2009/10	3 700 000	4 475 410	985125	26.6

Source: Ministry of Agriculture Food Security and Cooperative (2011).

Moreover, Table 2 shows that the proportion of area planted with improved maize varieties is very low. Only about 26% of the total area was planted with improved maize varieties by the year 2010. The use of traditional varieties leads to low production. Therefore in order to increase production and meet the prevailing demand there is a need to promote adoption of modern or improved agricultural technologies. These new technologies are central to agricultural growth and poverty reduction efforts. Other strategies which can be done so as to increase production through adopting improved maize varieties are increasing access to key inputs like fertilizer and assurance of produce market.

1.1.4 Efforts to increase adoption of improved agriculture technologies in different parts of the world

1.1.4.1 Promotion of adoption of improved agriculture technologies

The adoption of new technology plays a fundamental role in the development process. In order to increase adoption of new technology different strategies needs to be undertaken. One of these strategies is promotion of the introduced technology. Promotion can be done through field trials and demonstration plots. Promotion can enable farmers to see the benefit from the introduced technology. After promotion then evaluation must be done in order to see whether the technology has been adopted by the target group. Adoption of improved varieties is important because it helps farmers to have enough food and reduce poverty. For instance, a study in Mexico showed that adoption of improved maize varieties improves household welfare (Becerril and Abdulai, 2010). Similarly, in sub-Saharan Africa, adoption of improved maize varieties was indicated to have positive outcomes in poverty reduction (Alene *et al*., 2009).

1.1.4.2 Access to key inputs like fertilizer

Access to key inputs is another important strategy in promoting and increasing adoption of the newly introduced technology. Access to key inputs like fertilizer can be increased through input subsidy programmes. Improved maize varieties need more fertilizer and pesticides for their growth. But empirical studies from Mwakalobo and Kashuliza (1999) show that the depreciation of currency rises price of inputs like seed, fertilizer, herbicides, and pesticides. Also URT (2008) reported that the price of Di-Ammonium Phosphate (DAP) fertilizer rose more than 300%. High price of key inputs is among the reasons for low rate of input use especially to most of small-holder farmers with low income.

1.1.4.3 Assurance of produce market

Market assurance is among the key determinants for adoption of improved maize varieties. Literature shows that market for staple crops like maize is fairly informal and underdeveloped. A study done by Temu *et al.* (2011), found that 65% of Tanzanian farmers sell their produce in front of their houses, or at the farm gate. The main reason for selling in front of their houses is unavailability of formal markets and poor transport infrastructure.

Generally, in order to increase use of improved varieties, there is a need to understand factors which could affect adoption of technology (Gregory and Sewando, 2013). Understanding those factors could provide ways in scaling up the use of improved maize varieties so as to increase production.

The present study aims at finding the reasons for low rate of adoption of early maturing maize varieties in Tabora, specifically in Nzega District, which were introduced in 1999/20 as a mechanism of drought escape so as to come up with recommendations on what could be done to increase adoption of early maturing maize varieties and hence yield among smallholder maize producers in the study district.

1.2 Problem Statement and Justification

1.2.1 Problem statement

Although Tanzania has committed resources to agriculture research and extension, the ensuing technologies has not significantly been adopted by farmers who continuous to use traditional agriculture techniques (Mafuru *et al*., 1999). For example, in Nzega District Bucheyeki (2012), in his study on characterization and genetic analysis of maize germ plasm for resistance to northern corn leaf blight disease in Tanzania found that only

35% of the farmers used improved maize varieties. Majority of the farmers grow traditional varieties with low production potential. According to Makurira *et al.* (2007), maize yield under farmer's conditions in Nzega District is 1.69 t/ha which is far from the potential yield of 4-5 t/ ha. Increase in maize yield could be achieved by many approaches, one of the major factor is increase in use of the improved maize varieties (Lyimo *et al.*, 2014). Average maize yield of the improved maize varieties is greater than the traditional varieties. For example Kito St has a yield potential of 6.3 t/ha, Kilima ST yield 7.5 t/ha and TMV1 yield 6.3 t/ha (Moshi 1997: Kirway *et al*., 2000 and TOSCA, 2001).

Study by Makurira shows that yield in Nzega District is only 1.69 t/ha, which is far from the potential yield of improved varieties. Poor yield is mostly caused by the low use of improved maize varieties. Adoption of early maturing maize varieties is important especially in marginal areas like Nzega, because it helps to increase production and hence poverty reduction. Adoption could be increased if stakeholders involved will understand reasons for such low adoption. So research on factors affecting adoption of early maturing maize varieties in Nzega District is an important because it will enable stakeholder to devise measures for scaling up adoption of the improved maize varieties.

Different efforts for increasing adoption in the area have been undertaken. For example the government of Tanzania through Tumbi Research Institute in Tabora conducted different promotional activities like field days and field demonstrations since the introduction of early maturing maize varieties in 1999. However, with all these efforts the adoption of early maturing maize varieties is still very low. The adoption rate is only 35% (Bucheyeki, 2012). Furthermore there is little or no empirical information which can establish the factors behind such low adoption rate of early maturing maize varieties

in the District. Therefore, there was a need to conduct this research to identify factors affecting adoption of the introduced maize varieties.

1.2.2 Justification of the study

Increase in maize production could be achieved if farmers will adopt improved maize varieties. Increase in adoption of IMV could be achieved if factors which may affect adoption of that technology are identified and explained. The current study aims at determining factors influencing farmer's adoption decision and intensity of use of early maturing maize varieties. The study is useful in explaining reasons behind the low adoption of early maturing maize varieties. Findings will facilitate the designing of strategies for scaling up adoption of this technology. Technology adoption will increase production, ensure food security, and increase rural income and ultimately poverty reduction.

1.3 Objectives of the Study

1.3.1 Overall objective

The overall objective of the present study is to analyse challenges facing efforts to improve maize production through the promotion of adoption of early maturing maize varieties.

1.3.2 Specific objectives

i. To compare profitability of early maturing maize varieties and local varieties.
ii. To identify determinants of adoption of early maturing maize varieties in Nzega District.
iii. To determine factors affecting the level of adoption of early maturing maize varieties in Nzega District.

1.4 Research Question

i. What are the costs and benefit associated with the use early maturing maize varieties in Nzega District?

ii. What are the factors affecting adoption of early maturing maize varieties in Nzega District?

iii. What are the factors affecting levels of adoption of early maturing maize varieties in Nzega District?

1.5 Hypothesis

The profitability of early maturing maize varieties is the same as for the traditional varieties.

1.6 Organization of the Dissertation

This dissertation is organized into five chapters. The first chapter presents the background information of the study; problem statement; objectives of the study; research questions and hypothesis. The second chapter reviews literature on maize production in the study area, concept of adoption, theoretical framework of adoption, studies on factors affecting adoption and a review on maize research in Tanzania. The third chapter presents the methodology used in the study, it describes the study area, the research design used, the methodology used in sample selection and data collection and the approach used in data analysis. Chapter four present results of the study and the discussion. Chapter five presents the conclusions and recommendations emanating from the major findings of the present study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Maize Production in Nzega

Nzega is one of the seven districts of Tabora Region. Agriculture is the main economic activities in the District (Brooks *et al*., 2012). Principle food crops grown in the district are maize, sorghum, rice, cassava, sweet potatoes and pulses. Maize is the major staple food crop. It is ranked as the most important crop in the area followed by cassava, beans and groundnuts (Bucheyeki, 2012). Maize production in Nzega is affected by factors such as drought which cause low production. According to Makurira *et al.* (2007), under farmers condition maize yield in the area is only 1.69t/ha while the National potential yield is 4-5t/ha. The major reasons for low production in Nzega District is low annual rainfall received, poor soil fertility and low use of improved maize varieties. According to the region social-economic profile Nzega receive about 650mm and 850mm of rainfall per year and is covered by sandy loam soil.

2.2 Challenges Facing Maize Production in Nzega

Maize production in Nzega District is affected by many factors including low soil fertility, soil acidity and low rainfall. A large proportion of soils in Nzega is sandy loams (Nyadzi *et al*., 2003a). Other factors which affect maize production in Nzega are insect pests like army worms, cutworms, stalk borers, *Sitophilus spp* and large grain borer. The common diseases that affect maize production in the District include fusarium and gibberella stalk and cob rots, leaf rust, Maize Streak Virus disease (MSV) (CIMMYT, 2004).

2.3 Theoretical literature review

2.3.1 Concept of Adoption

Adoption is conventionally conceptualized to be the mental process through which an individual passes from first learning about an agricultural innovation to final adoption (Mutandwa *et al.*, 2007). Also Rogers (2003) define adoption as the decision of full use of an innovation as the best course of action is available. Adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making is the process through which an individual passes from first knowledge of an innovation, to forming an attitude toward an innovation, to a decision to adopt or reject it (Ray, 2001).

According to Doss (2006), adoption is a process where farmers start using a component or more of a technology and continued using it. Feder *et al.* (1985) in his study define adoption as the degree to which a new technology is used in long-run equilibrium when farmers have complete information about the technology and it's potential. Adoption at the farm level describes the realization of farmers' decision to apply a new technology in the production process. When a new technology is introduced, some farmers will experiment it before adopting.

The present study adopted the definition by Roggers (2003) whereby a farmer may adopt a certain technology after realizing the potential benefit accrued. This means adoption is a gradual process; it needs time for farmers to make decision to apply a new technology in the production process. In measuring adoption time of introducing that technology must be taken into account.

2.3.2 Theoretical framework of adoption

There are several theoretical frameworks one can draw upon to study the adoption process. These include; Theory of Reasoned Action, Consumer Behaviour Theory, Diffusion Theory, Bounded Rationality and the Theory of Extension **(**Botha and Atkins, 2005).

2.3.2.1 Theory of reasoned action

According to Southey (2011) the theory of reasoned action provides a model that has potential benefits for predicting the intention to perform a behaviour based on an individual's attitude and normative beliefs. Individual attitude and belief are the building blocks of this theory, which means a person will opt to adopt a certain technology basing on the norms and beliefs of his/her culture (Jackson *et al*., 2006). Attitudes result from an individual's beliefs about the consequences of a particular behaviour and the evaluation of those beliefs. The more an individual expects that a particular behaviour has good consequences for themselves, the more that individual will have a positive attitude towards that behaviour. Similarly, the more that an individual expects behaviour to have undesirable consequences for themselves, the more that they will have a negative attitude towards it. Peoples' attitudes influence their behaviour through the formation of intentions to behave in certain ways. A similar process exists with subjective norms (Parminter and Wilson, 2003). A positive consequence which will be brought by early maturing maize will cause positive attitude towards adoption and a negative consequences will bring negative attitude towards adoption of early maturing maize varieties. For the technology to be accepted by the farmer it must conform to their norms and belief. This model can be drawn as follows;

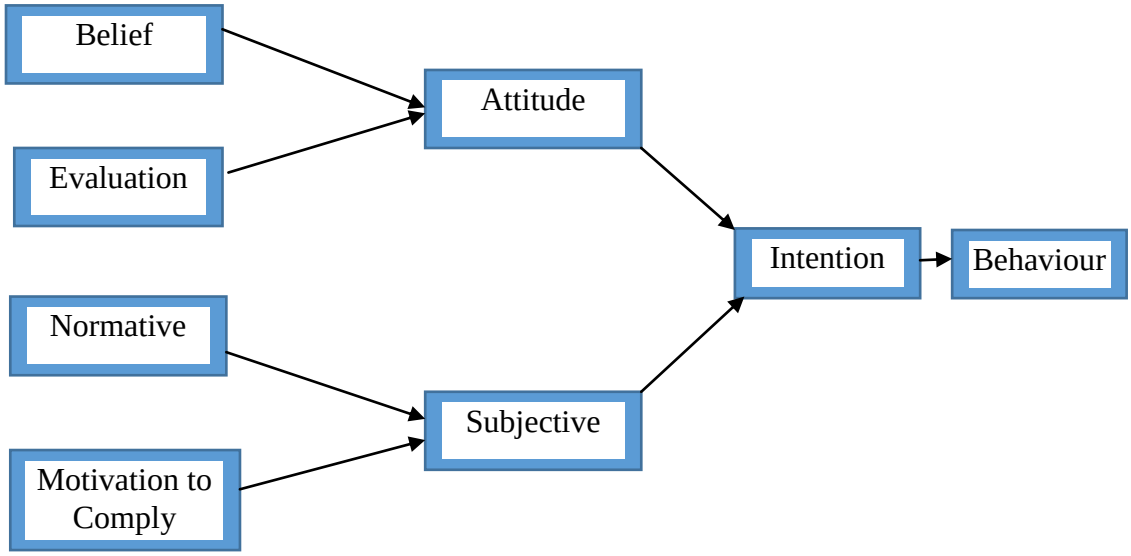

Figure 1: Model for the theory of reasoned action

Source: Southey (2011)

Belief is the fundamental building blocks of the model. The totality of the person's belief serves as the informational base that ultimately determines his attitude, and intentions (Fishbein and Ajzen, 1975).

2.3.2.2 Consumer's behaviour theory

According to Kaine (2004), Consumer Behaviour Theory (CBT) takes the needs of producers and uses this as a starting point for evaluating the advantages and disadvantages of an innovation. CBT assumes that a prospective adopter actively searches for information and devotes a great deal of time and energy in making decisions. The consumer will attempt to allocate his/her limited money income among available goods and services so as to maximize his/her utility (satisfaction). There are two approaches to the consumer behaviour theory; these are Cardinal Approach and Ordinal Approach (Bray, 2011).

(a) Cardinal approach

In Cardinal Approach given two goods X and Y and according to this research X and Y stand for traditional and early maturing maize varieties respectively.

$U_X = f(X)$, $U_Y = f(Y$…….……...……...…….(1)

Utility is maximized when:

$MU_X / MU_Y = P_X / P_Y$ Where U_x = Utility of X (traditional maize varieties)

U_y= Utility of Y (Early maturing maize varieties)

MU_x = Marginal utility of traditional maize varieties

MU_y= Marginal utility of early maturing maize varieties

P_x= Price of traditional maize varieties

P_y = Price of early maturing maize varieties

Farmers will adopt a new technology if its utility exceeds the utility of the traditional technology (Batz *et al*., 1999).

(b) Ordinal approach to the theory of consumer behaviour

The ordinalists argue that amounts of utility are naturally non-measurable technically, conceptually as well as practically. They consider that the basic principles of consumer's behaviour could be described without the notion of quantifiable utility. As per the idea of ordinal utility, the utilities resulting from the usage of goods can never be measured. Economists following the lead of Hicks, Slutsky and Pareto believe that utility is measurable in an ordinal sense-the utility derived from consuming a good, such as X, is a function of the quantities of X and Y consumed by a consumer. Utility measured by the consumer is the function of two goods *i.e.* early maturing maize varieties and the traditional varieties.

$U = f(X, Y)$ …….……..……(2)

In the present study the theory of consumers' behaviour is looked into the cardinal approach because in this approach a farmer will compare the marginal utility between the early maturing maize varieties and the traditional varieties. Farmers will opt for early maturing maize varieties if its marginal utility exceeds that of the traditional maize varieties.

2.3.2.3 Diffusion of innovation theory

Diffusion is a process in which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication in that the message(s) concerned with new ideas is communicated within a member of a socio system. Innovation is defined as an idea, practice, or object perceived as new (Robison, 2009).

Rogers (1995) points out that diffusion is not a single, all-encompassing theory, rather it is several theoretical perspectives that relate to the overall concept of diffusion; it is a meta theory (Yates, 2001). There are four factors that influence adoption of an innovation including:

i. The innovation itself, in the present study the innovation is the new varieties introduced (early maturing maize varieties).
ii. The communication channels used to spread information about the innovation. This refers to the extension agent who distributes the information concerning the innovation.
iii. Time- Time is needed for the innovation to be adopted; adoption is a gradual process which starts with low rate of adoption and then it may increase or decrease depending on the prevailing circumstances.

iv. The nature of the society to whom it is introduced. This refers to the socio-economic characteristics of the farmers in the study area.

Rogers (1995) explains that there are four major theories that deal with the diffusion of innovations. These are as described in the following sections;

(a) Innovation decision process theory

This is based on time and five distinct stages (Nutley *et al.*, 2002; Robinson, 2009):

i. Knowledge of the potential adopters- potential adopters who are the maize farmers need to have knowledge about the innovation (early maturing maize varieties).
ii. Merits of the innovation itself- adopters must know the relative advantage(s) of the new innovation to the existing one. Early maturing maize varieties must have advantage over the traditional varieties.
iii. The decision to adopt the innovation.
iv. The implementation of the innovation
v. Is the confirmation that their decision to adopt was the appropriate decision.

(b) Individual innovativeness theory

According to Nutley *et al.* (2002) individual innovativeness theory is based on who adopts the innovation and when. A bell shaped curve is often used to illustrate the percentage of individuals that adopt an innovation. Even though there are determinants of adoption at the individual level, but also there are a variety of external or social conditions that may accelerate or slow the diffusion process such as:

i. Whether the decision is made collectively, by individuals, or by a central authority.

ii. The communication channels used to acquire information about an innovation, whether mass media or interpersonal.

iii. The nature of the social system in which the potential adopters are embedded, its norms, and the degree of interconnectedness.

(c) Rate of adoption theory

The theory holds that adoption of an innovation grows slowly and gradually in the beginning, it will then have a period of rapid growth that will taper off and become stable and eventually decline (Rogers, 1995).

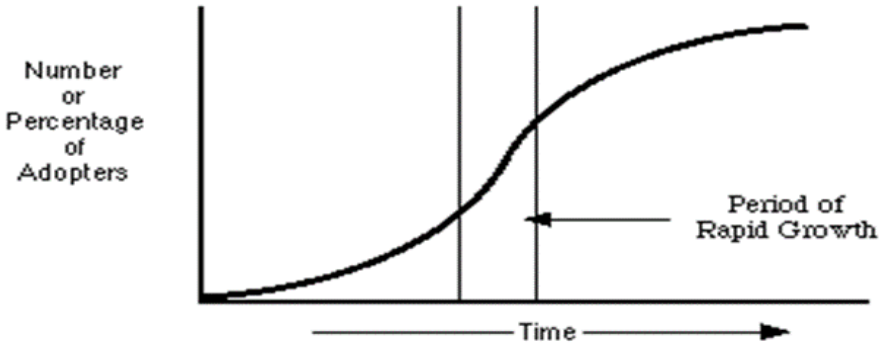

Figure 2: S-curve representing rate of adoption of an innovation over time

Adopters in a social system do not adopt a new product at the same time. Adopters can be classified into several categories, depending on when they adopt the product. Rogers (2003) classified adopters into five categories namely innovators, early adopters, early majority, late majority, and laggards.

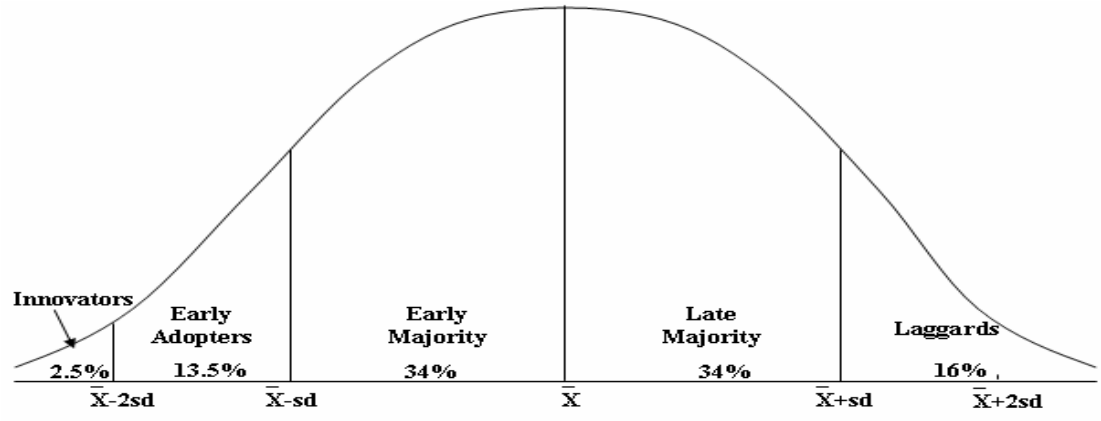

Figure 3: Adopter categorization on the basis of innovativeness

Source: Rogers (2003).

(d) Theory of perceived attributes

According to Nutley *et al*. (2002) the theory of perceived attributes is based on the notion that individuals will adopt an innovation if they perceive that the innovation has the following attributes;

i. Relative advantage over an existing innovation or the status quo
ii. The innovation must be compatible with existing values and practices
iii. It should not be too complex
iv. The innovation must have trial ability, this means the innovation can be tested for a limited time without adoption and
v. The last one is the innovation must offer observable results.

2.3.2.4 Extension theory

According to Botha and Atkins (2005), farmers would eventually see the benefit of new innovations (early maturing maize varieties) and thus adopt. Therefore, views and measures of the success of an innovation introduced are based on the level at which an innovation has been adopted. A further assumption is that increased adoption rates would occur if information about the innovation is communicated through farmers 'social

networks. That means farmers awareness of the early maturing maize varieties will be induced by extension services. Extension basically it is the process of changing voluntary behaviour via communication. The goal of extension is to determine how to convey information regarding a new innovation to a certain population (such as farmers) so that they will adopt it (Rolling, 1988).

2.3.2.5 Bounded rationality theory

According to Simon (1978), bounded rationality is the notion that in decision making, rationality of individuals is limited by the information they have, the cognitive limitations of their minds, and the finite amount of time they have to make decisions. Simon challenged the classical economic theory that economic behaviour was essentially rational behaviour in which decisions were made on the basis of all available information with a view to securing the optimum result possible for each decision maker. Instead, he contended that in today's complex world individuals cannot possibly process or even obtain all the information they need to make fully rational decisions. Rather, they try to make decisions that are good enough and that represent reasonable or acceptable outcomes. That means farmers will opt whether to adopt or reject the adoption of early maturing maize varieties basing on the information they have about those varieties and the time from which those varieties were introduced.

2.4 Empirical Literature

2.4.2 Factors Affecting Adoption

Technology adoption is associated with many factors. Pattanayak *et al*. (2003) and Doss (2003), classify factors affecting adoption into four groups. These factors are farmers' socio-demography characteristics, institutional factors, farmers' perception of the characteristics of technologies, and socio-economic attributes.

2.4.2.1 Farmers Socio demography characteristics

According to Doss *et al.* (2003), farmers' socio-demographic characteristics include household heads' gender, age, education and household size. Various studies have been conducted and explain the influence of these socio-demographic factors in adoption of agriculture technologies.

(a) Age of the household head

Household head' age has been explained differently by different researchers. Some researchers find that age positively influence adoption by saying that old farmers adopt the technology because they have accumulated capital or have greater access to credit, due to their age (Bekele and Drake, 2003; Etoundi and Dia 2008). While other studies explain that age is one of the hindrance to technology adoption by saying that age of the farmer erode confidence in adoption of a new technology, or aged farmer are more risk averse to new technologies than younger farmers (Zavale *et al*., 2005; Simtowe *et al*., 2007; Langyintuo and Mekuria, 2008; Cavane and Subed, 2009). Also a study done by Atibioke *et al*. (2012) found that age of the household head has a negative influence towards technology adoption. This imply that younger farmers are more risk takers than older farmers.

(b) Education of the household head

Education of the household head has a positive influence on adoption of new technology. The reason behind is that more educated household head are expected to be more efficient to understand and obtain new technologies in a shorter period of time than uneducated people. Also education level is assumed to increase farmer's ability to obtain, process and use the information relevant to adoption (Kafle, 2010).

(c) Gender of the household head

Few studies report that the rate of technology adoption is higher among male-headed households, compared to female-headed households because of discrimination i.e. women have less access to external inputs, services, and information due to socio-cultural values (Lopes, 2010). For male-headed households adoption is positively influenced because men in most societies are the ones who control productive resources such as land, labour and capital which are critical for the adoption of new technology (Abunga *et al.*, 2012) In contrast, female-headed households have a negative influence no technology adoption due to poor access of resources which are used in production.

(d) Household labour

The number of family members who provide labour has a positive influence to technology adoption. According to Feder *et al*. (1985), technology adoption requires more labour inputs and if this requirement is fulfilled by family members then adoption is positively influenced. A study done in Ethiopia which aimed at finding determinants of adoption through using Probit and Tobit models shows that family labour was an important factor in adoption of the use of fertilizer on maize (Fufa, 2006).

2.4.2.2 Institutional factors

(a) Access to credit

Technology adoption is accompanied with the use of inputs like fertilizer, pesticides and other associated inputs. If the farmer will have an access to credit this will enable him/her to have access to various inputs, hence access to credit has a positive influence towards technology adoption. Salasya *et al*. (2007); Mugisha and Diiro (2010) in their studies on factors influencing adoption found that access to credit relax income constraints of famers hence enable them to have access to key inputs as well as in hiring of labour.

(b) Access to extension services

Access to extension services has a positive influence on technology adoption because extension agents helps in creating awareness about the technology and its potential. Extension services play important role in the implementation and diffusion of innovation. Extension agent acts as a personal for change and as a communication media who build the gap between farmers and the innovation (Tura *et al*., 2010; Mignouna *et al*., 2011; Akpan *et al*., 2012).

2.4.2.3 Farmer's perception of the technology

Farmer perceptions of technologies may provide a better understanding of technology adoption since farmers deal with the technologies and probably perceive technologies differently from researchers and extension agents. Sinja *et al*. (2004) found that when investigating adoption of new agricultural technologies, it is important to analyze farmer's perceptions of technology and its characteristics. Also Kafle (2010) found that Farmer's perception on an innovation largely depends upon their knowledge and information about the innovation and socio-economic condition. Adoption depends on users' judgments of the value of the technology to them, and judgment factors like utility and efficiency of the technology. Preference of a certain technology depends upon farmers' evaluation on yield and total benefit accrued within a year.

2.4.2.4 Socio-economic factors

These attributes include farm size, income of the household head, ownership of asset and livestock. These attributes influence adoption both positively and negatively. For example, studies done by Langyintuo and Mekuria (2008); Tura *et al*. (2010); and Simtowe *et al*. (2007) found that land holding size returned a positive and significant result in influencing adoption of new technology. Households with larger land holdings

allocated more land to improved maize varieties. A study done by Kalinda *et al.* (2014) shows that farm size is often one of the first factors measured when modeling adoption processes. Farm size does not always have the same effect on adoption; rather the literature finds that the effects of farm size vary depending on the type of technology being introduced, and the institutional setting of the local community. Fixed costs are often a primary barrier to adoption. Spreading fixed costs over a larger farm may be one explanation for the observed positive association between farm size and propensity to adopt.

Amaza *et al*. (2007) in his research found that livestock keeping, ownership of asset and income positively influence adoption of the technology. The reason behind is that livestock provide cash as well as fertilizer, asset provide income and the income provide cash which can be used in buying input as well as for hiring labour.

Many studies have concentrated on finding factors affecting adoption of new technologies, but did not look on the factors which affect the level or strength of adoption of new agriculture technologies except studies done by Akpan *et al.* (2012),Gregory and Sewando (2013), Mignouna *et al.* (2011). Understand factors affecting level of adoption is important because level of adoption of each individual farmers hence a great impact in production and farmers development. The present study will add into the body of knowledge by explaining factors which affect adoption decisions and level of adoption. The study is useful because by knowing factors affecting adoption decisions as well as the level/strength of adoption stakeholders involved will be in a better position to design strategies for scaling up the adoption of early maturing maize varieties and hence increase maize production.

2.5 Maize Research in Tanzania

Research and extension efforts in Tanzania started in 1960. In this year breeding programs released Ukiriguru Composite A (UCA) and Ilonga Composite White (ICW). Tanzania initiated a maize project in 1974 with assistance of the U.S Agency for International Development (USAID). Objectives of the project were to promote maize production in pursuit of food self-sufficiency. The maize research program started with the objectives of developing cultivars suitable for major maize producing areas (Nkonya *et al*., 1998). Twenty four varieties were released between 1974-2000. These varieties were; ICW; UCA; KITO ST; KATUMAI ST; KILIMA ST; STAHA ST; TMV1-1, TMV-2, UAC ST; CHI; CG4141; CG4142; C6222; PAN695; PAN6549; PAN6195; PHB3253; KITO; KILIMA; TUXPENO; H6302; H614; and , H51, out of which NMRP released fifteen varieties (hybrids and Open Pollinated Varieties(Nkonya *et al*., 1998). These varieties are recommended according to the agro-ecological zones. Table 3 shows type of varieties released, potential yield and the agro-ecological zones.

Table 3: Maize varieties released by the maize research programme in Tanzania from 1974 to 2000, characteristics and the recommended agro-ecological zone

Variety	Year released	Characteristics	Yieldpotential (ton/ha)	Targetzone/Agro-ecological zone
Tuxpeno	1976	Open pollinated, white dent, good Standability	5.5	Low altitude (0-900 masl)
H 614	1977	Top cross hybrid, white dents, large cars	10.0	Over 1500 masl
H 6302	1977	Three-may; Cross hybrid, white flint, and good standability	11.0	Over 1500 masl
H614	1979	Top cross hybrid, white dent, good Standability	11.5	Over 1500 masl
Staha	1983	Open pollinated, white flint/dent streak Tolerant	6.5	Low altitude
Kilima	1983	Open pollinated, white flint/dent good Standability	7.5	Medium and high altitude
Kito	1983	Open pollinated, white flint early maturity	6.0	Low altitude 0-900 masl
TMV-1	1987	Open pollinated, white flint, medium maturity, streak resistant	6.3	Low and medium altitude
TMV-2	1987	Open pollinated, white flint, large ears	9.0	Medium and high altitude
CH-1	1992	Single cross hybrid, white flint.	6.8	Low and medium and altitude
CH-3	1992	Three - way cross hybrid white flint	6.9	Low and medium altitude
Kilima-ST	1994	Open pollinated white flint/dent, good standability, and streak tolerant.	7.5	Medium and high altitude
UCA-ST	1994	Open pollinated white flint, streak tolerant	7.5	Medium altitude
Kito-ST	1994	Open pollinated, white flint, early maturity, streak tolerant	6.3	Low and medium altitude
KatumaniST	1994	Open pollinated white dent early maturity, streak tolerant	4.3	Low altitude

Sources (Nkonya *et al.*, 1998)

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Location of the Study Area

The present study covers the district of Nzega in Tabora Region. Tabora Region is found between latitude 4^0 and 7^0 south of Equator and longitude 31^0 to 34^0. The region is located in central western Tanzania bordering Shinyanga Region to the north and Singida to the east. To the west is Kigoma Region and southern border is shared with Mbeya and Rukwa region. The region has an area of 76141sq.kms. According to the region socio-economic profile, Tabora Region is divided into seven districts which are Nzega, Igunga, Uyui, Tabora Municipal, Urambo, Sikonge and Kaliua.

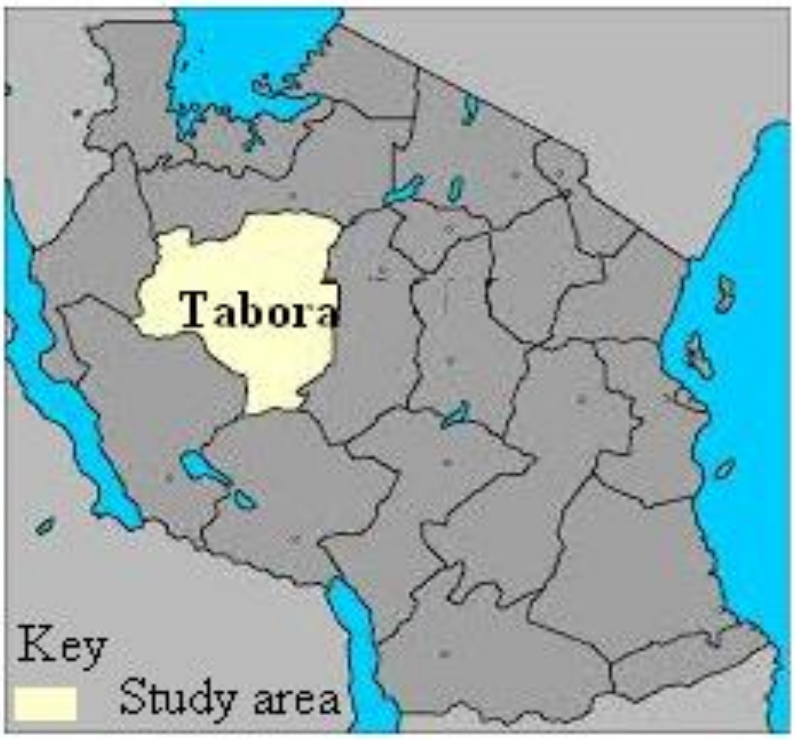

Figure 4: Map of Tanzania showing the location of Tabora Region

Source: URT (2013).

3.2 The Study District

3.2.1 Location

Nzega is one of the seven districts of Tabora Region. It is located in the Northern part of the region. Its coordinates are 4°19'60" N and 33°4'60" E in DMS (Degrees Minutes Seconds) (Region socio-economic profile, 2005). The District covers an area of 7864.2 square kilometers and with a population of about 502 252 (URT, 2012). It is bordered by Igunga District in the East, Uyui District in the South, Kahama District in West and Shinyanga rural District in the North. The district is divided into 4 division, 37 wards and 134 villages.

3.2.2 Climatic conditions and topography

According to the region socio-economic profile, Nzega District is located within central eastern zone and northeastern zone where rainfall is low at about 750mm to 850mm per year for the central eastern zone, and 650mm to 750mm on the northeastern zone. Alluvial soil and sandy loam exists in the large part of the district.

3.2.3 Economic activities

The major economic activities in the district are agriculture and livestock. Food crops grown include maize, paddy, cassava, sweet potatoes, sorghum and pulses. Cash crops grown include groundnuts, cotton and tobacco. Livestock kept include indigenous cattle improved cattle, goats, sheep and pigs (Majule *et al.*, 2013).

Figure 5: Map of Tabora region showing Nzega district.

Source URT (2013).

3.3 Justification of Selecting Nzega District

The district has been chosen because it is among the district located in semi- arid areas of Tanzania where drought and poor soil are limiting factors for agriculture development (De Pauw, 1984). A number of climate and environmental studies conducted in the area describe the area to be among the most vulnerable areas to climate change in Tanzania (Mongi *et al*., 2010; Kaijage, 2012; Muzo, 2012). Even though there is poor climatic condition for agriculture activities but in the district agriculture is the main economic sector which employs 80% of the economically active population. Principal food crops grown in the district are maize, sorghum, rice, cassava, sweet potatoes and pulses.

Maize has a high risk of failure in the district, as it requires higher rainfall and annual rainfall received per year is only between 650mm-850mm while traditional maize varieties require more than 1000mm of rainfall per year. Due to this the government of

Tanzania through Tumbi Research Institute in Tabora introduced early maturing maize varieties in the Nzega district. Early maturing maize varieties are those varieties which can take two and a half to three month to mature and are recommended to be grown in short rain zones. These varieties are like kilima St, Kito St, Situka and TMV1. They are recommended to be grown in low and middle altitude areas. Due to the climatic condition of the district farmers are advised to grow early maturing maize varieties but the adoption rate of those varieties is low. Bucheyeki *et al*. (2012) in his study found that the rate of adoption of improved varieties in Nzega District was 35%.

3.4 Research Design

Cross- section research design was used in the present study. In this design data were collected at a single point in time. According to IDRC (2003), this type of research design is used in descriptive research design and in determination of relationship of variables. This research design was used because of the limited time in field work and the fact that it was deemed to be adequate for addressing the study objectives.

3.5 Sample Size and Sampling Procedure

Determination of sample size was done by estimating proportions of the population. That is determining the proportions of the population using and not using early maturing maize varieties. Desired sample size is determined by the following formula put forward by Kothari (2

$$n= \frac{z^2.p.q.N}{(N-1)(e)^2+(z^2).p.q} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where;

n= sample size,

z = z score

p = proportion of the population, q = 1- p

e is the allowable error and

N is the population size.

Kothari (2004) recommends p to take the value of 0.5

q= 1-0.5 = 0.5,

N =1500 and

N -1= 1499,

z = 2.576 at 99% z score and

e = 10%.

Therefore

$$n = \frac{2.576^2 * 0.5 * 0.5 * 1500}{1499 * 0.1^2 + 2.576^2 * 0.5 * 0.5} = 149.46$$ Approximately 150 farmers.

A multistage random sampling procedure was used to get the total sample size of 150 maize growers comprising of adopters and non-adopters of early maturing maize varieties. First, six wards were selected from a total of 37 wards basing on the concentration of farmers who use and those who do not use early maturing maize varieties. Information on the area with high concentration of farmers who grow maize were obtained from the District Agricultural Office. One village was selected from each ward except at Isanzu, Utwigu and Ikindwa wards were three and two villages were purposively selected respectively basing on the concentration of maize growers and numbers of villages each ward has. From each village 15 maize growers were randomly selected.

3.6 Types of Data and Data Collection Methods

3.6.1 Types of data

Both primary and secondary data which involved farmers who grow maize, and specifically farmers who use early maturing maize varieties were used in study, primary data were collected from farmers through direct interview. Secondary data were obtained

from District Agricultural Office in Nzega, Tabora. Secondary data involve the potential yield of early maturing maize varieties.

3.6.2 Data collection methods

Structured questionnaire was designed for collecting primary data through direct interviewing. Main variables for which data were collected through direct interviewing were; demographic characteristics of the household head such as gender, age, education level and family size. Other variables were the institution factors like extension services, financial institutions which provide credit to farmers and market. Farmers were asked about cost used in maize production together with types of maize varieties used for the previous years. Another variable on which data were collected through interview was concerned with wealth in terms of livestock unit and farm size owned.

3.7 Data Processing and Analysis

Survey data were coded and summarized in Statistical Package for Social Science software version 16 (SPSS), before being transferred to STATA 11 software for analysis. Descriptive statistics such as mean and standard deviation were computed. Gross margin analysis was used in estimating benefit obtained from early maturing maize varieties as well as traditional maize varieties. Econometric analysis was done in finding factors affecting adoption and factors affecting level of adoption using Cragg's double hurdle model.

3.8 Conceptual Framework

A farmer makes his/her own choice to adopt or not to adopt a particular technology depending on various factors. The conceptual framework on which the present study is based focuses on the factors which may affect adoption of new technology such as socio-economic characteristics, perceptions, policy and technology features. Fig. 6 describes

the conceptual framework of adoption of early maturing maize varieties, the dependent variables are farmer's perception of early maturing maize varieties and decision to adopt those varieties and the independent variables are institutional factors, resource endowment and farmer characteristics. The Figure also shows that, farmer's perception of early maturing maize varieties and the farmers specific attributes are among the important determinants of adoption. The arrows in Fig. 6 represent a cause-effect relationship.

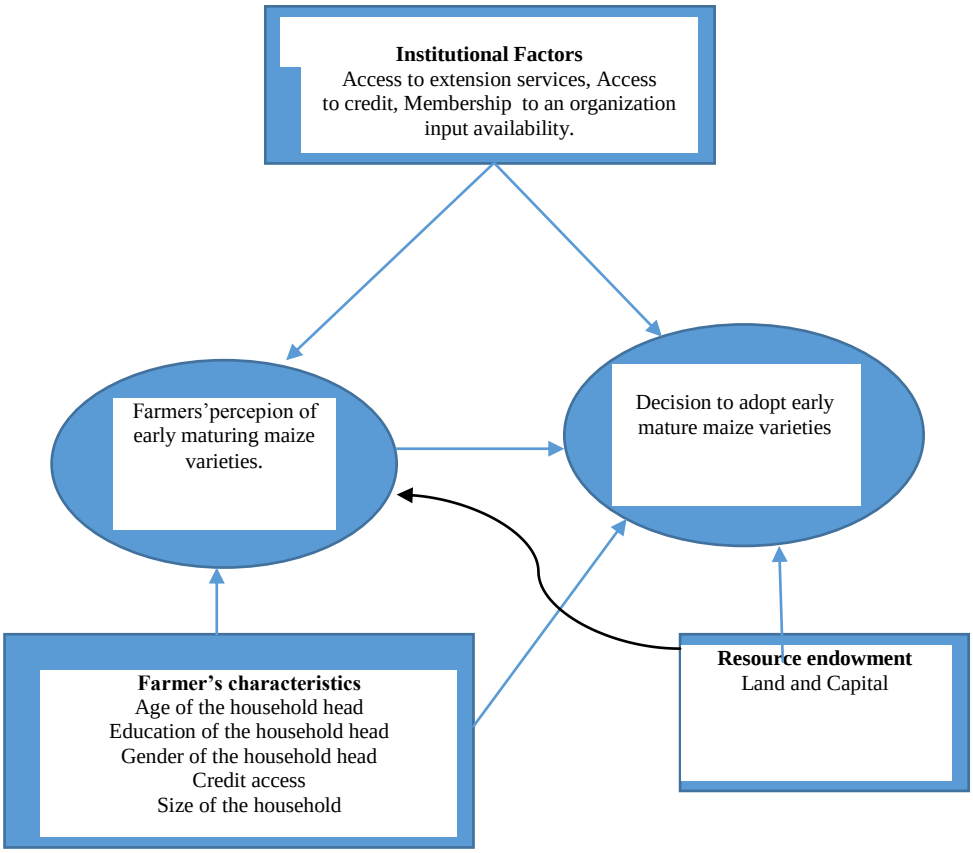

Figure 6: A framework for explaining adoption of early maturing maize varieties

Source: Modified from Wangare (2007).

3.9 Analytical Framework and Model Specification

Data analysis involved the use of gross margin, descriptive statistics and regression model. Descriptive analyses such as frequency distribution tables, percentage, mean, standard deviation were used to analyze the respondent's socio-economic characteristics.

In the regression, Gragg's Double Hurdle Model which consists of two stages has been used. The Probit model was used to determine the probability of adoption of early maturing maize varieties, the second stage of Gragg's model was a truncated regression which was used to determine factors affecting level of adoption, dprobit analysis was done in order to find the marginal effect for each independent variable.

3.9.1 Gross margin analysis

In estimating cost and benefit of the use of early maturing maize varieties gross margin were computed and compared between early maturing maize varieties and the traditional varieties. The method involved computation of average variable cost and average revenue for both early maturing maize varieties and the traditional varieties using the formular:

GM=TR-

TVC……(4)

Where:

TR= Total revenue obtained from using both early maturing maize varieties and traditional varieties.

TVC= Total variable cost for producing early maturing maize varieties and traditional varieties.

$TR=P_y y$

$TVC=\sum P_{xi} x_i$

$P_{y=}$ Price of output

P_x= Price of the i^{th} input (Tshs/Unit)

X_i=Quantity of i^{th} input (Unit/acre) used in producing Y.

3.9.2 Factors affecting adoption and level of adoption

The method used for finding factors affecting adoption and level of adoption in this study is Crag's double-hurdle model. This approach has been proposed by Martinez-Espineira (2006); Moffatt (2003). The method is most appropriate for this study because, according to Cragg (1971), a farmer faces two questions while deciding to adopt a certain technology. First is to decide whether to use the new technology and second is how much land to allocate to those improved varieties.

The most important underlying assumption under Cragg's double hurdle model is that the two decisions are made in two different stages but the first decision affect the second decision, in this case the error term are randomly distributed with mean 0 and standard deviation of δ^2.

$^{£}i \sim N(0,1)$ and $\mu_i \sim N(0, \delta^2)$ where;

£ is the error term from the decision equation

μ is the error term from the second question (The truncated equation)

The relation of the two error term can be written as follows;

$$P = \frac{\text{cov}(£_i \mu_i)}{\sqrt{\text{Var}(£i)\ \text{Var}(\mu i)}}$$

Smith, (2003) assumes that the error term from decision one and two are randomly distributed and independently, this gives us the following expression;

$$\begin{pmatrix} £_i \\ \mu_i \end{pmatrix} \quad N \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad \begin{pmatrix} 1 & 0 \\ 0 & \delta^2 \end{pmatrix}$$

Cragg's double-hurdle model, allows separate stochastic processes for the adoption decision and level of adoption. Also Cragg's double-hurdle model accommodates both non normality and heteroskedasticity of the error terms (Yen and Huang, 1996).

Other studies have employed different approach in finding factors affecting adoption decision. For instance Abunga *et al.* (2012) used logistic regression analysis in determining factors affecting adoption, also Amao and Awoyemi (n.d)conducted a study on factors affecting adoption of improved cassava by using a Tobit model. According to Wooldridge (2002), Tobit model is not appropriate for finding factors affecting adoption decision and the level of adoption. Tobit model assumes that both the decision to adopt and the level of adoption are determined by the same variables. That means decision and level are jointly determined and influenced by the same parameters. Moreover it restricts variables and coefficients in the two decision stages. Also Tobit is appropriate if the sample size is greater or equal to one thousand.

3.9.2.1 Model specification for factors affecting adoption

The first stage of Cragg's model is a probit model which is used to analyze determinants of adoption of early maturing maize varieties. This model can be written as;

yi =y* if y*>0…….…… (5)

yi =0 if y* ≤ 0…….…….(6)

$yi^* = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 . + ...\beta_n\chi_n$……..…….…. (7)

yi* is the dependent variable describing the farm's decision to adopt the technology, taking numeric value of 1 for adopters, and 0 for non-adopters, xi is a vector of variables explaining whether a farmer adopts early maturing maize varieties and vi is the error term. The hypothesized list of variables includes gender of the household head, age of the household head, education of the household head, farmer (years of formal schooling);

farmer's access to credit facilities available in the locality (dummy, 1=farmers have access, and 0 otherwise). Detailed model with hypothesized variables is as follows:

Adoption or $Y_i = \beta_{1AGE} + \beta_{2GEN} + \beta_{3EDU} + \beta_{4HHL} + \beta_{5HHDR} + \beta_{6LAND} + \beta_{7EXT} + \beta_{8CRED} + \beta_{9NL} + \beta 11FGR + \beta_{12INC} + \beta_{13DIM}$……(8)

Where;

AGE = Age group of the household head (Two groups Young +middle aged= 0, Elders= 1). Young and middle those aged <40 years, elder >40 years

GEN= Gender of the household head (1= Male, 0=female)

EDU= Education of the household head (1 if secondary school and above, 0 otherwise)

HHL= Family labour (Measured through using adult equivalent scale)

HHDR= Household dependency ratio

FARMSIZE = (1= if large scale farmer > 5ha, 0 otherwise)

EXT = Extension services (1=Yes, No=0)

CRED =Access to credit (1= yes, 0= otherwise)

NL =Number of livestock kept (Measured in Tropical livestock unit)

INC =Income from other crop (Tshs)

FGR = group or organization membership (1=yes, 0=no).

DIM =Distance to the nearest market (km)

Table 4: List of factors affecting adoption and level of adoption of early maturing maize varieties and the expected sign

Variable	Variable label	Expected sign	The theory and/ logic behind
X1=AGE	Ageof the household head	-	Aged farmer are more risk averse than younger farmers.
X2= GEN	Sexofthe household head (1= male, 0= female)	+ or -	Depending on culture male headed household and female headed household adopt technology differently. In culture where female have less access to resource adoption is negatively affected.
X3= EDU	Education level of thehousehold head	+	Educated farmer are expected to be more efficient in understanding a new technology in a shorter period of time than non-educated person.
X4= HHL	Labor availability within a house hold	+	Technology adoption require labor, labor availability within a household influence positive adoption of early maturing maize varieties.
X5=HHDR	Household dependency ratio	+	Dependency ratio has a positive influence towards adoption of the technology, big ratio means larger number of dependent within the household and this will enable the household to opt for high yielding varieties hence adoption.
X6=LAND	Size of the Land owned by the household	+	Land holding size positively influence adoption and level of adoption of early maturing maize varieties because adoption of technology needs resource like land, farmers with larger land are likely to adopt than those with small land.
X7=Extension contact	Extension agent visit to the farmer	+	Regular contact with extension makes the farmer aware of the new technology and how such technology can be applied in their farming.
X8= CRD	Credit access	+	Credit has a positively influence to technology adoption because it enable in buying the technology and its associate input
X9= NL	Number of livestock kept	+	Has a positive influence in technology adoption because it provide income
X10= INFOC	Income from other crop	+	Income has a positive influence because it facilitate in acquiring associate input used in technology implementation
X11=MARK	Distance to the market	+	Short distance to the nearest market has a positive influence because it enable farmer to sell the surplus obtained from production.
X12=GROUP	If the farmer belong to any group	+	Belongingness to farmers group increase social capital and allows exchange of new ideas between farmers, a farmer with social capital is more likely to adopt the technology than those without.

3.9.2.2 Factors affecting level of adoption

Second stage of Cragg's model was a truncated equation because it includes adopters only. This analysis was used to find factors affecting the level of adoption. The model in the second stage can be written as;

$yi^* = \beta\, xi + \varepsilon i$,……..(9)

$y^* = \beta_0+\beta_{1educ} +\beta_{2farmsize} +\beta_{3Ext} +\beta_{4Cred} +\beta_{5NL} +\beta_{6Inc} +\beta_{7Fgr} + £i$…….(10)

yi* is the variable describing the level of adoption. The level of adoption is measured by using the ratio of quantity of land under early maturing maize varieties to total farm land for maize, xi is a vector of variables explaining level of adoption, these variables are education of the household head, access to credit, availability of extension services, land size owned by a farmer, and membership to any group and εi is the error term. Equations 5 and 9 are assumed to be independent, and the error terms are randomly and independently distributed, vi ~ N (0,1) and εi ~ N (0, σ^2)) (Mignouna *et al.*, 2011).

3.9.2.3 Limitation of the model

Cragg's double hurdle model is built on the assumption of the normality of the error terms. If the normality assumption is violated then the maximum likelihood estimates of the model will be inconsistent (Aristei and Pieroni, 2008).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Social-economic Characteristics of the Respondent

4.1.1 Gender of the household head

The results from the present study show that most household heads in Nzega District were male. The male household heads accounted for 91% of the total number of households while female-headed household accounted for 9% of the households. Whether a household is male or female headed households has an impact in access to resources as well as in agriculture production. Also Tanellari (n.d.) in his study on Gender Impacts on Adoption of New Technologies: Evidence from Uganda found that there was high percentages of male headed households than female headed household.

4.1.2 Age of the household head

Table 5 shows that 6.7% of the farmers were below 30 years of age, 33% were aged between 30-40 years, 34.7% were aged between 40-50 years and those household above 50 years were 24.3%. The findings show that a significant proportion of the farmers were between 30 and 50 years. This indicate that the farmers were mainly middle aged who are in their economically active stage, this has an implication for productivity. Bluemling and Mosler (2010) in their study on adoption of agricultural water conservation practices in China found that most farmers were middle aged with year ranging from 30-50.

4.1.3 Education level of the household head

The results from Table 5 shows that 9.3%% of the household heads had no formal education, 62% had primary education, 28% of the household ‘head had secondary education while only 0.7% attained higher education. The findings show that high

proportion of the household's heads in Nzega District had primary level of education. Education is important in adoption because it enable farmers to understand and implement the technology easily. Also the results show that household's heads with education higher than primary were few because most of them have opted for other source of income rather than agriculture. Also Chirwa (2005) in his study on adoption of fertilizer and hybrid seeds by smallholder maize farmers in southern Malawi found that the level of education among maize farmers is low. The mean number of years of schooling was 3. This imply that majority of the farmers have low education.

4.1.4 Family labour

Findings in Table 5 show that a reasonable percentage (54.7%) of the farmers had 1 to 5 family members who can provide labour. Families with family labour of an average of 8 members were only 33.3% while those families with labour greater than 10 members were only 12%. Family labour has an implication in agriculture production as well as in adopting new technologies in agriculture because most of the new technologies are labour intensive.

4.1.5 Group belongingness

Group membership has an impact in adoption. In the present study the results show that 32.2% of the farmers were members of cooperative societies while 67.8% were not. Since majority were not members of cooperative societies, their access to farm resources like agro-inputs, credits and even extension contact might be low and this is likely to be among the reasons for low adoption of early maturing maize varieties.

4.1.6 Access to extension

The results in Table 5 show that 50.7% of the farmers had been visited by extension agents, while 49.3% were not visited by extension agents. This is not too good because visit or contact with extension provides opportunity for transfer of skills, knowledge and

information which facilitate adoption. For the adoption to be increased percentages of farmer with access to extension services should be higher because extension agent brings awareness of the new technologies and the benefit associated with those technologies.

Table 5: Socio-economic characteristics of the respondents

Variables	Frequency	Percentage
Gender of the household head's		
Male	137	91.3
Female	13	8.7
Total	**150**	**100**
Age of the household head		
<30 year	10	6.7
30-40	50	33.3
40-50	52	34.7
>50	38	25.3
Total	150	100.0
Education level of the household head's		
no formal education	14	9.3
Primary	93	62.0
Secondary	42	28.0
Diploma	1	0.7
Total	150	100.0
Household labour size		
1-5	82	54.7
6-10	50	33.3
>10	18	12.0
Total	150	100.0
Access to extension		
No	74	49.3
Yes	76	50.7
Total	150	100
Group membership		
No	101.7	67.8
Yes	48.3	32.2
Total	150	100

4.2 Gross Margin Analysis Results

Table 6 presents the gross margins per acre for early maturing maize varieties and for the traditional varieties grown in Nzega District. The results show that more fertilizer and pesticides are used for early maturing maize varieties than for the traditional maize varieties. The other different is on yield, early maturing maize varieties yield more than the traditional maize varieties.

Table 6: Gross margin result for early maturing maize varieties and traditional varieties for the year 2012/13

Type of seed	Traditional varieties	Early maturing varieties
Seed quantity/Acre	3.2	4.1
Seed price	4 650	13 791.7
Fertilizer cost	50 321.43	78 500.00
Pesticide cost	7 333.33	11 089.24
Land preparation cost	20 000	20 000
Cultivation cost	33 285.7	30 042.75
Sowing cost	11 166.67	11200.84
Weeding cost	20 333.33	40 333.33
Fertilizer application cost	20 854	25 646
Pesticides application cost	30 000	35 000
Harvesting &storage cost	20 000	27 500
Transport cost	18 000	22 000
Storage cost	11 625	15 000
Total cost	247 569.7	251603.7
Yield/Acre(kg)	944	1240
Price/kg	450	450
Revenue	424 800	558 000
Gm/acre (Tshs/acre)	177 230.3	306 396.3

The results from Table 6 show that the average yield for farmers using early maturing maize varieties was 1240 kg/acre while for those who use traditional maize varieties the average maize yield was only 944 kg/acre. Yield for early maturing maize varieties is only 1240 kg/acre which is equivalent to 3400 kg/ha. The yield is less than the maximum yield potential which is 6300 kg/ha. Low yield of early maturing maize varieties under farmer's conditions is because most farmers do not follow the recommended agronomic practices in terms of input usage and the management principles.

4.3 Descriptive Statistics on Factors Affecting Adoption of Early Maturing Maize Varieties

The descriptive statistics results show that 45.3% of farmers were adopters of early maturing maize varieties while 54.7% were non-adopters. Socio- economic factors used to explain adoption process were gender of the household head, age of the household head, education level. Another variable used to explain adoption were family labour, household dependency ratio, and livestock unit. Institutional support factors were also used to explain adoption; these include extension services and market access.

4.3.1 Gender of the household head

Table 7 shows the distribution of adopters basing on the gender of the household head. The Table shows that for male headed households about 95.6% were adopters while for female headed household only 8.3% were adopters of early maturing maize varieties. This shows that male headed household are more likely to adopt early maturing maize varieties than female headed. These results show that in Nzega District women have less access to assets like land which can be used in production. That is why for female headed household adoption of early maturing maize varieties is low. A study done by Doss (2001) in Ghana which was titled "How does gender affect the adoption of agricultural innovations", found that women headed households have a negative influence to technology adoption because women often have less access to credit and land.

4.3.2 Age of the household head

Table 7 shows that high percentages of adopters were young aged and middle aged household heads. About 96% of adopters were aged between 30-50 years. The results show that for elders, adopters were only 38%. This means that adoption is positively influenced by younger farmers. The major reason which could explain the negative influence of age is the fact that older farmers have a tendency to stick to their old production techniques and that they are usually unwilling to accept change. In addition young people are associated with a higher risk taking behaviuor than the elderly. Another study which found the negative influence of age to technology adoption is Simtowe and Zeller (2006) in the study titled "The Impact of Access to Credit on the Adoption of hybrid maize in Malawi"

4.3.3 Education level of the household head

Table7 show the influence of education on adoption of early maturing maize varieties. The results show that education has a positive influence towards adoption of early maturing maize varieties. The Table shows that 67.4% of adopters had secondary education and above, but only 36.4% of adopters were those household's head having primary school and below. This means that highly educated farmers are more likely to adopt improved technologies because education helps farmers to obtain and understand the technology more easily than non-educated farmers or farmers with less education. Also Uematsu and Mishra (2010) in the study titled Net Effect of Education on Technology Adoption by U.S. farmers found a positive effect of education towards technology adoption.

4.3.4 Family labour

The present study found that family labour influence adoption of early maturing maize varieties positively. This is because adoption of the technology needs labour and if this labour is provided by the household then it will have a positively influence to technology adoption. Table 7 shows that households with high family labour had an adoption of about 77.8%. Also Tura *et al*. (2010) in the study titled "Adoption and continued use of improved maize seeds which was done in Ethiopia found that family labour had a positive influence on technology adoption.

4.3.5 Household dependency ratio

Results show that household dependency ratio has a positive influence towards the adoption of early maturing maize varieties. Table 7 shows that 54% of adopters were found at the family with high dependency ratio of about 1.25 in average. Also Akpan *et al.* (2012) in his study titled "A Double-Hurdle Model of Fertilizer Adoption and

Optimum Use among Farmers in Southern Nigeria", found that increase in household dependency ratio increases adoption and optimum use of fertilizer. Higher ratio means that larger number of dependants within the household, and because of this the household head will opt for early maturing maize varieties which have high yielding ability in order to sustain the family requirement.

4.3.6 Income received from other crops

Table 7 shows that the amount of income received from other crops have a positive influence towards adoption of early maturing maize varieties. The reason behind is that income from other crops can be used in buying seeds and other key inputs like fertilizer and pesticides. Also Kassiea1 *et al.* (2012) in the study on Interdependence in Farmer Technology Adoption Decisions in Smallholder Systems found a positive influence of other crops income in adoption of the new maize varieties in Tanzania.

4.3.7 Livestock unit owned

Results in Table 7 show that the number of livestock unit owned has a positive influence towards adoption of early maturing maize varieties. This is because livestock provide manure which can be used as organic fertilizer which decrease input cost. Also ownership of livestock promotes adoption since it generates income to finance the inputs associated with the technology and reduces the risks that may arise from crop failure (Nega and Sanders, 2006). Moreover Table 7 shows that about 78% of adopters were those with more than 20 livestock units. The study done by Tura *et al.* (2010) which was titled "Adoption and continued use of improved maize seeds in Central Ethiopia", also found positive influence of livestock ownership in adoption.

4.3.8 Group affiliation/group membership

Results in Table 7 show that group membership influence adoption decisions positively This is because affiliation to any group or an organization is a socio capital as well as an indication of the farmer's level of networks and contact with organized groups and informal groups. Organization enables farmers to learn about agricultural technologies, share experiences and exchange ideas about agricultural technologies with other farmers. Table 7 shows that about 65.3% of adopters were members of farmers group. These studies are similar to those reported by a study conducted by Gregory and Sewando, (2013) which was titled "determinants of the probability of adopting quality protein maize (QPM) technology in Tanzania". This is because farmers organization/groups enables farmer to educate each other on the new technology.

4.3.9 Access to extension services

The results from the present study show that access to extension services has a positive influence on adoption of early maturing maize varieties. Extension agents play a very great role in the implementation and diffusion of innovation. Also extension personnel act as an agent for change and as a communication media. Table 7 shows that about 92.6% of adopters had access to extension services. Similarly, Wozniak (1997) in his study titled Human capital, information, and the early adoption of new technology found that extension services has a positively influence to technology adoption because extension provides farmers with information on availability and properties of the new technology and technical skills for using it.

4.3.10 Distance to the nearest market

Distance to the market has a negative influence on adoption of early maturing maize varieties because these varieties have high yielding ability which enables the farmer to

have surplus for selling. Consequently, if the market where a farmer can sell that surplus is far then adoption is likely to be compromised. Table 7 shows that when the distance is less than 5% the proportion of adopters was only 82% while when the distance is greater than 15% the proportion of adopter was only 43%. The Table shows that a large proportion of adopters was found at the distance which was less than 5%. Adopter percentage decrease as the distance to the nearest market increases. Generally the shorter the distance to the nearest market the higher the rate of adoption. A study done by Uaiene (2009) which was titled determinants of agricultural technology adoption in Mozambique also found a negative relationship between distance to the market and adoption of technology.

Table 7: Distribution of adopters and non-adopters basing on socio-economic factors

Variables	Adopters (Frequency)	Non adopters (Frequency)	Total
Gender of Hhh			
Female	2	13	15
Male	66	69	135
Total	68	82	150
Age of hhh (Years)			
< 30	6	10	16
30-40	27	28	55
41-50	20	20	40
> 50	15	24	39
Total	68	82	150
Education of the hhh			
Primary school and below	39	68	107
Secondary level and above	29	14	43
Total	68	82	150
Family labour			
3	8	66	74
8	30	8	38
>10	30	8	38
Total	68	82	150
Family dependency ratio			
0.5	20	50	70
1.25	30	26	56
1.8	9	2	11
2.55	9	4	13
Total	68	82	150
Income from other crops			
150,000	47	14	61
250,000	16	32	48
350,000	5	36	41
Total	68	82	150
Livestock Unit			
0	4	31	35
5.5	4	27	31
15.5	10	10	20
>20	50	14	64
Total	68	82	150
Group affiliation			
Yes	62	33	95
No	6	49	55
Total	68	82	150
Extension services			
Yes	63	16	79
No	5	66	71
Total	68	82	150
Distance to the nearest market			
<5 km	14	17	31
7.5km	14	19	33
12.5km	10	6	16
>15km	30	40	70
Total	68	82	150

4.4 Econometric Results

The results from the present study show that the coefficients for most of the variables hypothesized to influence the decision to adopt and the level of adoption for early maturing maize varieties have the expected signs. The Probit results show factors affecting adoption decision of early maturing maize varieties and the truncated regression analysis results show factors affecting the level of adoption.

4.4.1 Factors affecting adoption of early maturing maize varieties

The results in Table 8 show that nine factors have significant influence on farmers' decision to adopt early maturing maize varieties. These factors are gender of the household head, education level of the household, household labour, household dependency ratio, income from other crops, livestock unit owned, farm size, access to extension services and membership to any rural group or organization. The log likelihood for the fitted model is -49.35 and the χ^2 value of 92.5 indicates that all parameters are jointly significant at 5%, and Pseudo R^2 = 0.48. All variables were tested at three different levels of significance which are 1%, 5% and 10%. The results show that gender of the household head, education level of the household head, household dependency ratio, farm size, family labour, livestock unit, extension services, income from other crop and group affiliation were significant in influencing adoption of early maturing maize varieties.

Table 8: Probit regression results showing factors affecting adoption of early maturing maize varieties in Nzega Tabora.

y_hat	Coef	Std err	Z	P>|z|
Gender of HHH	0.5741273***	0.1557283	3.69	0.005
Age of HHH(1if >40, 0 if <40)	-0.5377014	0.1642993	-3.27	0.001
Education(1if Secondary and above, 0 if primary and below)	0.5718046***	0.1910345	2.99	0.003
Family labour	0.4747075***	0.1560339	3.04	0.002
HH dependency ratio	0.8538828***	0.1890821	4.52	0.000
Farm size	0.8126428***	0.1998083	4.07	0.000
Income from other crop	0.4897618***	0.1580107	3.10	0.002
Livestock unit of the hh	0 .4839161***	0.1558202	3.11	0.002
Group affiliation	0.2022994**	0.1688977	1.20	0. 023
Access to extension	0.5061181***	0.1700476	2.98	0.003
Distance to the market	-0.0909082	0.1551252	-0.59	0.558
-Constant	-0.8688227	0.1740743	-4.99	0.000

* means significant at ***=1%, **= 5%, * = 10% level of significance

Log likelihood	= -49.349383	Pseudo R2	= 0.4831
Number of observation	= 150	Prob > chi2	= 0.0000
LR chi2(12)	= 92.26		

4.4.2 Age of the household head

The results in Table 9 show that age has a negative relationship with the decision to adopt early maturing maize varieties. This imply that younger farmers are more willing to adopt early maturing maize varieties than older farmers. This can be attributed to the fact that younger farmers are more receptive towards newly introduced technologies than older farmers. Younger farmer are more risk takers than older farmers. These findings are similar to those found by Langyintuo and Mulugetta (2005); Rahelizatovo and Gillespie 2004; Barham *et al*. (2004) and they differ with Etoundi and Dia (2008), who found a positive influence of age to technology adoption. The marginal effects show that the probability of adopting early maturing maize varieties for elder farmers is lower by about 15.7% than that of younger farmers. The reason behind is that younger farmers are more risk takers than older farmers.

4.4.3 Effect of family labour on the adoption of early maturing maize varieties

The results in Table 9 show that family labour has a positive and significant influence on adoption. Increase in household labour increases the level of adoption of early maturing maize varieties. The marginal effect of labour indicate that a one unit increase in family labour increase the probability of adoption of early maturing maize varieties by 13.8%. The reason behind this is that early maturing maize varieties is labor intensive technology and as long as labor is provided by household then adoption is positively influenced. These findings goes together with the findings obtained by Feder *et al.* (1985) in his study titled adoption of agricultural innovations in developing countries, were he found that family labour positively influence adoption of agriculture innovations.

4.4.4 Effect of household dependency ratio on the adoption

The results in Table 9 show that household dependency ratio has a positive and significant influence on the adoption of early maturing maize varieties as it was expected. The reason behind is that big ratio means larger number of defendants within the household, this will motivate the household head to opt for early maturing varieties which have high yielding ability in order to fulfill the requirement of the family. The marginal effect show that a unit increase in family dependency ratio increase the probability of adoption of early maturing maize varieties by 24.8% while holding other variables constant.

4.4.5 Effect of Group Affiliation on Adoption

The result presented in Table 9 show that farmer's affiliation to an organization influence adoption decisions. This is likely to be due to the fact that affiliation to any group or an organization is a social capital. Also group membership is an indication of the farmer's level of networks and contacts with organized groups and informal groups. Organization enables farmers to learn about agricultural technologies, share experiences and exchange

ideas about agricultural technologies with other farmers. Networking enables farmers to assess and understand the risks and benefit associated with the use of an innovation thus high probability of adopting. These result are consistent with those from a study done by Sall *et al.* (2000) in his study titled "A quantitative Assessment of Improved Rice Varieties Adoption in Senegal", who found that membership to any organization influence adoption decisions positively. Group affiliation enables farmers to learn about a technology via other farmers and from other development agencies (Nkamleu, 2007). Farmer groups give their members a wider opportunity for educating each other.

4.4.6 Extension services visit

Access to extension services has been found to influence adoption of early maturing maize varieties positively. This is because extension agent plays a very great role in the implementation and diffusion of innovation, extension act as an agent for change and as a communication media. Also extension services popularize the innovation by providing necessary information, appropriate knowledge and special skills, which enable farmers to apply the innovation. These results conform to those by Abebaw and belay (2001) in the study of "Factors influencing adoption of high yielding maize varieties in Southwestern Ethiopia" who found a positive influence of extension services and adoption of high yielding maize varieties.

4.4.7 Effect of gender of the household head on the adoption

The results show that gender of the household head (whether the head is male or female) influence adoption of early maturing maize varieties. The result in Table 9 show that male headed household are more likely to adopt early maturing maize varieties while female headed household has a negative influence. This is because according to the culture and norms of many societies women have less access to resources like land.

Also Lopes (2010), in his study on adoption of improved maize and common Bean varieties in Mozambique found that the rate of adoption for female headed household is low because women have less access to external inputs, services, and information due to socio-cultural values.

4.4.8 Income from other crops

The results in Table 9 show that, income from other crops has positive and significant influence on adoption of early maturing maize varieties. Income from other crops increases capital to the farmer which boosts adoption by enabling him/her to have the capacity to purchase technology and associated inputs which can be used in implementing the technology. Adoption of early maturing maize varieties needs capital which can be used in buying inputs like fertilizer, pesticides as well as hiring labour. Income received from other crops assist the farmer in acquiring those inputs hence it has a positive influence in adoption of early maturing maize varieties. These results conform with those findings from Karanja (2002) and Govereh and Jayne (2003) who found that income generated from other crops is used to purchase inputs necessary for crop production. The marginal effect show that a unit increase in other crop's income increases adoption of early maturing maize varieties by 14.3%.

4.4.9 Distance to the nearest market

The results in Table 9 show that, distance to the market draws a negatively result in adoption of early maturing maize varieties because these varieties have high yielding ability which enable the farmer to have surplus for selling. If the market where a farmer can sell those surplus is far this will have a negative influence in adopting high yielding varieties. This was also reported by Sserunkuuma (2005); Langyintuo and Mekuria (2008) and Salasya *et al.* (2007) who found a negative correlation between distance to the nearest market and adoption of technology. It is generally perceived that the shorter the

distance from the household to the nearest market, the higher the probability of adoption. The marginal effect show that increase in the distance to the nearest market decreases the probability of adopting early maturing maize varieties by 2.6%.

4.4.10 Education level of the household head

The results in Table 9 show that education level has a positive influence in adoption of early maturing maize varieties. This is because more educated household head are expected to understand new technologies in a shorter period of time and implement the technology than those with poor education (Paudel and Matsuoka, 2008; Kudi *et al*., 2011). The marginal effect show that the probability of adoption of early maturing maize varieties is higher for about 16.7% for farmers having secondary education and above than those with primary education and below

4.4.11 Livestock Unit of the household

The results in Table 9 show that, livestock has a positive influence to the adoption of early maturing maize varieties as it was expected. Livestock stand for wealth in most African societies. In general rich farmers are better placed in terms of risk bearing (Gregory and Sewando, 2013). The results of the marginal effect show that increase in livestock increases the probability of adopting early maturing maize varieties by 14.1%. Other studies like Alumira and Rusike (2005) found a negative influence of livestock but this was typical according to the nature of their study and the area.

Table 9: Maximum likelihood estimates of double hurdle models for adoption decision and level of adoption of early maturing maize varieties among household head in Nzega Tabora

Variable name	Coefficient 1st Hurdle	Marginal Effect	Coefficient (2nd Hurdle)
Gender of HHH	0.5741273	0.167464	2.270161
Age of HHH(1if >40, 0 if <40)	-0.5377014	-0.1568392	4.526882
Education (1 if Secondary and above, 0 if primary and below)	0.5718046	0.1667866	0.041469**
Family labour	0.4747075	0.1384648	1.901119
HH dependency ratio	0.8538828	0.2490644	0.582329
Farm size	0.8126428	0.2370353	2.202941*
Income from other crop	0.4897618	0.1428559	0.8613107
Livestock unit of the hh	0.4839161	0.1411508	0.3525893
Group affiliation	0.2022994	0.0590076	0 .7855627
Access to extension	0.5061181	0.1476268	2.281675**
Distance to the market	-0.0909082	-0.0265165	-0 .37689
-Constant	-0.8688227		10.01998

R-squared = 0.6292
Adj R-squared = 0.5090

4.4.12 Farm size

The results in Table 9 show that farm land has a positive influence in adoption of early maturing maize varieties. This is because farmers with large pieces of land can afford to be more experimental because for them even a more relatively small percentage of their total land may be large enough to support land-intensive technology. This results are similar to those found by (Simtowe *et al.*, 2007); Langytuo and Mekuria, 2008). This is because large scale farmer are good risk taker because they can devote a relatively small percentage of land to new technology while still having enough land for their traditional varieties.

4.5 Determinants of the Level of Adoption

Three variables were found to have significant effects in explaining the level of adoption of early maturing maize varieties. These variables were education level of the household head, access to extension services and farm size.

4.5.1 Access to extension services

The results in the second stage of Cragg's model (second hurdle) in Table 9 show that access to extension services was statistically significant in explaining the level of adoption as it was expected, also Tesfaye *et al.* (2001); Habtemariam (2004) in their study found similar results. Extension services enable farmers to get exposed and more familiar with new varieties. Extension services create awareness and build the necessary knowledge for using the innovation.

4.5.2 Farm size

Results from in Table 9 show that farm sizes has a significant influence in explaining the level of adoption of early maturing maize varieties. The reason behind is that large scale farmers have the ability to expand areas for the introduced varieties due to the available land. Also farmers with large land holdings are more likely to acquire credit which could help in buying inputs like fertilizer and pesticides. Positive influence of farm size to level of adoption was also explained by feder *et al*. (1985) who found that farm size may be a surrogate for other factors such as wealth, access to credit as well as access to information. Also Rogers (1995) point out that adopter categories and farm size are interrelated. Rogers (1995) explain that innovators and early adopters have higher social status as measured by variables such as income and wealth, have large farms, tends to be commercial farmers rather than subsistence farmers and are likely to have greater association with extension officers. Hence large farm size has a positive and significant influence on the level of adoption.

4.5.3 Education of the household head

The results in Table 9 show that, education of the household head has a positive influence on the level of adoption of early maturing maize varieties because educated farmers are more capable than uneducated farmers in processing information, allocating inputs efficiently, and assessing the profitability of new technologies. Once the farmer

has accessed the profitability of the technology and has knowledge on how to allocate input then the probability of increasing the level of adoption is higher than the farmer with low education. Adegbola and Gardebroek (2007) in the study titled “The effect of information sources on technology adoptionn and modification decision” found positive relation between education level and the level of adoption of agriculture technology.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The main objective of the present study was to analyse challenges facing efforts to improve maize production through the promotion of adoption of early maturing maize varieties. In achieving this objectives the following specific objectives were undertaken; to compare profitability of early maturing maize varieties and local varieties, to identify determinants of adoption of early maturing maize varieties in Nzega District and lastly was to determine factors affecting the level of adoption of early maturing maize varieties in Nzega District. The major findings from the study were as follows;

Early maturing maize varieties have high yielding ability than the traditional maize varieties hence the gross margin for early maturing maize varieties is higher than the traditional maize varieties. Even though the yield for early maturing maize varieties is higher but the present study has found that only 45.3% of the farmers had adopted early maturing maize varieties. The major factors which were found to influence adoption of early maturing maize varieties were extension services, markets access and farmers income.

i. From the above findings the present study concludes that extension services availability is very important in creating awareness about a new technology, in distribution of the innovation and in implementation of the innovation correctly.
ii. Formal market availability enable farmers to sell their produce obtained, because early maturing maize varieties have high yielding ability than the traditional maize varieties. If the farmer will be assured of where to sell the surplus obtained then this will motivate the farmer to use and adopt the new varieties.

iii. Farmer's income increase adoption by enabling farmers to have access to key inputs like fertilizers and pesticides.

5.2 Recommendations

Extension services, formal market availability and farmers income are important factors which influence adoption of early maturing maize varieties. Based on this conclusion the following recommendations are suggested towards increasing adoption of early maturing maize varieties in Nzega District, Tabora.

i. Since agriculture extension influence adoption of innovations, there is a need to strengthen agriculture extension services in the villages, the focus should be more on training extension agent and also increasing extension agent capacity to reach farmers through provision of transport and housing.

ii. Since income in terms of livestock, farm size and other crops income increases adoption by enabling famers to buy inputs like fertilizer and pesticides, the government should provide input subsidies to farmers in Nzega District.

iii. Formal markets also influence adoption of early maturing maize varieties. The government should construct rural roads in order to make transport of product produced to the market possible.

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APPENDICES

Appendix 1: Farmers Questionnaire

Title: Determinants of Adoption Of Early Maturing Maize Varieties Ni Nzega Tabora

Questionnaires

Interview schedule of farmer for primary data collection

General identification variables

1. Date of interview…….
2. Name of interviewer…….
3. Name of respondent…….
4. Village name…….
5. Ward……..
6. Division……..

A. Demographic information

1. Gender of the household head
    i. Male
    ii. Female
2. Age of the household head (Please tick one)
    i. <30 years
    ii. 30-40 years
    iii. 41-50 years
    iv. >51 years
3. Education level of the household head (Tick one)
    i. No formal education
    ii. Primary education
    iii. Secondary education
    iv. Diploma education

4. Number of individual in the household who are able to work

   i. Male…….

   ii. Female……

5. Provide number of the following age group in your household

Household age group	Number
1.Infant 0-5yrs	
2.Children 6-14yrs	
3.Yourth 15-18yrs	
4.Adult male18-65yrs	
5.Adult female18-65yrs	
6.Over 65 yrs	

B. Economic activities

1. What is the total area of your farm land

   i. Less than one hactare

   ii. One hectare

   iii. More than one hectare

   iv. None of the above

2. Do you cultivate maize?

   i. Yes

   ii. No

3. What is the total area under maize?

   i.) 1 acre

   ii.) 1.5-3 acre

   iii.) 3-4.5 acre

   iv.) 4.5-5 acre

4. If yes which type of maize varieties do you use? (Tick one)
    i. Improved varieties(Early maturing maize varieties)
    ii. Local varieties
    iii. Both improved and local varieties
5. If you use improved varieties give the name and indicate the time you start using them and the area you cultivate:

Name of the varieties	**Time of using**	**Area**
1.		
2.		
3.		

6. Give reasons why you decided to use early maturing maize varieties?(Tick where appropriate)
    i. Resistance to drought
    ii. Taste good
    iii. High yielding ability
    iv. Resistance to pest
    v. Resistance to disease
    vi. Mature early
    vii. Others (specify)**……**
7. If you didn't use early maturing maize varieties what were the reason? (Tick where appropriate).
    i. I don't know it
    ii. Lack of Access to seeds
    iii. Seed not available
    iv. I don't like the variety

v. Others (Specify)……..

8. Indicate cost of input used in producing maize for the year 2012/2013

Crop	Seed cost			Fertilizer cost			Pesticide cost		
Maize	Type	Quantity	Price	Type	Quantity	Price	Type	Quantity	Price
Total									

9. Indicate labor cost for the following activities for maize production

Activities	Area	Unit	Cost/Unit	Total cost
Land preparation				
Cultivation/Ploughing				
Sowing/Planting				
Weeding				
Fertilizer application				
Pesticides application				
Harvesting and processing				
Transportation				
Storage				
Others(specify)				

10. How many bags of maize did you harvest for the year 2012/2013?

……

11. What was the selling price of maize for the year 2012/2013?.....

12. Do you grow other crops?

i. Yes

ii. No

13. If yes what other crops do you grow? (Tick where appropriate)

i. Sorghum

ii. Paddy

iii. Groundnuts

iv. Tobacco

v. Cassava

vi. Others (Specify)……..

14. What is the main occupation of the household head (Tick where appropriate)

i. Mixed crop production (crops are the major source of funds)

ii. Livestock production (Livestock is the major source of funds)

iii. Wage employment (Specify)……..

iv. Off farm employment (Specify)……..

v. Others (Specify)…….

15. What is the secondary occupation of the household head

i. Mixed crop production (crops are not the major source of funds)

ii. Livestock production (Livestock is not the major source of funds)

iii. Wage employment (Specify)…….

iv. Off farm employment (Specify)……

v. Petty business (specify)…….

vi. Business (specify)…….

vii. Others (Specify……

16. Do you keep livestock?

i. Yes

ii. No

17. If yes indicate the number and type of livestock owned by your household

Type of animal kept		Number
1.	Cattle	
2.	Sheep	
3.	Goats	
4	Poultry	
5	Pigs	
6	Others(Specify)	

18. Ownership of assets

Give the number of each of the items owned by your household

	Types of asset	Number
1.	Motor vehicle	
2.	Bicycle	
3.	Tractor	
4.	Cart(animal pulled)	
5.	Ox Plough	
6.	Others (specify)	

C. Extension services

19. How frequently are you visited by extension services? (Tick one)

i. Once in a week

ii. Twice in a month

iii. Once in a month

iv. Some times

vi. Never

20. Do you have any affiliation to any group or organization?

i.) No

ii.) Yes

21. If yes mention the name of the organization…….

22. Are you satisfied with the service? (Tick one)

i. Very satisfied

ii. Not satisfied

iii. Satisfied

iv. Not sure

23. How do you evaluate the relevance of extension services?

i. not good

ii. Good

iii. very good

D. Technology supply

24. Where did you get improved maize seed? (Tick where appropriate)

    i. Cooperatives

    ii. District Agriculture Office

    iii. Research

    iv. Market

    v. Others (specify)

25. Did you face any problem in obtained those seed?(Tick one)

    i. Yes

    ii. No

26. What problems did you face? (Tick where appropriate)

    i. Not available on time

    ii. Not available in required time

    iii. Price is high

    iv. No problem

    v. Others (Specify)

E. Credit availability and repayment

27. Do you receive any credit? (Tick one)

    i. Yes

    ii. No

28. If yes where did you get the credit?

    i. Cooperatives

    ii. Banks

    iii. Microfinance

    iv. Others (Specify)

29. Are you comfortable with the interest rate?

    i. Yes

    ii. No

30. If no why?.....

31. Distance to the nearest market

    i.) < than 5 km

    ii.) 5-10 km

    iii.) 10-15 km

    iv.) > 15km

Appendix 2: Tropical Livestock Conversion Units

NO	Livestock Categories	Liveweight (kg)	Conversion factor
1.	Cattle	200-250	1
2	Donkey	250-300	1.2
3	Goat	30-40	0.2
4	sheep	30-40	0.2

Appendix 3: Conversion Factors for Calculating Household Labor

NO	Household age group (years)	Conversion factor
1.	0-5	0.00
2.	6-10	0.3
3.	11-17	0.75
4.	18-60	1
5.	Over 60	0.5