

**FACTORS INFLUENCING THE USE OF IMPROVED MAIZE SEED  
TECHNOLOGY IN KILOSA DISTRICT IN TANZANIA**

**MSc. (RURAL DEVELOPMENT AND EXTENSION) THESIS**

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**LILONGWE UNIVERSITY OF AGRICULTURE AND NATURAL RESOURCES  
BUNDA CAMPUS**

**MAY, 2017**

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**BSc (Agric. Edu &Extension), Tanzania**

**A THESIS SUBMITTED TO THE FACULTY OF DEVELOPMENT STUDIES IN  
PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF  
THE DEGREE OF MASTERS OF SCIENCE IN RURAL DEVELOPMENT AND  
EXTENSION**

**LILONGWE UNIVERSITY OF AGRICULTURE AND NATURAL RESOURCES**

**BUNDA CAMPUS**

**MAY, 2017**

## **DECLARATION**

I Nicholaus Shokela Nchembi, declare that this thesis is a result of my own original effort and work, and to the best of my knowledge, the findings have never been previously presented to Lilongwe University of Agriculture and Natural Resources or elsewhere, for the award of any academic qualification. Where assistance was sought, it has been accordingly acknowledged.

**Nicholaus Shokela Nchembi**

**Signature:** .....

**Date:** .....

## **CERTIFICATE OF APPROVAL**

We, the undersigned, certify that this thesis is a result of the authors own work, and that to the best of our knowledge, it has not been submitted for any other academic qualification within the Lilongwe University of Agriculture and Natural Resources or elsewhere. The thesis is acceptable in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on .....

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## **DEDICATION**

To the late Shokela Nchembi my father who was source of inspiration and moral support in my life. My dedication also goes to Kashinje Majahasi my mother who has always been a source of encouragement in my life.

## **ACKNOWLEDGEMENT**

I am grateful to the Innovative Agricultural Research Initiative (iAGRI)/USAID and the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for the financial support that enabled me to pursue studies at Lilongwe University of Agriculture and Natural Resources.

I would also like to give my sincere thanks to farmers who participated in the study. Special thanks are due to Kilosa District Executive Director and staffs of the Department of Agriculture, Irrigation and Cooperatives (DAICO) for their support.

My gratitude is also extended to my supervisory team Dr. C. Chonde, Dr. I. M. C. Mambo and Prof A. Edriss from the Faculty of Development Studies for their guidance and encouragement during execution of this study. My special recognition also goes to Prof. Z. S. K. Mvena from Sokoine University of Agriculture for his guidance during the field work in Tanzania.

I am especially indebted to my wife Mrs. Nchembi, T. J. for her material, moral support and that she allowed me to leave her to undertake this study successfully.

Finally, I thank the research team for the hard work, patience and integrity during data collection exercise.

## **ABSTRACT**

Around the world, the use of improved agricultural technology among maize farmers to boost agricultural productivity has been emphasized. In view of this development, Tanzania Government implemented numerous initiatives and policies aimed at improving varieties of maize, in a quest of yielding a successful productive of the crop. As such, the study explored factors influencing use of improved maize seed technology among smallholder farmers in one of the purposefully selected district of Kilosa in Tanzania. The study used data that was collected in Kilosa district in which 286 maize farmers were selected. Using a multi-staged sampling technique, a questionnaire was administered to collect retrospective information from farmers for the past 5 years preceding. The study used a multinomial logistic, logit and tobit regression techniques and descriptive statistics to analyse data objectively in order to answer the study questions. The results revealed that high yield, early maturity, tolerant to drought, resistant to pest and diseases, household labour, hired labour, cooperatives, extension services and education have a variedly statistically significant contribution to promote farmers' choice of maize varieties and their continued or discontinued use decision, respectively. Further, high yield, early maturity, tolerant to drought, large grain size; and resistant to pest and diseases were the major criteria used by farmers to make decision on utilisation of the variety. The findings imply that technology perceived attribute, farmers' characteristics and institutional factors are the key drivers to increase the extent of production of the variety. The findings suggest the high importance of socio-economic, institutional and technological aspects as key factors in ensuring the use of improved maize seed varieties.

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## **LIST OF ABBREVIATIONS AND ACRONYMS**

FAO	Food and Agriculture Organization
IMV	Improved Maize Variety
KDC	Kilosa District Council
Kg	Kilogram
NAIVS	National Agricultural Input Voucher Scheme
NBS	National Bureau for Statistics
NGO	Non- Governmental Organization
OPV	Open Pollinated Variety
SPSS	Statistical Package for Social Sciences
SSDG	Semi Structured Discussion Guide
STATA	Statistics and data
TSH	Tanzanian Shillings
UN	United Nations
URT	United Republic of Tanzania
US	United States

## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Introduction**

This chapter introduces the study which assesses the factors influencing the use of improved maize seed technology in Kilosa district in Tanzania. The chapter also presents background information, statement of the problem, justification, objectives, research questions, concept and operational definition used in the study.

#### **1.2 Background information**

Agricultural development is highlighted as key to attaining food security and alleviating poverty in the Sub-Saharan African region (World Bank, 2008). To meet this demand more effort have been done in ensuring that farmers are provided with appropriate technologies so that they increase productivity and therefore, alleviate food insecurity in their households.

##### **1.2.1 The role of agriculture in food security**

A significant proportion of the population in sub-Saharan Africa including Tanzania is food insecure and malnourished. Increasing food insecurity is one of the main concerns in many developing countries (Food and Agriculture Organization of the United Nations [FAO], 2015). Food crisis is more serious in sub-Saharan Africa, where the attainment of food security is basically linked with low food, agricultural productivity and production, among other set of factors that contribute to this dire situation (FAO, 2012). Agricultural growth has also been found to be four times more effective in reducing poverty than growth in

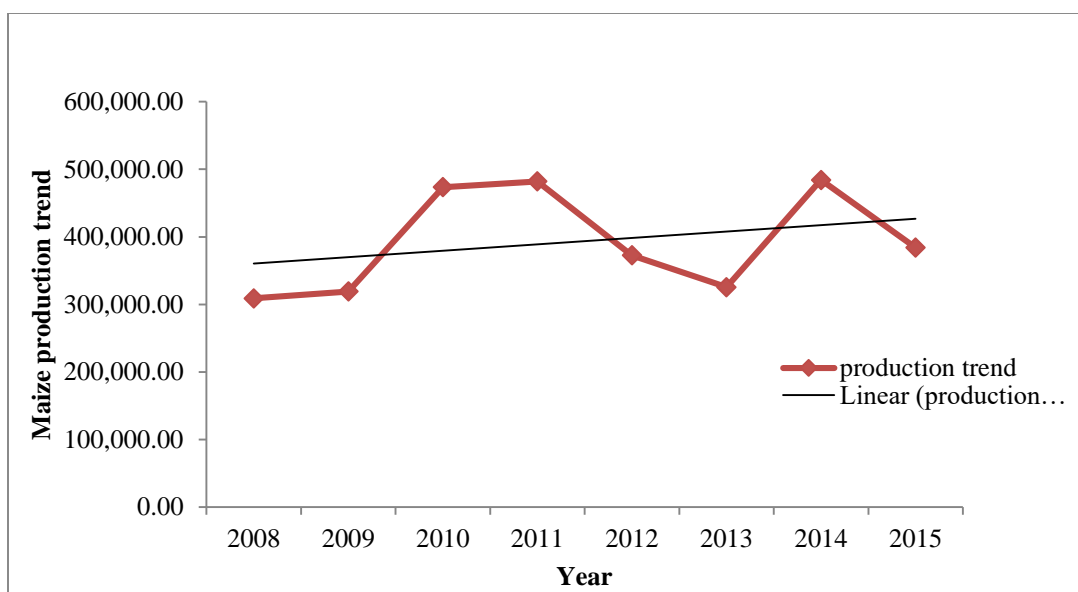
other sectors, such as growth in the oil sector (United Nations [UN], 2008). Consequently, the implementation and scaling-up of initiatives to improve agricultural productivity, particularly among small-scale holder farmers, will enhance food security and efficient food distribution.

Addressing food security and poverty problems in agricultural-based economies demand for substantial efforts in improving agricultural production and productivity (World Development Report [WDR], 2008). In Tanzania, the Government has developed several policies to recognize agriculture as a pillar of the economy, with priority being centred on ensuring food security and increased export earnings aimed at diversifying its present economy. Maize is important for the country's food security as it provides 60 percent of dietary calories and more than 50 percent of utilizable protein to the Tanzanian population (Katinila et al, 1998). Production of maize has been emphasized in the country since 1960s where several improved maize varieties have been developed. The maize breeding efforts resulted in the release of Ukiriguru Composite A (UCA) and Ilonga Composite White (ICW). Between 1973 and 1975, Tanzania experienced a severe food shortage due to drought and the villagisation campaign that displaced farmers (Maliyamkono and Bagachwa, 1990). The food crisis prompted the nation to launch several campaigns such as 'agriculture for survival' (*Kilimo cha Kufa na Kupona*) with the objective of attaining food self-sufficiency. The country also launched a maize project in 1974 with the assistance of the U.S. Agency for International Development (USAID). Its objective was to promote maize production in pursuit of food self-sufficiency. According to Kaliba et al., (1998) maize is an important food crop in the Eastern Zone and accounts for 9% of total national

maize production and 14.5% of national maize area. Most of the maize in Eastern zone was produced in Tanga (40%) and Morogoro (55%), and 5% is grown in the Pwani and Dar-es-Salaam regions (Kaliba et al., 1998).

### **1.2.2 Maize production in Morogoro region**

Maize is the major and most preferred staple food crop in Tanzania (Regional Agricultural Trade Expansion Support [RATES], 2003). Over two million hectares of maize are planted per year with average yields of 1.2–1.6 tonnes per hectare. Maize accounts for 31% of the total food production and constitutes more than 75% of the cereal consumption in the country (Seth et al., 2011). It is indicated that about 74% of Tanzanian population depends on agricultural sector for their livelihood (United Republic of Tanzania [URT], 2012). According to NBS (2012) report; maize is the main and staple food consumed by most of people in all districts in Morogoro region. Figure 1.1 shows increase in the production trend from 2008 to 2015 in a region which perhaps is attributed to the continued use of improved maize in the region (Morogoro region[MR], 2016).



**Figure 1.1** Maize production trend in Morogoro region

Source: Morogoro region (2016)

### 1.2.3 Maize production in Kilosa district

Kilosa is the district in Morogoro region which offers a variety of agro-ecological (lowland, intermediate and highland zones) conditions for farming (Maganga and Odegaard, 2007). The lowland and intermediate zones are the suitable zones for production of maize and they were targeted study areas for this research. More than 77% of the population in Kilosa district depends on agriculture (Kilosa District Council [KDC], 2015) and one of the grown crops is maize whereby farmers grow both improved maize seed as well as local seed varieties. The adoption rate of improved maize seed in the district has attracted many studies. For example, Kaliba et al., (1998) observed that by 1994 about 85% of lowland farmers and 92% of intermediate zone farmers had adopted improved maize varieties. The average rate of adoption from 1974-1994 was 22% for the lowlands and 52% for the intermediate zone.

Improved maize varieties gained popularity in the mid-1980s, when farmers allocated more land to improved maize than local maize (Kaliba et al., 1998). Between 1992 and 1994, however, the land allocated to improved maize declined especially in the intermediate zone (Kaliba et al., 1998). The decline possibly occurred because improved seeds were hard to obtain during that period, when the seed market was liberalized. Formal seed marketing channels were disturbed and the informal sector could not respond quickly enough to take over the market of improved seed. The consequence was a reduction in maize seed supply and higher seed prices. At the same time, maize prices fell, causing farmers to allocate less land to maize. This situation was faced by most of the farmers in the country (National Agricultural Input Voucher Scheme [NAIVS], 2015). In 2007/08, the Government piloted the voucher based subsidy in two districts and then expanded to encompass 53 districts (including Kilosa district) distributed across 11 high potential regions in 2008/09. The regions which were targeted were Iringa, Mbeya, and Ruvuma in the southern highlands; and Kilimanjaro, Arusha, Manyara, Kigoma, Tabora, Mara and Morogoro in the central and northern parts of the country. Pwani region was to be added in 2009/10 (NAIVS, 2015). The main aim of the input subsidy program was to increase maize and rice production, in order to improve household food security. The aim was reinforced by the sharp rise in grain and fertilizer prices in 2007 and 2008. The country had faced a major drought and significant rise in food prices in 2006, leading to a ban on grain exports. While rains improved in the following two years, the unexpected rise in international grain prices highlighted the concern to strengthen domestic production and grain stocks (NAIVS, 2015).

The study conducted by Kassie et al (2012) in three districts of Kilosa, Karatu and Mvomero showed that almost all (99.6%) of the sampled households in the survey areas grew maize and about 76.5 % of sampled households adopted improved maize varieties. The number of farmers who adopted improved maize was higher in Kilosa (25%) and Karatu (20%) compared to farmers in Mbulu (14%) and Mvomero (17%). It is approximated that 70% of farmers in Kilosa district have adopted improved maize varieties while only 30% farmers grow local varieties (KDC, 2015). The rate of adoption of improved maize varieties had been geared by the government intervention in input subsidy program whereby farmers were able to buy inputs (KDC, 2015). The majority of these farmers are purchasing improved seed on the retail market, and many are continuing to plant improved open pollinated varieties with seed obtained from their own harvests (NAIVS, 2015). It can be observed that there is a relative increase in the number of farmers who use improved maize varieties, and therefore, this study endeavours to assess the factors influencing the use of improved seed technology in Kilosa district.

#### **1.2.4 Type of improved maize variety grown in Kilosa district**

The use of improved maize varieties in Kilosa district goes back to the early 1960s where Ilonga Composite White was firstly produced at Ilonga Research Centre, thereafter a number of varieties have been produced. These varieties are open pollinated varieties and hybrid. In some instance, farmers in the district also grow local variety (Kaliba et al., 1998). Farmers do not adopt a new technology and forget old ones automatically for safety-first behaviour and learning reasons (Smale et al., 1994). Some studies have also shown that,

for satisfying reasons (like capturing desirable consumption and production traits), farmers who adopt improved varieties often continue to plant local varieties (Smale et al., 1995; Brush, 1995) and complete displacement may not occur. It is reported that improved maize varieties grown in the district are STAHA, SITUKA, TMV1, DELCALB 803, SEEDCO and PANNAR (Kaliba et al., 1998; KDC, 2015).

### **1.3 Statement of the Problem**

Adoption is a decision to make full use of a technology as the best course of action available (Fregene, 2008). However, the adoption of a production technology is not a unit and instant act; it consists of several stages and involves sequence of thoughts and decisions. According to Youngseek and Crowston, (2011) adoption is a process consists of three stages namely pre- adoption, adoption and post- adoption. At the pre-adoption stage, people may examine a new technology and consider adopting it. At the adoption stage, they form an intention to adopt the technology, and they eventually purchase and use it. At the post-adoption stage, people can either continue or discontinue using the technology. It is well recognized that improvement in agricultural productivity among farmers is achieved through improved agricultural technologies (Moshi, 1997). These technologies are developed at the research centres and disseminated to farmers mainly through extension services. Farmers' integration of these agricultural technologies into their field is greatly influenced by socio-economic, institutional, altitude and perceived technology attributes factors (An, 2008). Despite these factors, little attention has been given on factors which influence farmers to continue or discontinue utilizing the adopted technology as many researchers focus on the adoption stage of the technology (Tura et al., 2010). Only few



studies have investigated why farmers continue or discontinue using the technologies (Nell and Lee, 2001; Akili and Graaf, 2007; An, 2008; Olalekan and Simeon, 2015). This argument implies that there is much to be investigated to find what happens at the continued or discontinued use stage in the adoption process to ensure that the adopted technologies (e.g. improved maize varieties) are sustained by adopters. In some cases, some technologies are discontinued by adopters when they are not satisfied with the previous experience. Besides, the studies did not look at characteristics of improved maize varieties that make the varieties to take long or less time to be discontinued. This study, therefore, seeks to explain why farmers adopt and keep using (or stop using) improved maize seed technology. It contributes to the literature on adoption and diffusion theory by focusing on the concerns and conditions for continued or discontinued use of a technology.

#### **1.4 Justification of the study**

Food insecurity in Tanzania has occurred several times and maize as one of staple food has been given first priority for ensuring that people are food secured. Many varieties of improved maize seed have been generated since 1960s, and farmers adopted them according to their ecological zones (Hassan et al., 2001). Findings of this study will help to understand why farmers continue or discontinue utilizing improved maize varieties, what are the evaluation criteria for continued or discontinued use of the technology; influence of the extent of production on the use of improved maize seed varieties. The knowledge gained will therefore, help on informing the researchers, extension agents as well as policy planners on how to promote continued use of agricultural technologies to the optimal level for high production potential of the land to be used.

### **1.5 Objective of the study**

The overall objective of this study was to assess factors which influence use of improved maize seed varieties among farmers in Kilosa district. Specifically, the current study intended to:

- i. Identify factors which influence farmers to continue or discontinue utilization of selected adopted improved maize seed varieties.
- ii. Assess the evaluation criteria that farmers use to make decision to continue or discontinue using the adopted improved maize seed varieties.
- iii. Assess the extent of production of the selected adopted improved maize seed technologies.

### **1.6 Research questions**

The study sought to answer the following research questions.

- i. What factors influence farmers to continue or discontinue using selected adopted improved maize seed technologies?
- ii. What evaluation criteria did farmers use to continue or discontinue using adopted improved maize seed technology and why?
- iii. What is the extent of production of the selected adopted improved maize seed technologies?

## **1.7 Concept and operational definitions of the study**

**The concept of adoption has been defined differently by researchers:**

Definition of adoption has faced a number of controversies. For example, Jabbar et al., (1998); Tura et al., (2010); Kaliba et al., (2010) and Youngeek and Crowston, (2011) defined adoption as the stage in which a technology is selected for use by an individual or organization, while Kinyangi, (2014) defined adoption as the decisions that individuals make each time that they consider taking up an innovation or decision of an individual to make use of an innovation as the best course of action available (Rogers, 2003). Therefore, based on this, the study which collected information for the past 5 years regarding use of improved maize varieties, the study defined adoption to be a stage when farmers have used the variety for the period of two years since the variety was introduced to them. While continued use is defined as the stage when farmers have used the variety for three or more years since they were first adopted it and else discontinued use.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter presents literature review on the concept of adoption and innovation process, adoption of technologies and practices in agriculture, factors affecting adoption of technologies as well as factors influencing the continued or discontinued use of improved maize seed technologies. Furthermore, the chapter contains the importance of maize, adoption of improved maize seed in Tanzania, maize production in Kilosa district and farmers' evaluation of maize seed technology. Finally, the chapter presents the conceptual framework supporting the present study.

#### **2.2 The concept of adoption process and innovation**

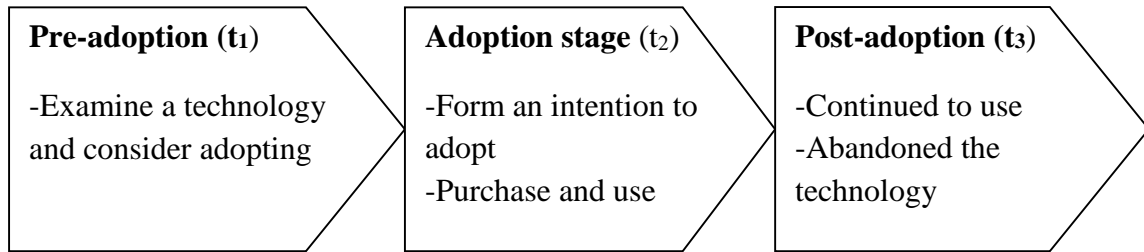
##### **2.2.1 Adoption process**

According to Rogers (2003), adoption process is a decision of the full use of an innovation as the best course of action available and rejection is a decision not to adopt an innovation. Depending on the support for adoption of the innovation and the attitude of the individual, later rejection or discontinuance happens. Discontinuance may occur in two ways. First, the individual rejects the innovation to adopt a better innovation replacing it. This type of discontinuance decision is called *replacement discontinuance*. The other type of discontinuance decision is *disenchantment discontinuance*. In the latter, the individual rejects the innovation because he or she is not satisfied with its performance. Another reason for this type of discontinuance decision may be that the innovation does not meet

the needs of the individual. So, it does not provide a perceived relative advantage which is the first attribute of innovations and affects the rate of adoption (Rogers, 2003).

Feder et al., (1985) defines adoption as the degree of use of a new technology in long run equilibrium when a farmer has full information about the new technology and its potential. Therefore, adoption at the farm level describes the realization of farmers' decision to apply a new technology in the production process. On the other hand, aggregate adoption is the process of spread or diffusion of a new technology within a region (Feder et al., 1985). Therefore, a distinction exists between adoption at the individual farm level and aggregate adoption within a targeted region. The rate of adoption is defined as the proportion of farmers who have adopted a new technology over time. Rogers (2003) defined the rate of adoption as the relative speed with which an innovation is adopted by members of a social system. As the study was interested to investigate the use of adopted improved maize varieties, the study adopted Feder et al., (1985)'s definition of adoption.

The adoption process, according to De Graaff et al., (2005) divided the process of technology adoption into three phases: acceptance, actual adoption, and continued use. According to Jabbar et al., (1998), the adoption process involves a sequence of learning, adoption and continued or discontinued use of introduced technologies, while Youngseek and Crowston, (2011) categorized the process into three stages: pre- adoption, adoption, and post-adoption. Looking at the stage of adoption process, this study goes beyond the first two stage of adoption process and therefore will focus more on what is happening at post adoption stage.



**Figure 2.1** Technology Adoption Process including Pre- Adoption, Adoption, and Post- Adoption Stages

Source: Youngseek and Crowston (2011)

### 2.2.2 Concept of innovation

The concept of innovation is socially constructed and therefore, has different meanings to different people (Berdegué, 2005). An innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption (Rogers, 2003). Spielman et al., (2009) defined it as anything new successfully introduced into an economic or social process. An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. Rogers (2003) identified five characteristics of an innovation: relative advantage, compatibility, complexity, trial ability, and observability. Rogers (2003) defined relative advantage as the degree to which an innovation is perceived as being better than the idea it supersedes. Rogers (2003) stated that compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. Rogers (2003) defined complexity as the degree to which an innovation is perceived as relatively difficult to understand and use. Opposite to the other attributes, complexity is negatively correlated with the rate of adoption (Rogers, 2003) Thus, excessive complexity of an innovation is an

important obstacle in its adoption. According to Rogers (2003) trial ability is the degree to which an innovation may be experimented with on a limited basis. The last characteristic of innovations is observability. Rogers (2003) defined observability as the degree to which the results of an innovation are visible to others. Role modelling (or peer observation) is the key motivational factor in the adoption and diffusion of technology (Parisot, 1997). Rogers (2003) stated that individual's perceptions of these characteristics predict the rate of adoption of innovation.

The presented concept of the perceived attributes of the technology above does not stipulate if they have influence on the post adoption stage of adoption process. This study therefore needed to investigate whether they had impact on the post- adoption stage.

### **2.3 Adoption of technologies and practices in agriculture**

The adoption of new technologies such as fertilizer and improved seed is central to agricultural growth and poverty reduction efforts (Tura et al., 2010). For instance, a study in Mexico shows that adoption of improved maize varieties improves household welfare (Becerril and Abdulai, 2010). Likewise, in sub-Saharan Africa, adoption of improved maize is indicated to have positive outcomes (Alene et al., 2009). Despite of this effort, reducing rural poverty in many developing countries remains a challenge due to low adoption of productivity enhancing technologies (World Bank, 2008).

Farmers are being challenged with several factors to integrate agricultural technologies in order to increase agricultural productivity. Barret (2001) in Ethiopia observed that, farmers

continue to lose in terms of crop yields despite introduction of new agricultural technologies since the cost of fertilizers and improved seeds continue to be high. He further said that, if the technology is not cost - reducing, farmers are not likely to adopt it in future seasons unless policy options such as provision of credit facilities are effected. Mose (1997) in Western Kenya, found that farmer's adoption behaviour is influenced by costs of inputs especially maize seed and fertilizers, access to credits, off - farm income, perceived yields and risks. The study on factors influencing adoption stage by Ransom et al., (2003) on the hills of Nepal reveals that, a significant and positive relationship exists between years of use of fertilizer, off-farm income and contact with extension agent. Another study (Etoundi and Dia, 2008) found that socio economic characteristics of farmers have influence on adoption of technology.

The study by Doss et al., (2003) on adoption of maize and wheat technology in Eastern Africa reported that farmers mentioned several reasons for not adopting improved technologies. The first was lack of or inadequate information about the technologies, or that these technologies could provide benefits. This may include misconceptions about the related costs and benefits. The second reason was that the technologies were not profitable, given the complex sets of decisions that farmers made about how to allocate land and labour across agricultural and non-agricultural activities. This may be due to the fact that appropriate varieties for farmers' agro ecological conditions are not available or that farmers favour characteristics that are found only in local varieties. It may also be due to institutional factors, such as the policy environment, which affect the availability of inputs (land, labour, seeds, and fertilizer) and markets for credit and outputs. These institutional



factors also affect input prices. It may also be that use of improved technologies may increase production risks: if crops fail, the financial losses would be higher. Finally, technologies were not adopted because they were simply not available (Doss et al., 2003). However, these studies do not account for farmers who adopt improved seed for a particular period of time and discontinue it afterwards. The presented economic literature is biased toward a particular point in the dynamics of technology choice, namely the adoption decision: who adopts what technologies and when (An, 2008). Understanding the evolution of technology choice is critical to understanding individual, sectoral and aggregate economic performance (An, 2008). The entire timeline of a technology is important as the duration of its lifespan and the reasons for its dis-adoption signal its effectiveness in respect of existing technologies and offer suggestions for future improvements (An, 2008). Graaf, (2007) argues that analysis of the determinants of adoption *per se* may not provide a full understanding of the range of factors influencing farmers' decision of sustained investments.

#### **2.4 Factors influencing continued or discontinued use of improved maize seed technologies**

The use of improved maize seed technologies to farmers has been the key concern in literature as it is believed to increase productivity to farmers. However, this may not be taken for granted if the adopted technologies are not sustained by farmers in their field. It therefore, calls up more investigation on the factors which determine the continued or discontinued use of improved maize seed technologies after they have been adopted by farmers.

According to Doss (2006), an adopter is a farmer who has adopted a component or more of a technology and continued using it, whereas non-adopters are those who have never tried a technology. Defining adoption in this way presupposes that once households adopt a technology, they will keep using it. It is, however, apparent that farmers might adopt a technology and decide to (or not to) continue using it. Therefore, in this study adopters are defined as farming households that have been using improved maize seed after having been satisfied with its previous experiences. An adopter is a continuous user simply if he or she uses improved maize seed every season since the time he or she first adopted the improved seed. Farmers who have tried improved maize seed varieties at once and are not satisfied by its experience; are essentially referred to as trial adopters.

The adoption of a technology and its continued use are outcomes of interdependent decisions. Since adoption occurs before continuation or discontinuation of a technology, variables that are stable overtime are the ones assumed to affect technology adoption (Neill and Lee, 2001). The hypotheses are that continued use of improved maize is influenced by area allocated to maize, farmers experience, access to extension on complementary technologies labour market, and credit (Tura et al., 2010). Furthermore, the study reiterates that the decisions on adoption and on whether to continue using a technology or not, are complex and involves factors that are normally beyond the control of farmers, such as institutional, agro ecological, socioeconomic, psychological and technological factor (Tura et al., 2010). Additionally, the decisions of adopting and continuing the use of improved maize seeds are relevant to those farmers who adopted it in the first place. On the same note, De Graaf (2005) has a different view in this argument as he found that the factors

influencing adoption and continued use of the technologies may not be the same. Adoption is influenced by farmers' age, farm size, perceptions on technology profitability, and characteristics of a farm, while the decision to continue using the technology is influenced by actual technology profitability, family size, and participation in off-farm work.

As pointed out earlier that adoption occurs before continuation, the underlying assumption is that the continued use is impacted by various factors that influence adoption (Wendland and Sills, 2008). The study on the continued use of technology by Sain and Martinez (1999) indicated that access to farm assets such as land, or livestock, is expected to enhance continued use of improved technologies. Sain and Martize (1999) argued that the larger the farm size the less binding is the financial and land constraints faced by a farmer. Ownership of livestock is believed to encourage adoption and continued use of improved maize seed in the sense that it generates income to back up the cost of the inputs associated with the technology and reduces the risks that may arise from crop failure (Nega and Sanders, 2006). Inadequate infrastructure such as roads is another external factor affecting the continued use. Households living near major towns have good access to both physical infrastructure and seed supplies, and can purchase seed from the market, hence are expected to continue using adopted technologies. It is, therefore, important to have information on the factors that determine technology adoption by farmers as well as factors that may increase the probability of continued use of these technologies. Many studies (Lee, 2001; Oladele, 2005; Aklilu and Graaf, 2007; Bradshaw, 2007, An, 2008; Tura et al., 2010) reported that ownership of farm assets, off farm activity, institutional factors and market conditions can explain the decision to continue or not to continue using agricultural

technologies. While on the other hand, An (2008) reported that the same factors that explain the binary decision to adopt the technology also affect the adoption intensity. With respect to continued use of technology, this study defined continued use intensity as an amount of land area allocated for the continued use utilization of improved maize seed technologies. Oladele (2005) concluded that adoption of improved technologies will neither improve food security nor reduce poverty if barriers to their continued use are not overcome.

Tenkir et al., (2004) in Tura et al., (2010) in Ethiopia reported that about 40% of farmers who try new inputs discontinued using them. However, farmers try technology before they consider it for adoption; if they are not satisfied with its experience, rejection may occur (Adesina et al., 2000 and Kiptot et al., 2007). According Youngseek and Crowston, (2011) discontinued use stage of technology occurs after adoption and not as it has been reported by Tenkir et al., (2004). The authors reported the adoption rates were 92.4% for maize seeds and 86% for chemical fertilizers. Also, some growers can adopt a technology or practice and then stop using it for a while, but then reuse it again because it becomes useful at the given circumstances (Kiptot et al., 2007).

Rogers (2003) argued that there are two types of reasons for discontinuing a technology use on the part of farmers; that is, replacement discontinuance, where farmers discontinue using the existing technology in order to adopt a superior one, and disenchantment discontinuance, where a decision to discontinue a technology, with or without replacement, is due to dissatisfaction with its performance. The study conducted by Tura et al., (2010)

in Ethiopia showed that 61.5% of farmers who could not continue using improved maize seed reported high price of seed and fertilizers as reasons for discontinuation, mainly due to lack of financial resources. Here the decision to discontinue using the technology is not based on inherent characteristic of the technology but factors external to the technology. Lee, (2001) reported that ownership of farm assets; institutional factors and market conditions can explain the decision to continue or not to continue using agricultural technologies. Variables like age, education, experience profitability and farm characteristics seem to play a role in discontinued decision (An, 2008).

Discontinued of improved maize seed varieties is also apparently within some areas in Tanzania. A study in Tanzania by Kaliba et al., (1998) indicated that in the lowlands, about 32% of the respondents reported they no longer grew ICW, and another 23% mentioned that they no longer grew Katumani. Other discontinued varieties included TMV1, STAHA, and Kito. In the intermediate zone, about 46% of farmers discontinued ICW and 23% no longer grew Kito. Other discontinued varieties include Katumani, Kilima, STAHA, and CG4142. Farmers' major reasons for discontinuing a variety are low yield, susceptibility to pests and diseases, and unavailability of seed. Although later studies looked at factors that influence the continued or discontinued use of technology (improved maize varieties in this case). None of them was interested in assessing the inherent characteristics of improved maize varieties that affect its continued or discontinued use.

## **2.5 Importance of maize**

Maize production ranks second among the major cereal grains and it is a major cereal crop in West and Central Africa (WCA), currently accounting for a little over 20% of domestic food production in Africa (Manyong et al., 2000). Its importance has increased as it has replaced other food staples, particularly sorghum and millet (Smith et al., 1994), and it has also become a major source of cash for smallholder farmers (Smith et al., 1997). In Tanzania, maize is the major cereal crop consumed mostly by households. According to NAIVS, (2015) the concentrated commitment of support for maize subsidies reflects the importance of this crop as food grain. The total area planted with cereals is 5,830,972 ha of which 5,797,269 ha (99.4%) is in Tanzania Mainland and 33,704 ha in Zanzibar. From the total planted area in the Mainland, maize occupies the largest portion of the planted area and accounts for 4,082,500 ha (70.4%) of the total cereal planted area. Likewise, maize production is the highest amongst the cereals at 5,436,776 tons equivalent to 71.6 percent of the total cereals production in the Mainland. Its productivity is about 1.3 tons/ha (NBS, 2012; Khalfani, 2015). Maize is grown in all regions of the country (Kassie et al., 2012 and NAIVS, 2015) with the largest share of crop area found in Iringa, Shinyanga, Morogoro, Mbeya, and Kigoma; all areas originally targeted by the NAIVS program. The southern highlands (Iringa, Mbeya and Ruvuma) tend to produce surplus maize compared to consumption levels, while there tend to be deficits in the northern highlands, Dar es Salaam, and central regions. Similar studies (FSD, 1992; Mdadila 1995) indicated that most of the maize is produced in the Southern Highlands (46%), the Lake zone, and the Northern zone. Dar es Salaam, Lindi, Singida, Pwani, and Kigoma are maize-deficit regions. Dodoma is a surplus region during good growing years, and in years following a plentiful

rainfall the region is the number one supplier of maize to Dar es Salaam. It is approximated that the annual per capita consumption of maize in Tanzania is over 237kg, national consumption is projected to be three to four million tonnes per year, and it contributes 41.3 of dietary calories to Tanzanian consumers (Nancy and D'Souza, 2015).

## **2.6 Adoption of improved maize seed in Tanzania**

Different studies led to different estimations of adoption rates for improved maize varieties in Tanzania (Lyimo et al., 2014). By conventional definition, an improved variety is that which has been improved by formal plant breeding (Lyimo et al., 2014). This would include replanted varieties that have not yet lost their desirable attributes and, hence, perform better than unimproved varieties. The adoption rate of improved varieties for the various zones in the country is estimated at 28% for the Central Region, 66% for the Eastern Region, 44% for the Lake Region, 66% for the Northern Region, 24% for the Southern Region, 81% for the Southern Highlands and 36% for the Western Zone (Moshi, 1997).

Another study, based on seed sales, estimated the total national maize area planted to improved OPVs and hybrids at only about 4% (Hassan et al., 2001). Those rates might be misleading in terms of the impact of improved maize varieties to both household and national food security, as well as in the country's economy. The study might have failed to reveal the concrete impact of the different partners in the supply of improved seed to the farming communities, as well as the importance of replanting (Lyimo et al., 2014).

Adoption rates based on the number of farmers' planting certified seed in Northern Tanzania are estimated at 52% (Nkonya et al., 1997), while adoption rates based on both certified seed and recycled seed from improved varieties is estimated at 94% (Nkonya et al., 1998). Maize farmers in Tanzania have benefited from the investments in maize research through increased maize yields. These yield gains are attributed to the adoption of improved maize varieties as well as management practices (Moshi, 1997). An impact study showed that the observed 38% increase in maize yield, as well as the greater proportion of maize being marketed, could largely be attributed to the improved varieties and management practices (Moshi, 1997). Adoption rate computed in these studies did not clearly state the number of reasons or years a farmer has replanted a given improved maize seed variety. This is particularly important to hybrid maize variety that quickly loses its yield potential even for the first generation recycled seed (Pixley and Binzanger, 2001). Also these studies did not account for farmers who adopted improved seed at one season and discontinue it afterwards.

## **2.7 Farmers' evaluation of maize seed technology**

Farmer assessment/evaluation of technology is a tool through which farmers articulate their perception or views on a given set of alternatives, potential technologies which are designed to give options to solve farmer felt-needs. The core objective of farmer evaluations is to provide feedback to researchers or technology designing process about farmers' criteria for deciding whether and how to use a potential innovation in order to increase the chances of adoption by addressing better user expectations. Therefore, the



earlier the farmer evaluations are conducted, the more likely it is that farmers' and researchers' ideas about desirable features of a technology will coincide (Ashby, 1991).

Farmers are more likely to assess a technology with criteria and objectives that are different from criteria used by scientists. However, farmers' and scientists' criteria for technology assessment are harmonized and vital for effective research and technology development. Farmer evaluations help scientists to design, test and recommend new technologies in light of information about farmers' criteria for usefulness of the innovation (Ashby, 1991). Farmers use a combination of many but similar criteria in selecting the maize varieties they grow.

In their studies (Obaa et al., 2005; De Groote et al., 2002; Banziger and de Meyer, 2002) observed that the most important criterion across many varieties is early maturity. Early maturity is considered an important criterion for three main reasons. Early maturity varieties allow farmers to prepare land in order to plant the crop twice a year to fit the bimodal rainfall pattern. Other reasons are that early maturity allows the crop to escape drought and ensure early and quick provision of cash and food to the households to alleviate hunger (Obaa et al., 2005). De Groote et al., (2002) and Obaa et al., (2005) also found that among the favoured criteria are tolerant to drought, cob size; while Obaa et al., (2005) and Fitch (1983) found that resistance to pests and diseases, and grain size to be some of the criteria. Others are grain longevity, tastes, and colour (Obaa et al., 2005). It is therefore, important to determine from farmers their preferred traits in crop varieties or include the

farmers in a variety selection process. This enhances the potential for adoption decision process of the varieties in the respective communities.

Despite the above, limited studies (Fitch, 1983) in the literature show that the assigned criteria in selection of maize seed varieties during the adoption stage are similar to the continued use stage in the adoption process of the adopted technology. Before taking up the question of how seed selection criteria are maintained by the farmer for the continued use of the technology, it is useful to review farmers' seed selection practices. According to Louette and Smale, (1998) seed selection can take place at different times (e.g., prior to the harvest, at the time of harvest, after the harvest), at different places (e.g., in the field, at a drying or storage facility, in the home), and by different people (e.g., the farmer, the farmer's spouse or children, hired labourers). Harvested ears are brought home and segregated by variety, and the largest ears with good husk cover are opened and examined for characteristics such as kernel colour, kernel size, cob length, number of rows, and number of seeds per row. After that, ears that do not meet the selection criteria have been discarded, those remaining are shelled, and the grain is stored in storage facilities along with insecticide. Most maize farmers periodically choose to replace their seed, although seed replacement is frequently associated with the decision to change varieties (Maize variety adoption or Maize variety replacement). It is also observed among farmers who are satisfied with the variety they are growing and who have every intention of continuing to grow the same variety (seed replacement). For this latter group of farmers, the decision to replace seed is usually motivated by an observed decline in the performance of their current seed assortment (Fitch, 1983).

## **2.8 Conceptual framework**

For farmers to adopt a technology they are affected by a number of factors namely socio-economic characteristics, institutional, psychological and technological factors. Ehui et al., (2004) explained that a new technology introduced to smallholder farmers by itself alone does not guarantee for wide spread adoption and efficient use. For efficient utilization of the technology, fulfilment of specific socio-economic, institutional, psychological and technological conditions is required. From the farmers' perception, the new technology should be economically more profitable. The rate of adoption is influenced by the farmers' perception of the characteristics of the innovation. The new technology must also be technically easily manageable by smallholders and adaptable to the surrounding socio-cultural situations. Likewise, the availability of the new technology and all other necessary inputs to smallholders at the right time, place, quantity and quality should be basically given to guarantee adoption of the technology. According to van den Ban and Hawkins (1996), innovations usually are adopted rapidly when they have a high relative advantage to the farmers; compatible with the farmers' values, experiences and needs; are not complex; can be tried first on small scale and easy to observe the results. However, technology adoption incorporates two essential elements, the embracement of the technology by individuals and its embedment in society (Baron et al., 2006), cited by Deligiannaki and Ali, (2011).

It is apparently technology adoption involves different decision and stages. This may happen due to different in background, goal and circumstances in which farmers are passing through. With this background, it may be expected that farmers will adopt

agricultural technology in the reversible way in the adoption process. However, the decision-making process of farmers with respect to the adoption of new technologies is still poorly understood (Doss, 2006). Most previous studies focus on a onetime dichotomous adoption decision or on the intensity of technology adoption (Feder et al., 1985; Doss, 2006). Only very few studies separate the adoption process of farmers into different intermediate steps (Lambrecht et al., 2014). For instance, Diagne and Demont (2007) and Asuming- Brempong et al., (2011) separated between exposure and adoption to more accurately estimate technology adoption rates and investigate the factors determining adoption. Kabunga, Dubois, and Qaim (2012) further distinguished between awareness exposure (having heard about a technology) and knowledge exposure (understanding the attributes of a technology) to estimate adoption. Additionally, some studies have distinguished between try-out and continued adoption (or disadoption), and analysed the determinants of these decision steps (Moser and Barrett, 2006; Neill and Lee, 2001).

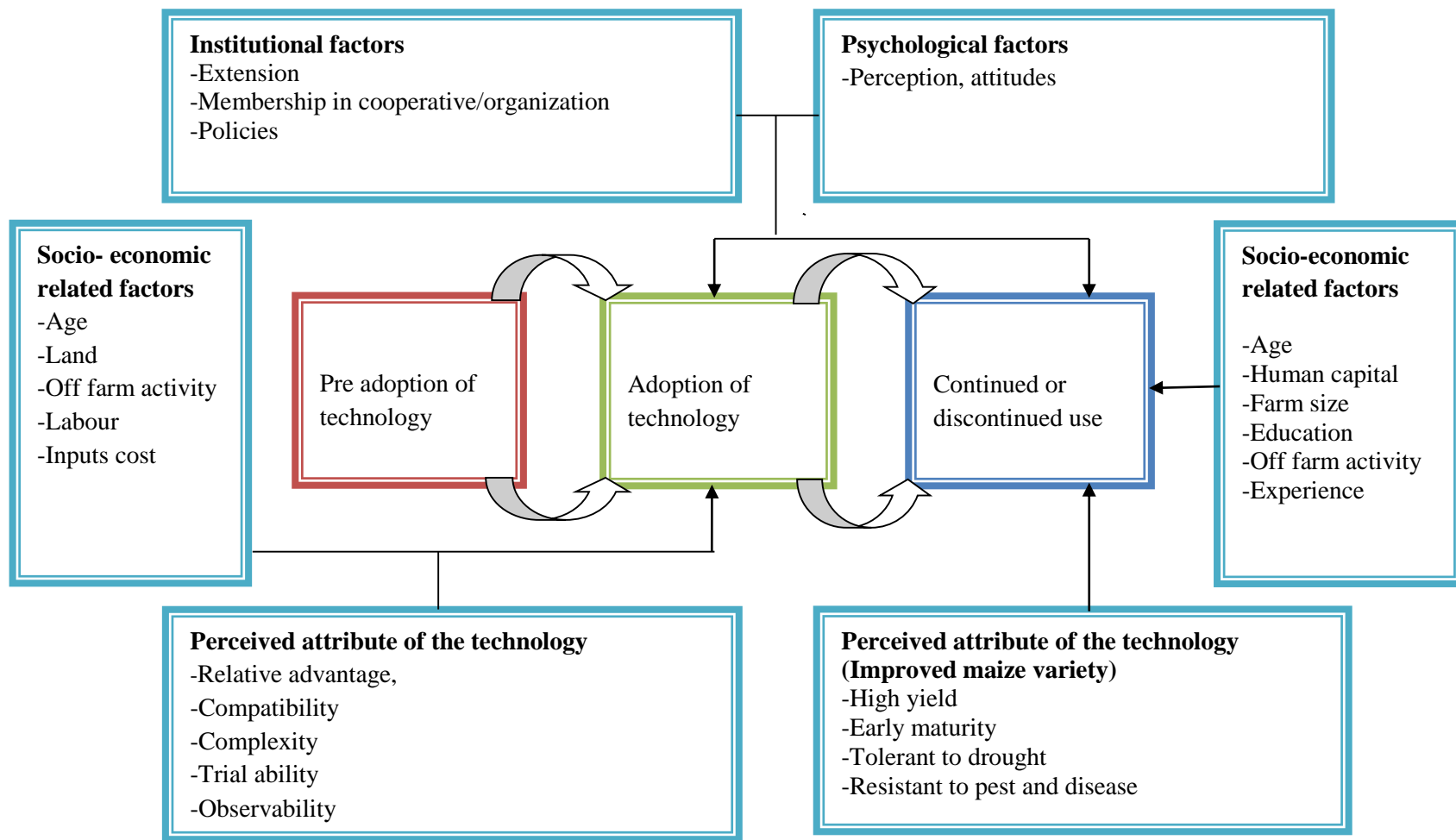
Qaim et al., (2006) identified age, education, farm size, as key explanatory factors of farm adoption. In the whether or not to adopt stage farmers' characteristics, farm traits as well as factors relevant to farmers' attitude toward risk, their current farm efficiency in return, and their expansion plan may all affect the adopt or not to adopt decision. Adoption intensity stage occurs in response to perceived risk of the new technology. All factors that affect adoption or not could also affect the adoption share. The adoption intensity decision must be dependent on the acquired information level determined in phrase 1, and the adoption versus non-adoption decision in phrase 2 (Pei and Zhigang, 2012). Youngseek and Crowston (2011) categorized adoption process into pre adoption, actual adoption,

continue or discontinue the adopted technology. According to Pei and Zhigang, (2012) considered pre adoption stage into information gathering where the farmer acquired information level; determine whether or not he understands the technology. When the information obtained reaches a threshold level, the farmer understands the technology and thus become potential adopter of this technology (Pei and Zhigang, 2012).

However, an important component of technology adoption decision making process which has received little attention is continued or discontinued use (Olalekan and Simeon, 2015). Furthermore, a household makes a decision to continue with the use of improved maize seed technology in a particular year only if the use of the technology can generate a net gain (Carletto et al., 1999). The little attention on the factors influencing the continued or discontinued use of technology entails an assumption that adoption is permanent change on farmer's decision which is not the case as it has been explained formerly. This is supported by Oladele (2005) who argued that adoption of improved maize seed technology will not improve food security and reduce poverty if barriers to their continued use are not considered.

To sum up, increasing agricultural productivity through the adoption of technologies (improved seed and other technologies) in Africa and other developing countries has been the key policy option in order to fight undernourishment. In line with this move, many studies have been conducted on the adoption of these technologies. Through synthesis of empirical studies from the literature above, show that most of them are focused on the factors that determine adoption of agricultural technologies (e.g. Madadil, 1999; Moshi

1998; Nkonya, 1998; Hassan et al., 2001; Pixky and Binzange, 2001; Barret, 2001; Ramsom et al., 2003; Dos et al., 2003; Etoundi and Dia 2008; Lyimo et al., 20014) among others. However, there is a limited literature on which to find out if a particular adopted technology whether it is continuously utilized or not. With respect to this so far, there has been little discussion in the literature about what factors influence the continued or discontinued use of the technologies (e.g. Lee, 2001; Oladele, 2005; Kiptot et al., 2007; Aklilu and Graaf, 2007; An, 2008; Tura et al., 2010 and Olalekan and Simeon, 2015). Additionally, among these authors, none was interested to investigate what characteristics of the technologies that take short or long period of time to be discontinued by adopters. Furthermore, authors failed to find out if the criteria used in the adoption stage are similar to the post adoption stage in the adoption process. It is therefore, from this ground that motivated this study to fill up existing gaps from the literature.



**Figure 2.2** The Conceptual framework of the study

Source: Adapted from Borges et al (2015)

## **2.9 Chapter summary**

This chapter has presented a literature review explaining concept of adoption and innovation process, adoption of technologies and practices in agriculture, factors affecting adoption of technologies, the continued or discontinued use of improved maize seed technologies. Moreover, the chapter contains the importance of maize, adoption of improved maize seed in Tanzania, farmers' evaluation criteria of maize seed technology. Finally, the chapter has presented the conceptual framework supporting the present study.



## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Introduction**

The chapter contains information on the study area, target group sampling procedures, sample size, data collection methods and tools which were used to collect data. Also this chapter contains information on data quality as well as on how the data were analysed. Finally, it presents the limitations of the study.

#### **3.2 Description of the study area**

Kilosa is the district in Morogoro region. To the north, it borders Tanga and Arusha region, to the east is Mvomero district. On the western border are Dodoma and Iringa regions while Kilombero district borders to the south. It lies between latitudes 6° South and 8° North and longitudes 36° 30' East and 38° West (NBS, 2012). The district occupies an area of 14 918 square km and according to NBS, (2012) indicated that there were 438,175 people living in Kilosa, distributed over 105,635 households (average household size of 5). The area is characterized by semi humid climate, receiving an average rainfall of 800 mm annually. The district receives rainfall in eight months (October-May) with highest levels between February and March. Temperature ranges from 18°C in the hills to as high as 30°C in the lowlands. Although Kilosa district has two rainy seasons, the pattern and amount of rainfall allow for one harvest of the main staples per cropping season. The early rains start in November and end in January followed by the period of heavy rainfall between March and June. The district experiences a long dry season from June to October with its varied

conditions, ranging from a plateau characterized by seasonally flooded plains, to mountainous areas with altitudes surpassing 2000m.

The main economic activities in the district are crop production and livestock keeping. Over 77% of people in Kilosa district fully depend on agricultural activities (URT, 2012; KDC, 2015). The district offers a variety of agro-ecological conditions for farming of varieties of crops in the district (Maganga and Odegaard, 2007). Major crops cultivated include maize, rice, sorghum, cassava, and legumes. Major cash crops are cotton, sisal, sugarcane, sunflower and groundnuts. The area of study was chosen for its people majorly depend on agriculture and the main crop of favourite being maize (KDC, 2015).

### **3.3 Target group**

The study mainly targeted farmers who adopted the main three selected improved maize varieties namely STAHA, STUKA and TMV1 as they have a wider understanding on the factors that may influence them to use improved maize seed varieties in the study area.

### **3.4 Sampling procedures**

#### **3.4.1 Sampling methods**

The study utilized a multi stage purposive sampling techniques. According to Kothari (2004), multistage sampling is convenient for studying large and diverse populations. At the first stage, a total of four divisions were purposively selected. The divisions were purposively selected because these are the agro ecological locations in the district where STAHA, STUKA and TMV1 improved maize seed varieties were grown. In the second

stage, at least two wards were purposively selected from each division to get a total of eight wards. These were selected based on the concentration of farmers who adopted improved maize varieties. In the third stage, simple random sampling (SRS) was used to get the actual unit of study or the farmers to be interviewed from eight wards. SRS was basically selected to avoid sampling biases, and ensure representative sample of the study. A sample of 286 farmers was drawn from the 8 wards in proportion to the population size in each ward.

### 3.4.2 Sample size

Sample size refers to the number of items to be selected from the universe to constitute a sample (Kothari, 2004). In this study, the sample size was 286 smallholder farmers obtained from the sampling frame of smallholder farmers. Calculation of a representative sample required an estimation of a population proportion  $p$ , and hence the following formula was used:

$$n = \frac{z^2(1-p)p}{e^2}$$

According to Cochran (1963),  $n$  is the desired sample size,  $z$  is the  $z$ -value which give the desired degree of confidence,  $p$  is an estimate of the population parameter and  $e$  is the size of error estimating the population parameter. The proportion of those farmers who adopted improved maize seed technology in Kilosa district was 77% (KDC, 2015).

Therefore, for 95% ( $z=1.96$ ) level of confidence, within  $\pm 5\%$  margin of error the sample size was determined as follows:

$$n = \frac{1.96^2(1.96e) 0.77}{0.05^2} = 272$$

And adding 5% for a possibility of non-respondents, the sample size was 286 smallholder farmers. Based on the total number of households in each ward which was obtained from Kilosa district the number of households selected from each ward (Table 3.1) was estimated using the following formula:

$$n_1 = \frac{P_1 * n}{P_2}$$

Where;  $n$ =Total sample 286,  $n_1$ = expected sub-sample,  $P_1$ = Population of the ward and  $P_2$ = Total number of households in 8 sampled wards.

**Table 3.1** The number of selected household in each ward

S/no	Wards	Households	Sample
1	Chanzuru	12229	31
2	Rudewa	18352	46
3	Masanze	7890	20
4	Zombo	9982	25
5	Ulaya	17354	44
6	Msowero	29361	74
7	Kitete	10247	26
8	Magole	7848	20
Total		113263	286

Source: KDC (2015)

### **3.5 Data collection methods and tools**

In this section, the data collection methods that were used to collect both qualitative and quantitative data in this study are presented jointly with the underlying reasons for their selection.

#### **3.5.1 Focus group discussions (FGD)**

The present study defines focus group discussion (FGD) as dynamic group discussions used to collect information in a specific topic (Wilkinson, 2004). A focus group discussion allows a group of 8 – 12 informants to freely discuss a certain subject with the guidance of a facilitator or reporter. FGD was selected with a number of reasons: it is quick and relatively easy to set up, group dynamics can provide useful information that individual data collection does not provide, and is useful in gaining insight into a topic that may be more difficult to gather information through other data collection methods (Margaret, 2009). Morgan (1997) recommends that 3 to 6 FGDs are sufficient to attain data saturation point. Because participants might not be available on the day of the focus group, Morgan (1997) has suggested over recruiting by at least 20% of the total number of participants required. In this study, 5 focus group discussions consisting of at least 3-4 females and 4 male maize farmers in each ward were employed. The participants were recruited with the help of ward agricultural extension and village executive officer. The discussion was guided with enumerators who had a focus group discussion guide. However, the discussion was influenced by what participants say. Some of the issues raised in the discussion were incorporated in the questionnaire for further investigation. With the participants' consent, all focus group discussions were audio recorded.

### **3.5.2 Survey questionnaire**

Survey questionnaire is a data collection instrument consists of a series of questions that prompt for the purpose of gathering information from respondents (Abawi, 2013). A questionnaire allows to collect the most complete and accurate data in a logical flow. This is done in order to reach reliable conclusions from what we are planning to observe. In this study survey questionnaire was selected because of providing a high level of general capability in representing a large population. Due to the usual huge number of people who answer survey, the data being gathered possess a better description of the relative characteristics of the general population involved in the study. As compared to other methods of data gathering, surveys are able to extract data that are near to the exact attributes of the larger population (Mae, 2012). In this study the questionnaire survey was organised into six modules:

#### **I. Questionnaire identification and summary of interview**

It highlights how the questionnaire was coded, name of researcher assistant involved in the process. Finally, it shows the period when data was entered in statistical software and the clerk who entered the data (refer appendix 5).

#### **II. Household identification and demographic**

This module summarizes how the respondents were identified in order to properly tract information during data collection and analysis, it also presents the demographic variables which affect choice and continued or discontinued use of improved maize varieties. Based on theory and empirical literature, variables of interest which were tested in order to identify their influence on choice and continued or discontinued use of improved

technology were age and education level of the household (refer Table 3.3 and 3.4 for description and measurements of variables).

### **III. Respondents' agricultural production**

This module presents the socio economic and institutional variables which influence respondents' choice and continued or discontinued use of improved maize varieties in the area. These included the total size of land respondents own for agricultural production, land allocated for improved maize varieties, farming experience, source of labour, engagement in off-farm activity, income obtained from off farm activity, access to credits/loans, amount of credits/loans and finally the section draws information of respondent's membership in cooperatives/ farmers organization. However, basing from literature synthesis only total size of land for agricultural production, land allocated for improved maize variety production, farming experience, source of labour, membership in cooperative/farmers organization variables were included in the models for further analysis (refer Table 3.3 and 3.4 for description and measurements of these variables).

### **IV. The use of improved maize seed varieties from 2010/2011-2014/2015 grown season**

This module highlights information on the name and type of maize varieties grown by respondents, source of seed, reasons for choosing maize variety, fertilizer application, and type of fertilizer applied. Finally, it presents farmers preference ranking of maize variety in order of importance based on the perceived attribute of varieties. The section also obtained information on the production trend of maize varieties where farmers were asked to give information on the quantity of harvest based on production records for the period of five years. Furthermore, drawing from the literature, only four variables on perceived attributes

of the variety such as high yield, early maturity, tolerant to drought; and resistant to pest and disease were selected for further investigation in the models. Additionally, the perceived attributes of the variety from the FGD were also input in the questionnaire (refer to Table 3.3, 3.4 & 3.5 for description and measurement of the selected variables).

#### **V. Agricultural extension services**

Here the module seeks information if farmers have access to extension services; where do they obtain the services. Finally, the module draws information on the frequency of extension service contacts in 2014/2015 growing seasons. Based on theory, empirical literature, and researchers' knowledge of the contextual setting, farmers access to extension services and frequency of extension contact were the variables which were sought for further analysis in the models (refer to Table 3.3, 3.4 and 3.5 for description and measurement of the variables).

#### **VI. Farmer's perception on specific maize varieties grown from 2010/2011-2014/2015**

The module captures information on the farmer's opinions on specific maize varieties that they continued or discontinued using them in their field. Also it draws the underlying reasons for their opinions. Farmers opinions raised during the FGD were also included in this module in order to capture farmers' diversity views on a variety being grown for the period of five years.

Using a semi structured questionnaire, 268 improved maize seed varieties household farmers were individually interviewed to obtain both qualitative and quantitative data (refer appendix 5 for more details of the survey questionnaire).



### **3.5.3 Key informant interviews (KII)**

Key informant interviews are qualitative in-depth interviews with people who know what is going on in the community. The purpose of key informant interviews is to collect information from a wide range of people including community leaders, professionals, or residents who have first-hand knowledge about the community (Carter and Beaulieu, 1992). These community experts, with their particular knowledge and understanding, can provide insight on the nature of problems and give recommendations for solutions. The method was selected because of its ability to complement FGD and survey questionnaire (Marshall, 1996).

A total of 18 key informants were selected from district, wards and village levels for interview. These included 1 District Agriculture, Irrigation and Cooperative officer, 8 ward agricultural extension officers and 9 village agricultural extension officers. A checklist was used to collect information from the key informants (refer appendix 2 and 3 for description of the checklist questions).

Key informants were obtained after seeking permission from the District Executive Director (DED) for conducting the research. They were informed prior in order to seek for their consent. In an attempt to make each interviewee feel as comfortable as possible, the interviewer gave participants a room to explain issues of concern that were also input into the research questions for further investigation.

### 3.6 Research Design

The methods and tools of data collection which has been presented above are summarized in the research design in Table 3.2.

**Table 3.2** Research design details

No	Specific objective	Specific type of data	Sources of data	Data collection method	Data analysis
1	To identify factors which influence farmers to continue or discontinue utilization of selected adopted improved maize seed varieties	Age, farm size, source of labour, education, farming experience, extension services, membership in cooperatives, high yield, early maturity, tolerant to drought, resistant to pest and diseases	286 Farmers, 10 key informants FGDs	Individual interview using semi structured questionnaire, key informant interview using checklist, 5FGD using SSDG	Descriptive statistics (means, percentage) Multinomial Logistic model, Logit model Content analysis(KII&FGDs)
2	To identify the evaluation criteria that farmers used to make decision to continue or discontinue using adopted improved maize seed varieties	Criteria used by farmers to decide to continue or discontinue using adopted improved maize seed varieties	286Farmers, 8 key informants FGDs	Individual interviews using semi structured questionnaire, key informant interview using checklist 5FGD using SSDG	Descriptive statistics (frequencies, percentages) Content analysis (KII&FGDs)
3	To assess the extent of production of the selected adopted improved maize seed technologies	Quantity of maize produced (kg) for the selected improved maize seed varieties in the past five years.	286 Farmers	Individual interview using semi structured questionnaire	Descriptive statistics (percentages, mean, frequencies Tobit model)

### 3.7 Methods of data processing and analysis

This section provides a description of the methods which were used in the actual analysis of the data set to test the statistical significance of the various factors hypothesized to

influence the use of technology. The data collected were coded and analysed using a Statistical Package for Social Sciences (SPSS) software to obtain descriptive statistics focusing on frequencies, means and percentages to summarize the farmers' characteristics. STATA was used to analyse proportional differences.

### **3.8 Modelling specification**

**Objective 1:** To identify factors which influence farmers to continue or discontinue utilization of selected adopted improved maize seed varieties.

In this objective, unordered multinomial logistic and binary logit models were employed to analyse factors influencing the choice and continued or discontinued use of improved maize seed varieties, respectively. The decision problem is separated into two stages, with each stage represented by separate model. First model dealt with farmers' choice of improved maize varieties. The second model targeted the continued or discontinued use (binary decision) of improved maize variety when it has been chosen by a farmer.

#### **3.8.1 Multinomial logistic model**

A multinomial logistic (MNL) regression model is to empirically identify the drivers of farmers' choice of improved maize variety. MNL models assume that the error terms are independently and identically distributed (Greene, 2003). In this study, an unordered multinomial logistic model is useful because it can take care of categorical dependent variables (such nominal categories of dependent variables having multiple choices). The multinomial logistic regression model which was used in this study estimates the effect of the individual variables on the probability of choosing a type of improved maize varieties.

Improved maize varieties used in the study area were characterized after which the most common varieties preferred by farmers (or decision categories) were identified. These varieties comprised of the decision categories for the multinomial logit model having combinations denoted as  $j= 1$  if farmer chooses STAHA(STA<sub>1</sub>) variety,  $j= 2$  if farmer chooses STUKA(STU<sub>1</sub>) variety,  $j= 3$  if farmer chooses TMV1(TM<sub>1</sub>),  $j= 4$  if farmer chooses STAHA and STUKA(STA<sub>1</sub>STU<sub>1</sub>) varieties,  $j=5$  if farmer chooses STUKA and TMV1(STU<sub>1</sub>TM<sub>1</sub>) varieties,  $j=6$  if farmer chooses STAHA and TMV1(STA<sub>1</sub>TM<sub>1</sub>) varieties,  $j= 7$  if farmer chooses both STAHA, STUKA and TMV1(STA<sub>1</sub>STU<sub>1</sub>TM<sub>1</sub>) varieties at ago,  $j= 8$  if farmer chooses other varieties than the selected maize varieties (STA<sub>0</sub>STU<sub>0</sub>TM<sub>0</sub>). Drawing from the discrete choice theory of utility maximization (McFadden, 1976), the choice of the improved maize variety is based on the option that maximizes utility subject to the inherent cost (financial or nonfinancial) which is determined by perceived attribute of the technology, institutional, socioeconomic characteristics of the farmer. However, the 8 possible combinations in the model were not possible as a negligible number of farmers chose more than one improved maize variety such as choice of STAHA and STUKA, STAHA and TMV1, STUKA and TMV1, and STAHA, STUKA and TMV1 varieties. This prompted the researcher to select only those alternatives/ choices which would bring significant results, so to say, the alternative dependent variables which were subjected into the model were STAHA, STUKA, TMV1 and other varieties (STA<sub>0</sub>STU<sub>0</sub>TM<sub>0</sub>). Therefore, following the work of Greene (2003), an unordered MNL model for the choices of the varieties subjected into the model was specified as follows:

$$Pr(Y = 1) = \frac{e^{\beta_j' x_i}}{\sum e^{\beta_k' x_i}}, j = 0, 1, 2, 3 \quad (1)$$

The estimated equation (1) leads to a set of probabilities for  $j^{th}$  choices of maize varieties for a farmer ( $i$ ), in this case, maize varieties are four that is STAHA, STUKA, TMV1 and other varieties (STA0STU0TM0). Vector  $X_i$  describes technology perceived attributes (maize varieties), institutional and individual socioeconomic characteristics.  $\beta^j$  describes the vector coefficients of  $X_i$  associated with the  $j^{th}$  maize variety (Greene, 2003).

$$Pr(y = 0) = \frac{1}{1 + e \sum e^{\beta_k' x_i}} \quad (2)$$

Normalization is achieved by setting  $\beta_0 = 0$  as presented in equation 2. Thus, obtain a vector  $\beta^j$  for each probability except for the one which is a normalized alternative (a reference or base outcome). The estimated coefficients of the model can therefore be interpreted as the effect of the vector  $x_i$  on the probability of an improved maize variety  $j$  relative to the improved maize variety which is a base outcome (reference category). In this case, the reference/base outcome was TMV1 variety.

The effect of a unit changes in any of the  $X$  explanatory variables on the probability that the  $i^{th}$  farmer will choose a particular maize variety is given by the marginal effect statistic (Greene, 2003), which is derived as follows:

$$\Delta P_j / \Delta X_i = P_j \left[ P_j - \sum_{k=1}^m P_k \beta_k \right] \quad (3)$$

Based on theory, empirical literature, and researchers' knowledge of the contextual setting, 9 explanatory variables were identified and used. The potential explanatory variables which were hypothesized to influence farmers' choice of improved maize varieties in the study area are briefly described and presented in Table 3.3.

**Table 3.3** Description of the variables used in the Multinomial Logistic regression model

<b>Dependent variables</b>	<b>Description and Measurement of the variable</b>	
Variety choice(Varieties2)	Choice of STAHA(STA <sub>1</sub> )variety=1, Choice of STUKA(STU <sub>1</sub> ) variety=2, Choice of TMV1(TM <sub>1</sub> ) variety=3, Other varieties (STA <sub>0</sub> STU <sub>0</sub> TM <sub>0</sub> )=4	
<b>Independent variables</b>	<b>Description and Measurement of the variable</b>	<b>Expected sign</b>
High yield (HIYDA)	Potential yield of maize variety (dummy: yes=1, no=0)	+
Early maturity(ERRMA)	Maize variety take short period to mature(dummy: yes= 1, no= 0)	+
Age	Age of household head ( $\geq 18$ years) in years of age	$\pm$
Land(landimv)	Land allocated to production of improved maize seed varieties (hectares)	$\pm$
Cooperatives (coptive)	Memberships in cooperatives/farmers organization (dummy: yes=1, no=0)	+
Extension (extnsvc)	Access to agricultural extension services (dummy: yes=1, no=0)	+
Household labour (HOUSEH)	Available household labour for farming(dummy: yes =1, n = 0)	$\pm$
Hired labour(HIRED2)	Available hired labour for farming (dummy: yes= 1, no= 0)	$\pm$
Education (Eductn)	Formal education of households head in years of schooling (continuous)	$\pm$

### **3.8.2 Diagnostic test for Multinomial Logistic regression model**

#### **i. Independence of Irrelevant Alternatives (IIA)**

In order for the parameter estimates of the MNL model in Eq. (1) to be unbiased and consistent, the Independence of Irrelevant Alternatives (IIA) is assumed to hold (Deressa et al., 2008). IIA assumes that an individual's choice of the alternative relative to another would not change if a third viable alternative is added or dropped. Basing on the approach of Hausman and McFadden (1984) and Cheng and Long (2007), the validity of this restriction for the model was tested using Hausman test. Test results showed that the IIA cannot be rejected<sup>1</sup>. The test indicated that the multinomial logit specification was appropriate in modelling farmers' choices of improved maize varieties in Kilosa district.

#### **ii. Normality**

This was done to examine the normality assumption which is basically the disturbance terms, the violation of the normality assumption is known as non-normality. Using kernel density plot, the kernel density graphs for the choice of maize varieties data were fairly smooth and they appeared to be closely matched the normal curve. Therefore, it can be concluded that the normality assumption was not violated in the regression.

#### **iii. Heteroskedasticity**

The aim of this test is to detect the non-exhibit of the constant variance of response variable against the explanatory variables in the model. Breusch-Pagan (BP) test (hettest) was conducted to assess the presence of heteroskedasticity in the model, the test result showed

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<sup>1</sup> The test compares the coefficients of a multinomial logistic model with 3 alternatives (i.e. one alternative is dropped from the initial set of 4 alternatives) to those of the original multinomial logistic model with 4 alternatives. Therefore, there was in total 3 tests that were conducted. Under the null hypothesis, the statistic follows a  $\chi^2$  (27) distribution. Computed statistics were equal to -3.02, -33.43 and -15.28 when the alternative 2, 3, and 4 were dropped, respectively. All of them were much lower than the critical value of a  $\chi^2$  (27) at the 5% level, 139.14. Hausman and McFadden (1984), Cheng and Long (2007) concluded that the negative statistics results is fairly often but taken as the evidence that IIA assumption holds.

that there was no problem of heteroskedasticity (non-constant variance) since the  $\text{Prob}>\chi^2 = 0.8173 > 0.05$ . Thus, the null hypothesis of constant variance cannot be rejected. According to Verbeek (2009) heteroskedasticity is likely to be encountered quite often in cross-sectional data and it causes parameter estimates to be inconsistent.

### **3. 8.3 Logit model**

To identify key reasons why farmers, continue or discontinue using the selected improved maize varieties, the Logit model was used. When the dependent variable is binary and can only take two values (continued user of the variety = 1 and discontinued user = 0), Logit model is the standard method for analysis (Hosmer and Lemeshow, 2000). The second advantage of using the Logit model, because it could identify the factors influencing the continued or discontinued use of STAHA, STUKA and TMV1 improved maize varieties (Agresti, 2007; Gujarat, 2004). Another advantage on the choice of the model is the fact that it does not impose the normality assumption on predictors (Al-Ghamdi, 2001) but directly estimates the probability of an event occurring or not occurring (Muchabaiwa, 2013).

To identify the impact of high yield, early maturity, resistant to pest and disease, experience in years of farming, household labour, hired labour, education level, and extension service contact on the continued or discontinued use of for the three selected improved maize varieties, three regressions using the binary logistic model were used. Therefore, following the work of Harrell (2001), Logit Model was specified as follows:



$$\text{Logit}[\phi(x)] = \log[\phi(x) / 1 - \phi(x)] = \alpha + \beta_1 x_1 + \beta_2 x_2 + \dots \beta_i x_i \dots e \quad (4)$$

Where:

$\phi(x)$  = The probability of success (case)

$1 - \phi(x)$  = The probability of failure (non-case)

$\alpha$  = The constant of the equation

$\beta$  = The coefficient of the predictor variables

$e$  = Error term

The above equation can be simplified as:

$$Y_1 = \ln(P/1 - P) = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9) + e \quad (5)$$

Where:

$Y_1$  = Continued use of STAHA, STUKA and or TMV1 improved maize varieties

$x_1$  = High yield perceived maize attribute

$x_2$  = Early maturity perceived maize attribute

$x_3$  = Resistant to pest and diseases perceived maize attribute

$x_4$  = Farm size

$x_5$  = Household head's farming experience

$x_6$  = Household labour

$x_7$  = Hired labour

$x_8$  = Education

$x_9$  = Extension service contact

$e$  = Error term

The description and measurement of the dependent and explanatory variables in the model are defined in Table 3.4.

**Table 3. 4** Description of the variables used in the Logit model

<b>Dependent variables</b>		
<b>Description and Measurement variables</b>		
Continued or discontinued use of maize varieties	1. Continued use of STAHA variety = 1, otherwise= 0 (dummy)	
	2. Continued use of STUKA variety = 1, otherwise= 0 (dummy)	
	3. Continued use of TMV1 variety= 1, otherwise = 0 (dummy)	
<b>Independent Variables</b>		<b>Expected sign</b>
<b>Description and Measurement of variables</b>		
High yield (HIYDA)	Maize variety with high yielding attribute(dummy: yes= 1, no=0)	+
Early maturity (ERRMA)	Maize variety that takes short period to mature (dummy: yes= 1, no= 0)	+
Resistant to pest and disease(RESFDA)	Maize variety with resistant to pest and disease attribute (dummy: yes=1, no= 0)	+
Farm size (Sizeagrl)	Total land owned by household for agricultural activity in hectares( continuous)	±
Experience (Yrsfarm)	Years of experience of the household in farming (continuous)	+
Household labour (HOUSEH)	Available household labour for farming(dummy; yes =1, n = 0)	±
Hired labour (HIRED2)	Available hired labour for farming (dummy: yes= 1, no= 0)	±
Extension service contact(Extcnt)	Number of visit by an extension agent to farmers (continuous)	+
Education (Eductn)	Household education level in years of schooling (continuous)	±

#### **3.8.4 Diagnostic Multicollinearity test for Logit model**

Variance Inflation Factor (VIF) was employed to detect Multicollinearity among the explanatory variables. Multicollinearity is a high degree of correlation (linear dependency) among several independent variables. No Multicollinearity exists if the VIF is below 10. The VIF values of independent variable in the continued use of STAHA, STUKA, and TMV1 variety range from 1.39 to 1.03, 1.26 to 1.03, and 1.41 to 1.03; and have a mean VIF of 1.13, 1.14 and 1.15, respectively. Thus, it can be concluded that no virtually Multicollinearity exists between the variables.

**Objective 2:** To assess the evaluation criteria that farmers used to make decision to continue or discontinue using the adopted improved maize seed varieties.

In this objective, evaluation criteria used by farmers were obtained during focus group discussion where main consensus in farmers' responses helped to create themes which were then input into the questionnaire to get descriptive statistics explicitly percentages and frequency with the purpose of quantifying farmers' evaluation criteria for the continued or discontinued use of the variety.

#### **3.8.5 Tobit regression model**

**Objective 3:** To assess the extent of production of the selected adopted improved maize seed technologies.

Tobit regression model was used to establish the relationship between the extent of production of continued use of adopted improved maize varieties and the independent variables that could impact it. The model encompasses deciding on the level i.e. the

intensity or extent of use of that technology; given that adoption has taken place (Wabbiet al., 2006). Tobin (1958) established a framework for estimating models of censored dependent variables. The Tobit model, named after its inventor, is defined as:

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases} \quad (6)$$

Where  $y_i^* = \beta x + \mu_i$  latent variable,  $\mu_i$  is an independently and identically distributed normal random error term with mean zero and constant variance  $\sigma^2$  and  $x$  and  $\beta$  are vectors of covariates and parameters to be estimated, respectively. The Tobit model is probabilistic and non-parametric in nature targeting missing observation on the dependent variable. Being probabilistic means that the success of an event is seeing a maize variety been continued to be utilized by farmers while the failure is observed when a variety is discontinued to be used by farmers. Whether the variety is continued or discontinued, the extent of production could be measured by the actual yield (kg) or harvest of maize of a given specific variety. The actual yields had to cover only farmers that have grown a variety for only five (5) years. Tobit (Tobin, 1958) is used to analyse quantitative adoption decisions when information on the intensity or extent of adoption is available (e.g., data on percentage of area planted to improved varieties, amount of fertilizer/herbicide applied, etc.).

However, in working with continuously measured dependent variables such as quantity or area, some of the data points will have a zero value (i.e., for discontinued-users). In this case the dependent variable is censored where information is missing for some range of the

sample. If information on the dependent variable is available (only if the independent variable is observable) the dependent variable is described as truncated (Kennedy, 1992). The Tobit model was chosen because it would offer coefficients that can be further disaggregated, and determine the effect of a change in the  $i^{\text{th}}$  variable. With respect to continued or discontinued use of the three selected varieties (i.e. STAHA, STUKA and TMV1), three Tobit models were estimated to determine the relationship between the extent of production of each variety and the explanatory variables; assuming that farmers have already made their decision to continue using the selected varieties for the period of five years.

Table 3.5 provides a description and measurement of the variables used to analyse objective 4 for each variety in the Tobit model, which were majorly drawn from literature and prior focused group discussions.

**Table 3 5** Description of the variables used in the Tobit model

<b>Dependent variables</b>	<b>Description and Measurement variables</b>	
Extent of production of the three selected varieties	4. Extent of production of STAHA variety in kg of yield harvested(continuous)	
	5. Extent of production of STUKA variety in kg of yield harvested(continuous)	
	6. Extent of production of TMV1 variety in kg of yield harvested(continuous)	
<b>Independent Variables</b>	<b>Description and Measurement of variables</b>	<b>Expected sign</b>
High yield (HIYDA)	Maize variety with high yielding attribute(dummy: yes= 1, no=0)	+
Early maturity (ERRMA)	Maize variety that takes short period to mature (dummy: yes= 1, no= 0)	+
Tolerant to drought (DROTA)	Maize variety which stands with drought occurrence (dummy: yes=1, n= 0)	+
Age	Age of household head ( $\geq 18$ years) in years (continuous)	$\pm$
Land (Landimv)	Land allocated on production of improved maize varieties in hectares (continuous)	$\pm$
Extension (Extnsvc)	Access to agricultural extension services ( dummy: yes=1, no=0)	+
Household labour (HOUSEH)	Available household labour for farming(dummy; yes =1, n = 0)	$\pm$
Hired labour (HIRED2)	Available hired labour for farming (dummy: yes= 1, no= 0)	$\pm$

### **3.8.6 Diagnostic test for Tobit model**

#### **i. Normality Test**

The maximum likelihood estimation of censored regression model has been named ‘Tobit’ after Tobin (1958). It is well known that the validity of the Tobit estimator depends on the assumption of normality (Jeong and Jeong, 2010). Arabmazar and Schmidt (1982) show that the Tobit estimator becomes inconsistent when the normal distribution assumption of the disturbance is not satisfied. To test for normality assumption of the data set used to fit this model, a kernel density plot was used. The kernel density plot provided fairly smooth graphs which seemed to be closely to the normal curve. Consequently, normality assumption still holds.

#### **ii. Multicollinearity**

Multicollinearity is a high degree of correlation (linear dependency) among several independent variables which may lead in majoring the same concept. Variance Inflation Factor (VIF) was used to check the statistics on whether Multicollinearity exists among the independent variables in the model. (No Multicollinearity exists if VIF is below 10). Since the mean VIF for three estimated Tobit models on the extent of production of STAHA, STUKA and TMV1 improved maize varieties was 1.20, 1.16 and 1.18 < 10, respectively. So, it can be concluded that there is no Multicollinearity problem exists in the variables.

### **3.9 Validity and reliability of instruments/tools**

Validity of an instrument can be defined as the degree to which an instrument accurately measures what it is expected to measure. According to Ary (2010), *validity* is often defined as the extent to which an instrument measure what it claimed to measure. Reliability of

measurement instrument can be defined as the ability of an instrument to yield similar or the same results on repeated trials. *Reliability* of a measuring instrument is the degree of consistency with which it measures whatever it is measuring (Ary, 2010). In this study, the measurement instruments/tools were developed at Lilongwe University of Agriculture and Natural Resources and shared with experts in the field from Lilongwe University of Agriculture and Natural Resources and Sokoine University of Agriculture for scrutiny and incorporation of their inputs. Finally, the instruments were pre- tested to check its reliability in line with farmers' responses, anticipation and understanding. A total of 29 farmers were involved in the pretesting. Baker (1994) stated that a sample size of 10-20% of the sample size for the actual study is reasonable number of participants to consider enrolling in a pre-testing study of the instrument.

Following the pre- testing and consultation from experts, necessary changes were made to the instruments to ensure consistency and validity of the questions, which was insured by employing among others triangulation technique. Patton (2001) advocates the use of triangulation by stating that "triangulation strengthens a study by combining methods". This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches.

### **3.10 Recruitment and training of research assistants (RAs)**

Four Research Assistants were recruited to help in data collection based on the following criteria: familiarity with issues in agriculture, experience with participatory methodologies for example focus group discussion and conducting face to face interviews. To guarantee



the quality of data that research assistants (RAs) collected, the two-day training was conducted on what was supposed to be done in the field. The topics that were covered in the training were: introduction to the study, purpose and objectives of the study; how to establish rapport with respondents; issues of confidentiality and voluntary participation by study participants; and ethics in research.

### **3.11 Limitation of the study**

Increasing the number of divisions studied for assessment of the factors influencing the use of improved maize varieties, may enhance the generalizability of the findings. However, this was not possible due to limited financial resources to conduct the study in a large coverage. Consequently, readers should therefore treat the current findings and conclusions with caution. Adequacy and convenience of the sample used in the current research may not be representative of the populations under study. In addition, the cross-sectional nature of the current data suggests that the interpretation of results should be limited to the information obtained from farmers with both informal and formal education at the time when this research was conducted. Farmers were asked to provide information regarding use of improved maize varieties for the period of five years, this situation led to memorization and sometime obtaining incorrect information. Together with these limitations, the findings are expected to provide valued information in designing appropriate agricultural technology interventions to farmers in Tanzania.

### **3.12 Chapter summary**

The chapter has discussed the methodology used in the study. The chapter further presented the description of the study area, target group, sampling procedure, data collection methods and tools, research design, methods of data processing and analysis, modelling specification, validity and reliability of instrument/tools, procedures for recruitment and training of research assistants. Finally, the chapter presented limitation of the study.

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSION**

#### **4.1 Introduction**

The chapter presents result and discussion of this study. The chapter first presents the respondents characteristics, socio- economical and institutional and technological factors that influenced the choice, continued or discontinued use of improved maize varieties, the evaluation criteria that farmers used to make decisions to continue or discontinue utilization of improved maize varieties. Lastly, presents how specific factors influenced respondents' extent of production of the selected adopted improved maize varieties.

#### **4.2 Socio-economic characteristics of respondents**

The findings show that 57.3 % of respondents were male headed households and 42.7% were female headed households (Table 4.1). This implies that proportion of female headed households who engage in farming is low compared to male headed households. According to Jera and Ajayi, (2008) and Kassie et al., (2012) female headed households may respond less favourably to adoption of new technology than male headed households due to wealth differences as well as cultural factors. Males are usually in a better position to attend extension meetings in traditional set-ups and thus have more access to information on new agricultural technologies. However, some female heads are also enthusiastic enough and would as well be more willing to try new technologies (Jera and Ajayi, 2008). Accordingly, Adisa and Okunade, (2005); Akinagbe et al., (2008) and Nsoanya and Nenna, (2011) reported that females are the backbone of agricultural sector and agricultural production.

With respect to use of improved maize seed varieties (Tura et al., 2010) argued that improved varieties traditionally require more male agricultural labour tasks.

**Table 4.1** Characteristics of respondents in Kilosa district (n=286)

Characteristics	Descriptions	Frequency	Percent	
Sex of the household	Male	164	57.3	
	Female	122	42.7	
Marital status	Single	25	8.7	
	Married	234	81.8	
	Divorced	15	5.2	
	Widow	10	3.5	
	Widower	2	0.7	
Main occupation	Farming	282	98.6	
	Business	2	0.7	
	Labourer	2	0.7	
	Mean value	S.D* value	Minimum	Maximum
Education level (year of schooling)	6.94	2.24	0	13
Age of respondent(years)	44.96	12.680	18	78
Farming experience(years)	19.29	11.571	2	60
Household size	5.28	2.681	1	23
Size of land(hectare)	2.1182	2.34208	0.40	20.00

Key: S.D\* = Standard Deviation

The results in Table 4.1 also present marital status of the respondents. About 9% of respondents interviewed were single, 81.8% married, 5.2% divorced 3.5% of the female widowed while 0.7% of males were widowed. The results indicate that most of the farmers in the area are married and it is assumed that marriage creates some stability and also improves access to more family labour for agricultural activities as they are forced to feed

their family (Omotesho et al., 2014). Marital status in most cases is considered to be a crucial aspect in household decision making, whereby the married ones are given priority to get involved in decision making (Ekong, 2000; Bamneke and Olowu, 2005).

Further, the results in Table 4.1 show that 98.6% of the respondents engaged in farming as their main occupation. Other occupations of the respondents were business and labourer. This implies that being engaged fully in farming is an indication that farmers depend mainly on farming activity as one of their endeavour in earning their livelihood (Afolami et al., 2015 and Urasa, 2015). On the other hand, Diagne and Demont, (2007) argued that farmers whose main occupation is farming may miss information about improved technologies since they do not attend meetings/training, and full time farmers spend more time on farm, thereby not availing themselves the opportunity of knowing about improved varieties.

The results in Table 4.1 also show education level of respondents, whereby the average education level was approximately 7 years while highest level was 13 years. The finding implies that majority of the respondents have basic education which can help them in their agricultural activity. Education has an important role in farming especially when farmers are trained on a particular aspect and put it into practice. Educated farmers can easily seek information and disseminate it to other farmers who are not knowledgeable enough. According to Ja'afar-Furo, (2007) argued that educational attainment of people plays an important role in their ability to acquire innovations faster, and introducing new agricultural techniques in the educated society should not encounter many difficulties. Also

other studies in the literature which show the positive effect of education level on adoption decision are Mishra and Park, (2005); Mishra et al., (2009); Robert et al., (2004); Fernandez-Cornejo et al., (2001). However, Tura et al., (2010) in Ethiopia reported that households headed by literates are relatively less likely to adopt improved maize varieties, which can be related to the fact that the relatively more educated household heads are youngsters and that land ownership among the youth is minimal, hence are land constrained. It was likewise reported in Ethiopia that education influences timing of adoption but not whether to adopt an agricultural innovation or not (Weir and Knight, 2000). Human capital accumulated through longer years of formal education becomes an advantage to find more off-farm employment opportunities, which makes farming relative less attractive (Uematsu and Mishra, 2010).

Age holds an important value to be considered in farming as it is sought to influence uptake of innovations. The results in Table 4.1 signpost that the average age of respondents was approximately 45 years. The oldest respondents were 78 years old while the minimum age was 18 years old. The result implies that majority of respondents possess active production age. This finding is in line with the finding of Adesope et al., (2012) who testified that, the active productive age of farmers is between 41 and 50 years and as such, farmers in this age range can withstand stress which may have an implication on farmers productivity as well as the spread of innovation (Ayoade, 2013 and Babasanya et al., 2013). It can be deduced also that young farmers are more knowledgeable on better practices and may be more ready to take risk and adapt to better farming techniques because of their willing to achieve more production in their fields (Abunga et al., 2012). On the other hand, the

literature suggests that as farmers get older they become more conservative and less open to new ideas (Tshikala et al., 2015).

The findings in Table 4.1 show that respondents have been farming for about 19 years on average, Standard deviation (11.571). The lowest farming experience was 2 years while the maximum year was 60 years. The finding implies that farmers had more experience in agricultural production and technology uptake. This is in line with Johannes et al., (2010) and Kudi et al., (2011) who argued that as farmers gain more experience they are abler to evaluate the benefits of new technologies and therefore, increase the rate of adoption. With respect to the use of improved maize varieties; farmers may use this experience in making decision on their utilization, this is supported by the finding of Edeoghon's, (2008) which indicated that farmers usually are more involved in practices that they are more familiar with than other practices.

Household size also in many village settings is believed to be one of the sources of labour. The findings in Table 4.1 reveal that, an average household size of respondents interviewed was approximately 6 people, above the average number of 5 household people in the country (NBS, 2012). In other instance, it was found that a household had 23 people while the lowest was one person. This may imply that households have labour source which is needed in farming activity. Household size is an important source of labour especially during the peak of farming, for example, during weeding and harvesting where an evenly available farming labour is required (Njuguna et al., 2015). Also large household size in village setting demands engagement of people in agriculture to feed the number of people

in their household (Feng, 2008). However, Kudi et al., (2011) reported that the larger the household size the lower the level of adoption of improved maize varieties. Large household size might imply more cash constrain as the need to meet the family daily requirements increase with large family size, thus leaving the household with little cash to purchase production inputs and new technologies (Audu and Aye, 2014).

Land in agriculture is sought to be one of the productive resources for people to engage in agriculture. The results in Table 4.1 show that the average land owned by the respondents interviewed was approximately 2 hectares while the smallest land size was 0.4 hectare. Other respondents possessed 20 hectares of land. This suggests that farmers have land to allocate improved maize varieties. This finding is in agreement with the finding from the report of African Development Bank[AfDB], (2009) which indicated that on average, Tanzanian smallholder farmers own an agricultural farm size of about 2 hectares which are cultivated mainly for home consumption and using traditional technologies.

According to Table 4.2, 52.8% of the respondents reported that land was owned by a husband; wife (9.4%); family (17.1%) and landlord (20.6%). These results show that majority of the households, husbands were the owners and a custodian of the land. This may be due to the fact that in families, husbands are the owners of the production resources. Women constituted the smallest category of the respondents who owned land. This has an indication that the society had gender segregation where females were denied of land ownership (Mugure et al., 2013). Morgon et al., (2015) reported that the household head (mostly the man) is the de facto owner of family land and the main decision-maker on



allocation to family members and different uses. This can be anticipated that those females are poor resource group whereby they are incapable of owning land.

**Table 4.2** Respondents agricultural production resource

	<b>Descriptions</b>	<b>Frequency</b>	<b>Percent</b>	
Land ownership (n=286)	Husband	151	52.8	
	Wife	27	9.4	
	Family	49	17.1	
	Landlord	59	20.6	
Source of labour (n=286)	Household labour	112	39.2	
	Hired labour	56	19.6	
	Both	118	41.3	
Off-farm income generating activity(n=286)	No	194	67.8	
	Yes	92	32.2	
Name of Income generating activity (n=92)	Business	78	74.8	
	Carpenter	4	4.3	
	Mason	5	5.4	
	Labourer	2	2.2	
	Driver	1	1.1	
	Smith	1	1.1	
	Engineering	1	1.1	
	Mean value	S.D*	Minimum	Maximum
Off farm income in TSH* per year (n=99)	1,625,260.87	1,639,135.90	30,000	9,000,000

Key: TSH\*= Tanzania shillings S.D\*= Standard Deviation

Furthermore, some land was also owned by landlords, this shows that some of the respondents were landless and/or land insufficient, as such, they depended on renting land. This implies that those farmers who may not be financially able to rent land may not engage fully in farming (Feng, 2008). However, farmers who rent land tend to adopt more than those who cultivate their own land (Mariano et al., 2012).

The study also sought to establish the source of labour for farmers to engage in farming. The results in Table 4.2 show that 39.2% of the respondents sourced labour from within the household members while 19.6% of respondents depended on hired labour. Majority of the respondents, (41.3 %) employed both household labour and hired labour (Table 4.2). It can be asserted that for farmers to use improved maize varieties, they employ both household labour and hired labour as this may enable them to allocate some of the labour to other technologies. This contradicts the finding of Takane (2008) who reported that main farmers' source of labour is from the family. The importance of family labour in farm work and the lack of mechanization in agricultural production imply that, the availability of family labour is a prerequisite for a household to increase farm size (Takane, 2008). However, the increase in farm size using abundant family labour is possible only under the condition that land is readily available for the expansion of a family's farm (Takane, 2008). Furthermore, the availability of labour in a village setting has an implication on farmers' ability to adopt and continue using a technology as it demands reasonable labour during the peak of production.

Majority of the respondents (67.8%) also reported that they did not have off-farm income generating activities. The results in Table 4.2 show that 34.6% engaged in income generating activities and out of that proportion, 74.8% of respondents engaged in business. The other off-farm generating activities reported were carpentry (4.3%); masonry (5.4%); hiring out labour (2.2%); driver (1.1%); tinsmithing (1.1%); and engineering (1.1 %). Also the results show that respondents had an average of 1,625,260.87TSH (773.93US\$<sup>2</sup>) income per year from off- farm income generating activity with a standard deviation of 1,639,135.90TSH (780.54US\$). The highest income was 9,000,000TSH (4285.71US\$) per year while the lowest income was 30,000TSH (14.29US\$) per year. The results indicate that only small proportional of farmers engaged and acquired income from nonfarm activities. Off-farm income generating activities may help farmers to finance production cost like buying inputs, seeking market information, accessing extension services and hiring of labour (Chilot et al., 1996 and Obisesan, 2015). However, the effect of off-farm employment on agricultural production is ambiguous. Off-farm employment enables households to increase their incomes, to overcome credit and insurance constraints and to increase their use of industrial inputs (Taylor et al., 2003). In addition, the reduction in food consumption resulting from household members working off-farm (e.g. those who migrate) may have an impact on agricultural production decisions if household production and consumption decisions are non-separable (Wouterse, 2006). Off-farm employment reduces the labour available for agricultural production, especially if hiring agricultural labour incurs transaction costs and if hired labour is not as efficient as family labour (Feng, 2008).

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<sup>2</sup>*Tanzania currency; 1US\$ = 2100TSH as of January 2016*

Furthermore, this study sought to find out if respondents had access to agricultural credits or loan. Results in Table 4.3 show that 87.8% had no access and only 12.2% had access to credits or loans. Furthermore, the results demonstrate that those who had access to credits/loan obtained an average of 748,860TSH (356.6US\$) per year, with standard deviation of 437,256TSH (208.22US\$). The lowest amount of money respondents acquired was 100,000TSH (47.62US\$) per year, while the highest amount of money was 2,000,000TSH (952.38US\$) per year. These results imply that there is a limited accessibility of credits/loan in the area which may impact on the usage of agricultural technology. According to Obisesan, (2015) new technologies aimed at improving farm productivity may require additional finances through credit facilities for their effective implementation.

**Table 4.3** Respondents' access to credit/ loan

	<b>Description</b>		<b>Frequency</b>	<b>Percent</b>
Access to credit/loan(n= 286)	No		251	87.8
	Yes		35	12.2
Challenges to credit/ loans (n=251)	Absence of collateral		110	37.9
	Absence of lending institution		91	31.4
	High interest rate		75	25.9
	Have producer price		14	4.8
Credit/loan per year in TSH* (n=35)	Mean value	S.D*	Minimum	Maximum
	748,860	4,37,256	100000	2,000,000

Key: TSH\*= Tanzania shillings S.D\*= Standard Deviation

In their struggle to improve agricultural production, farmers may sometimes need credit/loan. In the survey respondents were asked challenges they face in accessing credits/loan. The results in Table 4.3 indicate that majority of the respondents (37.9%) reported that absence of collateral as one of the challenges they face in accessing credit/loan. This means that as farmers do not have the necessary assets to act as collateral they are unable to acquire credits/loan. The other challenges were absence of lending institution, high interest rate and low producer price.

Credit/loans may play a predominant role in farming as they help farmers to purchase farm inputs and pay for extension services which enable farmers to improve agricultural production (Tesfaye et al., 2001). Farmers depend on land as their main asset which can be used as collateral for credit/loan acquisition (Obisesan, 2015). During the focus group discussion with participants, they mentioned that in many cases they do not have title deeds for their land to enable them access credit. This poses as the major challenge to them. Furthermore, participants in the discussion claimed that absence of lending institution affect farmers' access to credit and loans and in some cases, locally financial institution or lenders are available but may not be reliable. However, high interest rates from formal institution have been mentioned as challenges which prohibit famers to acquire credit/loans as they fear defaulting (Ribson, 2001 and Obisesan, 2015). Cooperatives/ farmers' organizations play a vital role in agriculture. The results in Table 4.4 show that 64.3% of the respondents were not members of cooperatives/farmers' organization. Those who belonged to cooperatives/farmers' organisations cited a number of reasons for joining.

**Table 4.4** Respondents' membership in cooperative/ farmers' organization

Description		Frequency	Percent
Membership in No cooperative/farmers' organization (n=286)		184	64.3
	Yes	102	35.7
Reasons to be a member in cooperative/farmers' organization(n=102)	Access to extension services	44	35.2
	Access to loans	38	30.4
	Access to help from peers	19	15.2
	Access to land	4	3.2
	Bargaining power	4	3.2
	Farm operating cost	16	12.8

Table 4.4 shows frequencies of responses that respondents gave as reasons for joining. Thirty-five percent of the respondents joined cooperative/farmers' organization to access extension services while 30.4% of them did so in order to have access to loan. Another 15.2% reported that they joined so that they should access help from peers while 3.2% of respondents joined cooperatives/ farmers' organization to have access to land and bargaining power. About 13% of respondents joined in order to meet farm operating costs. The results show that majority of the respondents joined so that they can have access to extension services. This implies that extension service plays a linkage between farmers and research on acquiring necessary information about production practices of a particular technology. This finding is in line with study of Gebru, (2007) who reported that

agricultural cooperatives are legitimate institutions which belong to farmers. Additionally, their main activities are to render variety of services and access the market for input supply particularly to the rural community.

**Table 4.5** Respondents' access to extension services

	<b>Description</b>	<b>Frequency</b>	<b>Percent</b>
Extension service (n=286)	No	81	28.3
	Yes	205	71.7
Accessing extension services (n=205)	Once a week	40	19.5
	Once fortnight	19	9.3
	Once a month	64	31.2
	Once a year	45	22.0
	Cannot remember	36	17.6
	Never	1	0.5
Source of extension services(n=205)	Government extension officer	152	46.3
	NGO extension officer	91	27.7
	News paper	9	2.7
	TV	17	5.2
	Farmer to Farmer	52	15.9
	Agriculture Training Institute	4	1.2
	Radio	3	0.9

Extension services have a significant role to play in agriculture as it plays as pivotal linkages between farmers and researcher in acquiring agricultural technologies (Kiptot et

al., (2011). Respondents were asked if they had access to extension services. The results in Table 4.5 show that 71.7% of the respondents had access to extension services while 28.3% had no access to extension services. Furthermore, during 2014/2015 growing season the results in Table 4.5 show that respondents accessed extension services at the following intervals: (31.2%) once a month; (19.5%) once a week; (9.3%) once in a fortnight; (22.0%) once a year, while 17.6% and 0.5% of the respondents could not remember and never received extension services, respectively.

Extension services in the area seemed to be limited as majority of the respondents accessed it once a month. This may be due to limited extension services in the area as it has been indicated in Table 4.5 where 46.3% of respondents got extension services from government officers. During focus group discussion participants claimed that government extension officers in many instances are limited in number and cannot afford to provide regular services to farmers. Lack of incentives to extension workers was also a challenge for them to provide services on a regular basis. However, to verify this argument, key informant interview was conducted. The finding showed that there were 31 extension workers who served 17,769 farmers in the area with farmers to extension worker ratio of 573:1. The current ratio of farmers to extension worker in Tanzania is 600: 1 (MoAL, 2016). This implies that the ratio in the district is higher and they may, therefore, be better able to serve farmers. During key informant interview with government extension officers in the areas, participants claimed that they do not provide regular services to farmers due to lack of enough incentives (working facilities) like bicycles or motorcycles just to mention a few, because some areas are difficult to reach. This is line with the finding of Kiptot et al.,



(2011) who reported that many public extension institutions are resource constrained and, therefore, do not offer timely advice to farmers. With respect to this, there is a need to strengthen the existing agricultural extension services in the district and perhaps the whole country by providing adequate incentives to extension workers.

#### **4.3 Farmers' choices of improved maize varieties**

The maximum likelihood estimates of the Multinomial logistic regression model for factors influencing the choice of improved maize varieties indicate that the fit of the model was satisfactory. The estimated coefficients for the likelihood ratio chi-square were significant ( $P < 0.000$ ), with chi-square value of 139.14 and the model accounted Pseudo  $R^2 = 1.94\%$ . This indicates the dependence of choice of improved maize varieties on the predictive variables.

The explanation of the variation of the independent variables on choice of use of improved maize varieties by farmers among the selected varieties in Multinomial logistic regression model depended upon variables whose p-value became significant. It can be assumed that variables whose p-values were not significant cannot be relied upon to explain the variation between the dependent and independent variables. This also depended upon the pre-stated hypothesis or pre-meditated sign of the coefficient of a given variable. For instance, the results in Table 4.6 shows that, in terms of high yield the study found that the choice of STAHA variety increases the probability to choose the variety by 31% relative to a unit of high yield produced when a farmer chooses TMV1. This implies that, farmers are likely to use maize variety as long as this variety show an outstanding yield as compared to others.

This finding is in line with Ransom et al., (2003) who stated that a high yielding variety could be a significant incentive for farmers to choose variety. Hassen, (2015) concludes that dis-adoption of improved maize varieties occurs if the varieties show insignificant yield difference with other varieties.

**Table 4.6** The choice of STAHA maize variety

Variable	Coefficient	Marginal effect	P- value
High yield	1.688215	.3083804	0.000***
Early maturity	-.9263774	-.2556545	0.000***
Age	.0047041	.0044208	0.045**
Land	.1477566	.0199148	0.517
Cooperatives	.0370262	-.0706585	0.229
Extension service	-.8144197	-.1750872	0.012 **
Hired labour	.2137705	.1228768	0.207
Household labour	.2415657	.1398019	0.042**
Education	.0013979	-.0144595	0.287
Number of observation = 267 LR $\chi^2$ (27) = 139.14 Prob> $\chi^2$ = 0.0000*** Log likelihood = -289.03121 Pseudo $R^2$ = 0.1940			

Note \*\*\*, \*\* and \*represents 1%, 5% and 10% level of significance

(Varieties2= TMV1 is the base outcome)

Surprisingly if farmer perceives STAHA as an early maturing variety, it is expected to decrease the probability of choosing it by 26% relative to a unit of early maturity attribute when farmers choose TMV1. In contrast to Hintze and Renkow (2002) argue that yield advantage and early maturity – consistently emerged as having a significant positive impact on the choice of variety. Increasing the age of household head by a unit, it is expected to increase the probability of choosing STAHA by 0.04% relative to a unit of age when

farmers choose TMV1. According to Nwakor et al., (2011) age has been found to be an important factor influencing the choice of farming technologies. However, more recently, there has been mixed findings on the effect of age on the use of improved technologies (Langyintuo and Mungoma, 2008). Adoption theories, for labour-intensive and complex technologies such as use of improved maize varieties retell that successful technologies should target young farmers (Defrancesco et al., 2008). Young farmers have been found to be more innovative and less risk averse than older farmers (Mazvimavi and Twomlow, 2009). The literature also suggests that as farmers get older they become more conservative and less open to new ideas (Tshikala et al., 2015).

Unlike the prior expectation, farmer's access to extension services is expected to decrease the probability of choosing STAHA variety by 18% relative to a unit of access to extension services when farmers choose TMV1. This shows that as farmers have access to extension services they are less likely to choose the variety perhaps due to much emphasize given to other crops in the areas. Nevertheless, the result highlights the likelihood that inefficiencies in extension and other nonstandard channels of transmitting information about variety may imply a key limiting factor on the choice of the variety in the area. This confirms the finding that extension service is not both necessary and sufficient to affect use of technologies but also the quality of the extension service matters (Kassie et al., 2012); however, the result is consistent with Amsalu and de Graaf (2006). Contrary to other previous studies (Kaliba et al., 2000; Tembo and Haggblade, 2003; Mavunganidze et al., 2013) argued that extension services to the household is positive significantly increase the likelihood of choosing agricultural technologies.

Labour accessibility at a farm household is also statistically significant in affecting a choice of STAHA variety. Accessibility of labour in a household, it is expected to increase the probability of choosing the variety by 14% relative to unit of available household labour when farmers choose TMV1. Results show that households that have more available labour for farming are more likely to choose the variety. The finding is consistent with other studies on the use of improved technologies (maize varieties) whose findings showed that some improved technologies are labour intensive and require enough labour (Haggblade and Tembo, 2003; Nyanga et al., 2011), if this requirement is fulfilled by the family members, choice of improved maize variety is likely to be positive (Kafle, 2010).

In terms of high yield (Table 4.7), the study found that the choice of STUKA maize variety by farmer is influenced by a number of factors. For instance, high yield attribute inversely influenced the choice of farmers in choosing STUKA variety by 30% relative to unit of high yield when farmers choose TMV1. The result implies that the higher the perceived yield attribute of the variety the less choice. This finding contradicts with previous studies (Smale et al., 1995; Tura et al., 2010; Kudi et al., 2011) who pointed out that farmers will use the variety provided that they have observed a positive yield variation compared to others. Yield is a direct measure of seed's performance, since high yield would raise output and gross earning (Kudi et al., 2011). Meanwhile if farmers perceive STUKA early maturing variety, it is expected to increase the probability of choosing the variety by 39% compared to the choice of TMV1 which is a unit. This suggests an importance of early maturity attribute to farmers. Additionally, it may suggest that due to climatic changes, farmers opt for a variety which will serve them during harsh condition. Early maturity is a

critical attribute for farmers because it may be linked to the ability to avoid drought. The shorter the period of growing the smaller the risk the crop been affected by drought. This result is consistent with research finding of Hintze et al., (2002) who reported that, when farmers are provided with two or more improved maize varieties to choose in an area prone to drought, the attributes which farmers value the most are early maturity and tolerant to drought.

**Table 4.7** The choice of STUKA maize variety

Variable	Coefficient	Marginal effect	P- value
High yield	-.9223904	-.3021278	0.000***
Early maturity	1.754574	.3864072	0.000***
Age	-.0329105	-.0057087	0.040 **
Land	-.2525319	-.0954729	0.039**
Cooperatives	.8193471	.1502036	0.051*
Extension service	.5477439	.1837818	0.005***
Hired labour	-.62534	-.1028581	0.207
Household labour	-1.070966	-.2066662	0.002***
Education	.1723698	.0331593	0.042**

Number of observation = 267 LR  $\chi^2$  (27) = 139.14 Prob>  $\chi^2$  = 0.0000\*\*\* Log likelihood = -289.03121 Pseudo  $R^2$  = 0.1940

Note \*\*\*, \*\* and \*represents 1%, 5% and 10% level of significance

(Varieties2= TMV1 is the base outcome)

Further analysis in Table 4.7 shows that a unit increase of the farmer's age; significantly decrease the probability of choosing STUKA variety by 0.06% compared to the choice of TVM1 which is a unit. The negatively significant age variable implies that younger farmers are more likely to choose STUKA variety. Among the several reasons that could explain

the negative effect of age on the choice of improved technology is the fact that older farmers tend to stick to their old production techniques and are usually less willing to accept changes (Tshikala et al., 2015). In addition, young people are associated with higher risk-taking behaviour than the elderly as stated by Simtowe et al., (2007).

Interestingly, any increase in hectare of land reserved for improved maize was observed to inversely influence the choice of farmers in choosing STUKA variety by 10% compared to choice of TMV1 which is a unit. This implies that when farmers increase their land, they will decrease their production of the variety. The land holding size returned a positive and significant in several studies (Simtowe et al., 2007; Langyintuo and Mekuria, 2008; Tura et al., 2010) that reported that households with larger land holdings, allocated more land to improved maize. Inconsistent with this finding, Etoundi and Dia (2008) pointed out that increasing the area diminishes the probability of using improved maize varieties.

The finding in Table 4.7 also shows that, as farmers become member to their groups or cooperative associations, they are likely to choose STUKA variety by 15% relative to a unit of cooperative membership when farmers choose TMV1. This means that as farmers cease to be members of cooperative unions, their likelihood of choosing the variety reduces because they deny themselves information regarding production practices, collective action that bring about the economies of scale in production activities such as harvesting, transportation, market participation and purchasing of input. This suggests that for farmers to utilize the variety efficiently, they need to join in cooperatives/ farmers organizations. This finding is consistent with the findings of Kassie et al., (2011); Ghimire et al., (2015)

and Olalekan and Simeoni, (2015) who reported that the likelihood of choosing improved maize varieties is positive significantly associated with the participation in farmers' group and cooperatives. This may be due to the fact that, membership in farmers' cooperatives has been found to enhance the interaction and cross fertilization of ideas among farmers thereby furnishing them with gains of consolidating a technology. This supports the hypothesis that farmers' exposure to various information sources enables them to analyse the risks, benefits and take advantage of technology (Tura et al., 2010).

When each variable is at its average level, having access to extension services increase the probability of choosing STUKA variety by 18% compared to a choice of TMV1 which is a unit. Extension service is a key source of linkages with research information such as new/modern technologies. Extension messages promote adoption of recommended improved maize variety practices which determine the proper use of the variety (Tura et al., 2010). This means that lack of access to extension services by farmers reduces their likelihood of using the variety. This finding is consistent with the research result of (Asfaw et al., 2012; Mariano et al., 2012; and Ghimire et al., 2015) who reported that access to extension services significantly affected utilization of IMVs among farm households, underlining the importance of extension services in farming operation because exposure to information reduces subjective uncertainty about the technology. Therefore, the result suggests that the use of improved maize varieties is impacted with access to extension services.

If farmers depend on household labour, it is expected to reduce the probability of choosing STUKA variety by 21% relative to a unit of household labour when farmers choose TMV1. This implies that choice of variety is attained only if farmers have another source of labour. According to Omotesho, (2014) some agricultural technologies are heavily labour-intensive with farmers relying on their households for labour supply to attain maximum productivity. Furthermore, family labour is gradually becoming recognized as unsustainable hence the need for alternative source of human power. Rural-urban migration and the more striking off-farm labour requirement have left mainly the aged and less mobile farmers to work on the farms which may be the case in hindering choosing agricultural technologies which need reasonable supply of labour (Oluyole et al., 2013).

Additionally, a unit increase in number of years of schooling would result in 3% increase in the probability of choosing STUKA variety compared to the choice of TMV1 which is a unit. This result has important policy implications to improve maize promoters that increase in formal education, increases the probability of using improved maize varieties in the area. It also confirms the finding from other studies (Johannes et al., 2010; Abunga et al., 2012; and Tshikala et al., 2015) that pointed out that education level, positive significantly influences choices of a variety, as farmers with more education are able to evaluate the advantages and disadvantages of technologies. However, Ransom et al., (2003); Aklilu and De Graff, (2007); Tura et al., (2010) found that education attainment of farmers is negative significantly influences the choices of agricultural technologies (in this case improved maize varieties).



The finding in Table 4.8 shows that, if farmers perceive other varieties than the selected varieties as early maturing, it is expected to decrease the probability of choosing the varieties by 12% relative to a unit of early maturity attribute when farmers choose TMV1. This finding suggests that farmers will choose other varieties provided that they take longer time to mature. According to Kaliba et al., (2000) preference of short maturing or intermediate or long maturing varieties depends upon farmers' evaluation on yield and total benefit accrued from the variety. So, sometimes farmers can choose intermediate and even long maturing varieties.

**Table 4.8** The choice of other maize varieties (not STAHA, STUKA and TMV1)

Variable	Coefficient	Marginal effect	P- value
High yield	-.0600876	-.0093418	0.879
Early maturity	-.4740431	-.1172007	0.064*
Age	-.0234255	-.0020819	0.390
Land	.473688	.0908016	0.001**
Cooperatives	.3559504	.0004251	0.995
Extension service	-.3590935	-.0448464	0.498
Hired labour	-.6619531	-.0816845	0.264
Household labour	-.3866863	-.0124631	0.843
Education	.046176	-.0036431	0.784
Number of observation = 267 LR $\chi^2$ (27) = 139.14 Prob> $\chi^2$ = 0.0000*** Log likelihood = -289.03121 Pseudo $R^2$ = 0.1940			

Note \*\*\*, \*\* and \*represents 1%, 5% and 10% level of significance

(Varieties2= TMV1 is the base outcome)

The coefficient of land reserved for improved maize varieties became positive as it was anticipated. It can be deduced that, keeping other variables at a steady state when none of the selected varieties were used, a unit increase in hectare of land area set aside for maize cultivation, is expected to increase the probability choosing others improved varieties by 9% compared to the choice of TMV1 which is a unit. This is only possible if farmers were willing to try new technologies. This suggests that when farmers are not expanding their farming area, they will keep on using STAHA, STUKA and TMV1 maize varieties. The effect of access to sufficient land is expected to be positive on the choice of improved maize seed technology (Tura et al., 2010 and Mariano et al., 2012). Those farmers who do not own sufficient land may not be able to capture the full returns from new technology investments thus will be less willing to use new technology (Tura et al., 2010). This result is similar to the finding of the earlier studies by (Mendola, 2007; Kassie et al., 2011; Mariano et al., 2012 and Ghimire et al., 2015) who reported that any additional increase in land, farmers tend to divert it to other varieties.

#### **4.4 Summary**

The Multinomial logistic regression model result indicates that STAHA variety is preferred due its high yielding property, and STUKA variety to its early maturity. While high yield and early maturity attributes did not have a positive impact on farmers from choosing other varieties. Furthermore, age, land size, cooperatives, access to extension services, household labour and education level are statistically significant key drivers in influencing the choice of varieties in a varying significance level across the varieties.

#### 4.5 Factors influencing farmers to continue or discontinue utilization of selected adopted improved maize seed varieties

Table 4.9 presents the maximum likelihood estimates of the logistic regression model for factors influencing continued or discontinued use of STAHA maize variety. The fit of the model was satisfactory. The estimated coefficients for the likelihood ratio chi-square were significant ( $P < 0.000$ ), with chi-square value of 48.91, degree of freedom of 9. The model accounted Pseudo  $R^2$  for 38.39% of the variation between continued users and discontinued users of the variety. This indicates the test of dependence of continued use of STAHA variety on the independent variables. The hypothesis that all the variables can be dropped from the model was rejected at 1% level significance since the Wald statistic was chi-square (9) = 21.94 ( $P < 0.01$ ).

**Table 4.9** Logistic regression model outputs for the continued or discontinued use of STAHA maize variety

Variable	Coefficient	Marginal effect	P- value
High yield	3.017512	.6150746	0.000***
Early maturity	-1.688538	-.2611898	0.004***
Resistant to pest& diseases	.8916178	.1467909	0.146
Farm size	-.3394185	-.0529644	0.010**
Experience	.0467132	.0072893	0.087*
Household labour	1.485792	.2207611	0.025**
Hired labour	1.341964	.1630391	0.045**
Education	-.2822697	-.0440466	0.097*
Extension service contact	-.4379695	-.0683427	0.012**
Number of observation = 105 LR $\chi^2$ (9) = 48.91 Prob > $\chi^2$ = 0.0000*** Log likelihood = -39.255172 Pseudo $R^2$ = 0.3839			

Note \*\*\*, \*\* and \* represents 1%, 5% and 10% level of significance

The result in Table 4.9 shows that if farmers perceive STAHA high yielding variety the probability of choosing it increases by 62%. This implies that farmers are likely to continue using maize variety provided that the variety continues to show an outstanding yield. According to Ghimire et al., (2015) if farmers perceive that the variety is superior to other in terms of yield, they will keep on using it continuously. While if farmers perceive STAHA variety to be early maturing, the probability of continued use of the variety decreases by 26%. This implies early maturity attribute has no positive impact on influencing farmers from continuing using STAHA. When each variable is at its average level, an increase in hectare of land for agricultural production is expected to decrease the probability of using STAHA variety continuously by 5.3%. This implies that households with more land are less likely to opt for continued use of the variety. This result is similar to the findings of the earlier studies by (Mendola, 2007; Kassie et al., 2011; Mariano et al., 2012 and Ghimire et al., 2015) who reported that any additional increase in land, farmers tend to divert it to other varieties. However, Tura et al., (2010) reported that effect of access to sufficient land is expected to affect positive significantly the continued use of improved maize seed technology. The decisions on adoption and on whether to continue using a technology or not, is complex and involves factors that are normally beyond the control of farmers, such as policy, institutional factors, environmental factors as well as the household endowments, the type of farm business, and the technology itself (Tura et al., 2010).

Experience in farming had a significant influence on continued use of STAHA variety. The results show that the probability of continued use of STAHA variety is directly related to years of the farmers' exposure to maize production. One more year of farming, the

household probability of STAHA variety continued use; it is expected to increase by 0.7%. This implies that as farmers gain experience in farming the more they will use STAHA variety continuously. The finding is consistent with previous studies (Tura et al., 2010; Alhassan et al., 2015) that pointed out that, experience in farming is positive significantly influencing the decision to continue growing improved maize.

Both source of labour from household and hired from outside the household were positive significantly influencing the continued use of STAHA variety, for instance availability of household labour increases the probability of using STAHA variety continuously by 22%. While if farmers hired labour from outside, it is expected to increase the probability of using the variety continuously by 16%. These findings imply that farmers can use both the two sources of labour for the continued use of this variety. The use of household labour is positive significantly influencing the use of improved technologies because of being regarded as cheap to farmers (Omotesho et al., 2014). While Blanc et al., (2008) reported that the much desired transition from small-scale farming to commercial level production by expansion of production resources definitely requires outsourcing additional labour. According to Bedemo et al., (2013) decision to use both household and hired labour depends on the seasonal nature of agriculture technology along with many other socio-economic features.

By keeping other covariates at steady state, a unit increase in education level of the household head; decreases the probability of continued use of STAHA variety by 4%. This implies that household heads that are educated are less likely to use STAHA variety

continuously. This is consistent with Tura et al., (2010) who justified his finding that households headed by literates were relatively less likely to use improved maize varieties in Central Ethiopia. As human capital accumulated through longer years of formal education becomes an advantage to find more off-farm employment opportunities, which makes farming relative less attractive (Uematsu and Mishra, 2010). Contrary to this, Johannes et al., (2010); Abunga et al., (2012) and Tshikala et al., (2015) reported that education level positive significantly influences the continued use of a variety, as farmers with more education are able to evaluate the advantages and disadvantages of technologies.

Interestingly, any increase in number of extension agent visit to household farmers; decreases the probability of using STAHA variety continuously by 7%. This implies that the more farmers are visited by extension agent the less likelihood of using the variety. This confirms the finding that extension service is not both necessary and sufficient to affect adoption of technologies but also the quality of the extension service matters (Kassie et al., 2012). Agricultural extension agents provide different information and alternatives depending on prevailing activities which impacts farmers differently and they are expected to choose an option that suits them best (Baethgen et al., 2003). However, Tura et al (2010) found that the number of visits to farmers by an extension agent, positive significantly influenced the continued use of improved maize varieties.

Table 4.10 presents the maximum likelihood estimates of the logistic regression model for factors influencing continued or discontinued use of STUKA maize variety. The fit of the model was acceptable. The estimated coefficients for the likelihood ratio chi-square were

significant ( $P < 0.000$ ), with chi-square value of 38.48, degree of freedom of 9. The models accounted Pseudo  $R^2$  for 24.47% of the variation between continued users and discontinued users of STUKA maize variety. The model estimation also shows that the covariates were all associated with the log odds of STUKA variety continued use. The hypothesis that all the variables can be dropped from the model was rejected at 1% level significance since the Wald statistic was chi-square (9) =26.09 ( $P < 0.01$ ).

**Table 4.10** Logistic regression model outputs for the continued or discontinued use of STUKA maize variety

Variable	Coefficient	Marginal effect	P- value
High yield	-1.104596	-.181578	0.023**
Early maturity	2.101584	.4457403	0.000***
Resistant to pest& diseases	-.8340837	-.1441625	0.078*
Farm size	-.0292147	-.0049766	0.872
Experience	-.0185957	-.0031677	0.373
Household labour	-1.474518	-.2734402	0.011**
Hired labour	-.756954	-.1457112	0.333
Education	-.0587414	-.0100063	0.636
Extension service contact	.0181958	.0030996	0.895
Number of observation =133 LR $\chi^2$ (9) =38.48 Prob> $\chi^2$ = 0.0000***Log likelihood = -59.396511 Pseudo $R^2$ =0.2447			

Note \*\*\*, \*\* and \*represents 1%, 5% and 10% level of significance

When each variable is at its average level, the result in Table 4.10 shows that if farmers perceive STUKA high yielding variety, it is expected to decrease the probability of using variety continuously by 18%. This suggests that any improvement on the high yield

attribute of the variety, farmers are less likely to continue using the variety. It highlights also that high yield attribute of the variety has no positive impact on the continued use of the variety perhaps there are other important attributes which farmers regard as important on the continuation of the variety. The result is inconsistent with the result of Ransom et al., (2003) and Kudi et al., (2011) who reported that increase in yield attribute of the variety leads to increased farmers' continued use of the variety. While if farmers perceive STUKA an early maturing variety, increases the probability of using it continuously by 45%. This implies the importance of early maturity attribute for the continued use of variety. According to Raphael, (2014) use of early maturing maize varieties is important especially in marginal areas, because it helps farmers in harsh condition like during severely famine. The popularity of the variety among farmers depends on how best this variety fit to the farmers' conditions and need (Jaleta et al., 2013). While Sinja et al., (2004) reported that preference of a certain technology depends upon farmers' evaluation on a total benefit accrued within a year.

Furthermore, if farmers perceive STUKA resistant to pest and diseases variety, the probability of using it continuously decreases by 14%. This implies that resistant to pest and disease not have a positive impact in influencing farmers from continuing using the variety. The finding is contrary to the study result of Ghimire et al., (2015) that pointed out that if farmers perceive a variety to be disease/pest resistance, they will keep on using it.

By keeping other covariates at a steady state, as the labour source is available within the household, it is expected to decrease the probability of using STUKA variety continuously



by 27%. This suggests that the more farmers solely depend on household labour the less possibility of using continuously the variety. This finding is inconsistent with the research result of Jaleta et al., (2013) that revealed that the probability of using improved maize variety continuously increases with the available family labour for farming.

**Table 4.11** Logistic regression model outputs for the continued or discontinued use of TMV1 maize variety

Variable	Coefficient	Marginal effect	P- value
High yield	3.089542	.6124485	0.000***
Early maturity	-1.862303	-.2672214	0.004***
Resistant to pest& diseases	1.052081	.1635081	0.111
Farm size	-.3620525	-.0520058	0.007***
Experience	.0329895	.0047387	0.243
Household labour	1.032128	.1438603	0.150
Hired labour	1.039793	.1216981	0.162
Education	-.1656395	-.0237927	0.335
Extension service contact	-.547155	-.0785943	0.003***
Number of observation =101 LR $\chi^2$ (9) =49.42 Prob> $\chi^2$ = 0.0000***Log likelihood = -35.843724Pseudo $R^2$ = 0.4081			

Note \*\*\*, \*\* and \*represents 1%, 5% and 10% level of significance

As far as continued use of TMV1 is concerned, Table 4.11 presents the maximum likelihood estimates of the logistic regression model for factors influencing continued or discontinued use of TMV1 maize variety. An alternative measure of model fit is the significance of the overall model, fit of the model was acceptable since estimated coefficients for the likelihood ratio chi-square were significant ( $P < 0.000$ ), with chi-square

value of 49.42, degree of freedom of 9. The model accounted Pseudo  $R^2$  for 40.81% of the variation between continued users and discontinued users of TMV1 maize variety. The model estimation also shows that the covariates were all associated with the log odds of TMV1 variety continued use. The hypothesis that all the variables can be dropped from the model was rejected at 5% level significance since the Wald statistic was chi-square (9) = 21.56 ( $P < 0.05$ ).

The variation of choosing to continue using TMV1 maize variety only relied on variables whose p- value were statistically significant. The results in Table 4.11 show that if farmers perceive TMV1 high yielding variety, it is expected to increase the probability of using it continuously by 61%. It can be asserted that high yield attribute has a positive impact on influencing farmers from continuous use of TMV1 variety. This is in line with the idea that farmers will only use a variety that has potential yield results (Kafle, 2010). However, if farmers perceive TMV1 early maturing variety, it is expected to decrease the probability of using the variety continuously by 27%. This underlines the importance of farmers' attribute preference in the particular variety they are growing. It also implies that early maturity attribute has no positive impact on influencing farmers from continued use of the variety. However, this result is contrary to the finding of Katengeza et al., (2012); Raphael, (2014) who reported that farmers prefer to use improved maize varieties known for their early maturity under farmers' conditions.

A unit increase in hectare of land for agriculture activities, is expected to decrease the probability of using TMV1 variety continuously by 5%. This suggests that as farmers

accumulate more land the possibility of using TMV1 become minimal. This concurs with Etoundi and Dia, (2008); Muchangi, (2016) who pointed out that increasing farm size farmer tends to devote nearly every available land to other crops. However, land holding size returned a positive and significant in several studies (Simtowe et al., 2000; Langyintuo and Mekuria, 2008; Tura et al., 2010) that reported that households with enough land to sustain the family were found to be more likely to keep on using improved maize variety. This highlights the importance of land ownership for continued use of agricultural technologies (Tura et al., 2010). A unit increase in number of extension agent visit to farmers, it is expected to decrease the probability of using TMV1 variety continuously by 8%. This implies that, as farmers are contacted with the extension agent they become less likely to use the variety. The finding also highlights that there are problems either in the way in which agricultural technologies/ information is disseminated to farmers or that there are some constraints which hamper farmers from implementing the technologies. This finding is consistent with research result of Omiti et al., (1999); Muchangi, (2016) that pointed out that extension contact to farmers is negative significantly influencing the use of agricultural technologies (case of improved of maize varieties), because extension messages may neither be practical nor relevant to the large number of farmers contacted. Furthermore, extension recommendations may not be suitable within the farmers' farming circumstances (Byerlee, 1994). Inconsistent with this finding, Tura et al., (2010) pointed out that increasing extension visits to farmers, increase the probability of the continued use of improved maize varieties.

## **4.6 Summary**

To sum up, the main finding shows that STAHA and STUKA varieties were preferred by farmers due to their high yielding and early maturity properties from adopting and continued use, respectively. While TMV1 variety was preferred only due to its high yielding property for the continued use. Additionally, resistant to pest and diseases property was not a preferred property from influencing farmers for their continued use of STUKA variety.

## **4.7 Evaluation criteria that farmers use to make decisions to continue or discontinue using the adopted improved maize varieties**

### **4.7.1 Type of maize varieties grown in 2014/ 2015**

The results in Table 4.12 show that majority (79.4%) of the respondents grew OPV varieties, hybrid (11.5%) and local variety (9.1%). A closer look at different types of maize varieties planted implies that most of farmers preferred to grow OPV than any type of maize variety. Early studies of Sibiya et al., (2013) and Machida et al., (2014) indicated that farmers prefer OPVs for the following reasons: the seed could be recycled; yields are higher than those of the local variety; and, OPVs have resistance to the main biotic stresses. Aquino et al., (2001) reported that although improved superior varieties have been developed in most countries of Sub Saharan Africa, the majority of the smallholder farmers still preferred to plant unimproved open-pollinated varieties (OPVs).

Furthermore, farmers grow both improved maize varieties and local varieties to meet their multiple objectives in maize farming (Dao et al., 2015). The results in Table 4.13 show that

many improved maize varieties together with local variety were grown for the past five years in Kilosa district. However, the three most preferred improved maize varieties were STAHA, STUKA and TMV1. The number of respondents who grew STAHA variety relatively decreased from 102(36.7%) to 87(26.4%) while the number of respondents who grew STUKA and TVM1 varieties relatively increased from 42(15.1%) to 110(33.4%) and 47(16.9%) to 61(18.5%), respectively. Unexpectedly, the number of respondents who grew local variety in 2011 outweighed those of STUKA and TMV maize varieties from 64(23%) to 51(18.1%) and 47(16.9%). In the discussions, participants mentioned that local varieties had high yield than STUKA and TMV1 although these varieties took short period to mature.

**Table 4.12** Type of maize varieties grown in 2014/ 2015

Type of maize varieties	Frequency	Percent
Hybrid	38	11.5
OPV	262	79.4
Local variety	30	9.1
<b>Total</b>	<b>330</b>	<b>100</b>

NOTE: The total frequency (330) of respondents on type of maize varieties grown is greater than that of the sample size (n= 286) because respondents had multiple responses on type of maize varieties they grew.

This is consistent with Kaliba et al., (2000) who argued that short maturing varieties usually yield less than long maturing varieties but can escape moisture stress easier than long maturing varieties. This could probably be reason why more farmers reported to have grown local variety compared to STUKA and TMV1 varieties. During focus group

discussion, participants mentioned that STAHA variety is a late-maturing variety, less tolerant to drought and is highly affected by pests and diseases. The three attributes of STAHA mentioned above could be the reasons that contributed to the decline in the proportion of farmers growing the variety. Discussions also revealed that, farmers have their varietal attribute preference before they opt for another variety which will be discussed later in subsequent sections. Other varieties which were also grown by respondents but for different periods of time included PANNAR, SEEDCO, DELCALB803, Kito, Katumani, Ilonga Composite White, NATA205, Kilima, CP201, TANH600, TAN250 and H4142. However, the proportions of respondents that grew these varieties were small and therefore, not warranting much attention.

**Table 4.13** Maize varieties grown for the past five year (2011-2015)

Maize varieties	2011(n=286)		2012 (n=286)		2013 (n=286)		2014 (n=286)		2015(n=286)	
	R*	Percent	R*	Percent	R*	Percent	R*	Percent	R*	Percent
STAHA	102	36.7	96	33.8	99	35.1	85	27.8	87	26.4
STUKA	42	15.1	50	17.6	50	17.7	95	31.0	110	33.4
TMV1	47	16.9	59	20.8	59	20.9	66	21.6	61	18.5
PANNAR	3	1.1	5	1.8	4	1.4	4	1.3	10	3.0
SEEDCO	14	5.0	11	3.9	10	3.5	13	4.2	14	4.3
DELCALB803	1	0.4	2	0.7	3	1.1	2	0.7	1	0.3
Local variety	64	23	56	19.7	51	18.1	36	11.8	30	9.1
Kito	x	x	x	x	x	x	1	0.3	x	x
Katumani	2	0.7	1	0.4	1	0.4	x	x	1	0.3
Ilonga Composite White	x	x	x	x	x	x	x	x	1	0.3
NATA 205	x	x	x	x	x	x	x	x	1	0.3
Kilima	x	x	x	x	1	0.4	2	0.7	1	0.3
CP 201	1	0.4	2	0.7	2	0.7	1	0.3	9	2.7
TANH600	x	x	x	x	x	x	x	x	2	0.6
TAN 250	1	0.4	1	0.4	x	x	1	0.3	1	0.3
H4142	1	0.4	1	0.4	2	0.7	x	x	x	x
<b>Total</b>	<b>278</b>	<b>100</b>	<b>284</b>	<b>100.0</b>	<b>282</b>	<b>100</b>	<b>306</b>	<b>100.0</b>	<b>329</b>	<b>100.0</b>

Key: R\*= number of response, x= Maize variety was not grown

#### **4.7.2 Maize varieties order of importance preference ranking based on perceived attributes of the variety**

Respondents were also asked to rank the maize varieties they had been growing from 2010/2011 to 2014/2015 growing season in order of importance to expose farmers' preferences. Their responses are discussed based on the following assumptions: (i) farmer's preference considers all good attributes as they rate the variety as 1<sup>st</sup> most important before opting for 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> most important; (ii) a variety with the highest scores of frequency on the order of importance is ranked number one and the rank drops as scores drop; (iii) the higher the frequency of the overall score of order of importance preference reported, the higher the utilization rank of a variety and this is independent of a good or bad attribute of the variety. The rank is highly determined as a function of number of responses given by farmers on good attributes of the variety that they are aware of, and the information gained from researchers/ breeders during key informant interview because the breeders of seeds are normally determined with a supply of varieties that have good attribute.

The results in Table 4.14 show that three improved maize varieties namely STAHA, STUKA and TMV1 were mostly preferred by respondents. STUKA maize variety was ranked number one because it had the highest frequency as the first most important maize variety. The variety scored as the first most important maize due to its overall outstanding ability to mature early, yield highly and tolerate drought (see Table 4.15). In terms of utilisation, STUKA was ranked number two. STAHA was the second most important maize variety. STAHA became second in varietal ranking to STUKA probably because it is a late maturing variety compared to STUKA (refer to Table 4.13). Nevertheless, STAHA



ranked number 1 in utilisation ranking. STAHA maize variety had the highest frequency of being grown by respondents from 2010/2011 to 2014/2015 than any maize variety. This may explain why STAHA had the highest utilisation ranking. However, findings reveal that STUKA became popular from 2014 and its production peaked up considerably outperforming STAHA in the process (Table 4.13).

**Table 4.14** Maize variety order of importance preference ranking

Maize varieties	Farmers order of importance preference ranking				Overall score	Rank	
	1 <sup>st</sup> most important	2 <sup>nd</sup> most important	3 <sup>rd</sup> most important	4 <sup>th</sup> most important		Ranking (inter-variety)	Utilization ranking
STAHA	79	58	12	12	151	<b>2</b>	<b>1</b>
STUKA	92	33	6	10	131	<b>1</b>	<b>2</b>
TMV1	37	31	11	1	80	<b>3</b>	<b>4</b>
PANNAR	9	2	0	0	11	<b>6</b>	<b>6</b>
SEEDCO	15	12	3	1	31	<b>5</b>	<b>5</b>
DELCALB 803	1	1	1	0	3	<b>9</b>	<b>9</b>
Local variety	23	38	18	4	83	<b>4</b>	<b>3</b>
Kito	0	0	0	1	1	<b>12</b>	<b>11</b>
Katumani	0	1	2	0	3	<b>10</b>	<b>9</b>
Ilonga	1	0	0	0	1	<b>9</b>	<b>11</b>
Composite							
White							
Kilima	1	1	0	0	2	<b>9</b>	<b>10</b>
NATA 205	1	0	0	0	1	<b>9</b>	<b>11</b>
CP 201	4	3	1	0	8	<b>7</b>	<b>7</b>
TAN 250	0	0	2	0	2	<b>11</b>	<b>10</b>
TANH600	3	0	0	0	3	<b>8</b>	<b>9</b>
H4142	1	1	2	1	5	<b>9</b>	<b>8</b>

It can thus be observed that in the past two years STAHA has lost popularity to STUKA rendering the latter as the most preferred improved maize variety. During focus group discussions participants reported that farmers are abandoning STAHA variety due to its attributes of late maturity, susceptibility to drought, pests and diseases. The participants further mentioned that with the current agro-ecological dynamics, they opted to grow crop varieties which are early maturing, more tolerant to drought and pests and diseases. Results from key informant interviews further support findings from focus group discussions and household survey that STAHA variety is recently not preferred by many farmers due to the reasons mentioned earlier.

TVM1 was given a varietal ranking of 3 and a utilisation ranking of 4. The variety performed poorly with regards to yield and resistance to drought when compared with STAHA and STUKA. However, TMV1 was reported to mature earlier than STAHA. TVM1 was utilised less than local maize variety which had a utilisation ranking of 3 and a varietal ranking of 4. This shows that local maize variety was the third most important variety. Discussions revealed that farmers who still grew local maize variety did so mainly for its good taste, recyclable seed, early maturity, tolerance to pest and disease, drought tolerance, grain size, big cob, easiness in getting seed and adequate yields even during unfavourable seasons. This means that farmers have subjective maize attribute preference for the use of the variety. This is in agreement with the findings by Magorokosho, (2006) on landraces collected from Malawi, Zambia and Zimbabwe, whereby farmers kept local variety because of the taste, tolerance to most abiotic and biotic stresses, early maturity and yield stability.

To sum up, farmers consider a numbers of attributes when ranking maize varieties in order of importance. This entails that farmers differ in the way they evaluate maize varieties before utilizing them continuously and therefore, the varieties which will not meet the criteria are less likely to be continued. In this study, findings show that the attributes that farmers consider when ranking the varieties are yielding ability, period of maturity, drought tolerance, resistance to pest and diseases, grain size, number of cobs, adaptation (can be grown in wide range of condition), good taste and ease of getting seed (See appendix 1). These results are consistent with the finding of Sibiya et al., (2013) who argued that farmers rank maize predominantly with high yield, early maturity, resistant to pest and disease, easy to get the seed, good taste and grain size. It can, therefore, be asserted that agronomic attributes were generally considered more important in ranking maize variety than quality attributes; the reason to this can be that farmers are likely to be less sensitive to quality attributes than agronomic attributes (Machida et al., 2014).

#### **4.7.3 Farmers' evaluation criteria employed to select maize varieties for continued use of adopted varieties**

As it was outlined in the objectives, this study set out to assess the evaluation criteria that farmers employ to make decisions on whether to continue or discontinue using maize varieties. The results in Table 4.15 indicate that the two top criteria for selection of a variety were high yielding variety (46)35.1 %, (43)28.7 %, (20)24.1% and early maturity, (52)34.7 %, (30)36.1% in STAHA, STUKA, TMV1 and STUKA, TMV1 maize varieties, respectively. Additionally, drought resistant 28(21.4%) and large grain size 24(18.3%) were the second and third criteria in STAHA maize variety, respectively. This indicates

that for farmers to make their decision on either to continue or discontinued using the variety, they base mainly on high yield and early maturing characteristics of the variety. A high yielding variety promises high return to farmers with regard to what they had invested in production (Obaa et al., 2005). Early maturity enables farmers to be served during starvation, to combat drought and allows farmers to prepare land so that the variety can be planted in the area which has bimodal rainfall pattern (Obaa et al., 2005). Although high yield and early maturity were the two top most criteria for evaluating the three varieties, these criteria are not in themselves a sufficient condition for the variety to qualify for continued use if the variety was affected by drought, pests and diseases. This is evidenced from the results in Table 4.13 that small proportion of (8)18% and (5)11.4% of respondents evaluated Local variety as drought resistant and resistant to pest and disease compared with (28)21.4% and (6)4.6% of respondents in STAHA variety, respectively (refer Table 4.13). It can, therefore, be argued here that the most important criteria namely; high yield, early maturity, resistance to drought, pests and diseases, large grain played an important role in ensuring continued use of the three improved maize varieties. The other evaluation criteria which were mentioned by respondents but not important in the study for continued use of maize varieties were white colour, big cob, strong grain, high germination, good taste, adaptability, ease in getting seed, marketability, good cooking quality and number of cob per plant. These findings are in agreement with finding of Sibiya et al., (2013) in South Africa who argued that farmers evaluated maize varieties with criteria like early maturity, yield, number of cobs/plant, grain size, drought tolerant, tolerant to diseases, insect pest resistance, taste, colour, good for sale and good for cooking. Findings show that the criteria that respondents used to evaluate maize varieties are subjective because farmers are unique.

A particular attribute considered as important criterion for selecting a given seed variety by one farmer may be considered less important by another farmer (Obaa et al., 2005).

**Table 4.15** Evaluation criteria for the continued use of maize varieties

Evaluation criteria	Maize varieties							
	STH	STK	TMV1	PA	SDC	LV	CP	TH
	(n=85)	(n=108)	(n=61)	(n=10)	(n=14)	(n=29)	(n=10)	(n=2)
High yield	46(35.1)	43(28.7)	20(24.1)	9(75.0)	4(22.2)	11(25.0)	5(41.7)	2(66.7)
Early maturity	3(2.3)	52(34.7)	30(36.1)	x	4(22.2)	5(11.4)	x	x
Drought resistant	28(21.4)	33(22.0)	14(16.9)	1(8.3)	5(27.8)	8(18.2)	x	1(33.3)
Resistant to pest and disease	6(4.6)	5(3.3)	9(10.8)	x	x	5(11.4)	x	x
Large grain size	24(18.3)	4(2.7)	2(2.4)	2(16.7)	3(16.7)	3(6.8)	1(8.3)	x
White colour	13(9.9)	1(0.7)	1(1.2)	x	x	x	x	x
Big cob	1(0.8)	x	x	x	x	3(6.8)	x	x
Strong grain	1(0.8)	x	x	x	x	x	x	x
High germination	x	1(0.7)	4(4.8)	x	x	x	x	x
Good taste	2(1.5)	x	x	x	x	x	1(8.3)	x
Adaptation	5(3.8)	2(1.3)	x	x	1(5.6)	x	x	x
Easy to get the seed	x	4(2.7)	x	x	x	4(9.1)	x	x
Good for sale	x	2(1.3)	x	x	x	x	2(16.7)	x
Good for cooking	1(0.8)	x	1(1.2)	x	x	x	2(16.7)	x
2 cob/plant	1(0.8)	1(0.7)	2(2.4)	x	1(5.6)	4(9.1)	1(8.3)	x
2-3 cob/plant	x	1(0.7)	x	x	x	1(2.3)	x	x
<b>Total</b>	<b>131(100)</b>	<b>150(100)</b>	<b>83(100)</b>	<b>12(100)</b>	<b>18(100)</b>	<b>44(100)</b>	<b>12(100)</b>	<b>3(100)</b>

Keys: STH= STAHA, STK= STUKA, TMV= TMV1, PA=PANNAR, SDC= SEEDCO, LV= local variety, CP= CP 201, TH= TANH60, n= Number of responses, x= no responses on evaluation criteria, numbers in bracket are responses percentage, numbers outside the bracket are frequencies

#### **4.7.4 Fertilizer application to maize fields**

The study also sought to find out if farmers applied fertilizers to maize crop. The underlying assumption was that the use of improved maize varieties may be influenced by the application of fertilizer as it affects yield. According to Ewool et al., (2016) improved maize variety will attain their potential yield if fertilizer is applied in the field. Additionally, access to fertilizers could increase area of land cultivated with improved varieties (De Groote et al., 2005; Fadare et al., 2014). However, fertiliser application by farmers for the period of five years in the district was low. Findings show that the proportions of farmers who did not apply fertilizer to maize fields were: 96.5%; 96.2%; 96.5%; 94.1% and 93.0% in 2011; 2012; 2013; 2014 and 2015, respectively (Table 4.16). The results seem not to agree with empirical findings in the literature which show that increased productivity among farmers is associated with the use of fertilizers (Kudi et al., 2011). During the discussions most participants claimed that their land was still fertile and that they did not need to apply fertilizer in their field as they still obtained high yield. This finding is in agreement with Kinsey, (1999) who argued that farmers may have actually been able to maintain yields without the use of fertilizer for several years as so long as their soil is still fertile. Here it means that farmers may continue and achieve more yields in using improved maize varieties regardless of the application of fertilizer provided that their field still support growth of the varieties. Yet again, low application of fertilizers by farmers may be attributed to unavailability of subsidized fertilizers. During the focus group discussion with participants, subsidized fertilizers were mostly available to influential people and better off farmers who were able to negotiate or buy fertilizers from government officials who were responsible for subsidy distribution. This is in line with the study finding of Odera et al.,



(1999) who reported that farmers who are in leadership positions tend to be financially secure and would rather continue using mineral fertilizers because of their position in the community, and would rather continue using mineral fertilizers because of their position in the community. Further, farmers claimed that even the available subsidized fertilizers were not transparently distributed. This argument entails that, farmers may be willing to apply inorganic fertilizer in their field but fertilizer accessibility become a challenge to them as such this affects the continued utilization of improved maize varieties where fertiliser application is required. Kudi et al., (2011) argued that farmers may be constrained with resources which affect them to buy inputs for their field and affect their technology adoption process. In contrast, Kaliba et al., (2000) reported that relatively poor farmers are more likely to use inorganic fertilizer to increase total production from the farm as they have no other alternatives.

**Table 4.16** Fertilizer application for the use of improved maize varieties from 2010/2011-2014/2015 cropping season

Year	Fertilizer application (n= 286)				Type of fertilizer			
	No		Yes		Inorganic		Organic	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
2011	276	96.5	10	3.5	8	80.0	2	20.0
2012	275	96.2	11	3.8	7	63.6	4	36.4
2013	276	96.5	10	3.5	7	70.0	3	30.0
2014	269	94.1	17	5.9	13	23.5	4	76.5
2015	266	93.0	20	7.0	18	85.7	2	14.3

Further results analysis in Table 14.16 show that the number of farmers who applied inorganic fertilizers in their field were 80.0%; 63.6%; 70.0%; 23.0% and 85.7% in 2011;

2012; 2013; 2014 and 2015, respectively, while those who applied organic fertilizer were 20.0%; 36.4%; 30.0%; 76.5% and 76.5% in 2011; 2012; 2013; 2014 and 2015, respectively. This finding shows that more farmers used inorganic than organic fertilizers as it evidenced that use of improved maize seed varieties is associated with the use of inorganic fertilizers (Kaliba et al., 2000 and De Groote et al., 2005). During the discussion, participants reported that they applied organic fertilizers in their field preferably farmyard manure because they obtained maize yield that was relatively equivalent to the yield they obtained when they applied inorganic fertilizers. Furthermore, participants reported more challenges associated with accessibility of inorganic fertilizers. This is supported with early studies of Odera et al., (1999) and Ewool, (2016) who argued that considering the problem of scarcity often associated with inorganic fertilizer, the choice of organic fertilizer is more likely to be accepted by the farmers because of their ability to provide required nutrients to crops.

#### **4.7.5 Source of improved maize seed in 2014/2015**

The study endeavoured to identify the different sources of seed that farmers accessed for use of improved maize seed varieties. During the survey, respondents indicated that they obtained improved maize seed from different sources. Forty percent of the respondents recycled maize seed from their harvest while about 30% of the respondents purchased maize seed from input suppliers or agro- dealers. Other sources of seed from which farmers bought maize seed were fellow farmers, research centres and local markets. Some farmers reported receiving maize seed gifts from friends, relatives, agricultural extension officer and NGOs (Table 4.17). It can be observed that about 53% of respondents obtained seed

by buying, recycled (40%) and gifts (7%). According to Sain and Martinez, (1999); Bernard et al., (2010) and Aweke, (2013) farmers who tend to continue using certified seed are those who have ability to buy them and incur cost in searching for them from different sources depending on the type of the variety. On the other hand, if farmers are constrained with resources they tend to obtain seed through recycling (Doss et al., 2003). This can be done when seed are carried over from the previous harvest either by the farmers themselves through the traditional on-farm selection process whereby the farmer identifies next year's seed stock while it is still maturing in the field and gives it special protection or by buying from preferred seed stock kept by other farmers in the same locality (FAO and WFP, 2009; Aweke, 2013).

**Table 4.17** Source of maize seed in 2014/2015

<b>Source of seed</b>	<b>Frequency</b>	<b>Percent</b>
Replant/recycled	132	40.2
Bought from fellow farmers	49	14.9
Bought from local market	22	6.7
Bought from input supplier/agro- dealers	98	29.9
Bought from research centre	6	1.8
Given by a friend	11	3.4
Given by a relative	4	1.2
Given by agricultural extension officer	2	0.6
Given by NGO	4	1.2
Total	328	100

#### **4.7.6 Discontinued use of maize varieties before 2010/ 2011**

Continuous utilization of improved maize seed varieties depends on farmer's decision after assessing adopted varieties to see if the variety will carry on giving good return (Tura et al., 2010). In the survey, respondents were also asked to mention maize varieties they discontinued growing before 2010/2011 growing season. About 14% of the respondents discontinued using STAHA variety. STAHA is characterized by its tolerance to maize streak, late maturity, large grain size and high yielding characteristics. The mean period of time for using the variety before discontinuation was 2 years with standard deviation of 1 year. The shortest period of time that farmers used STAHA before discontinuing was 1 year while the longest period of time was 6 years (Table 4.18). The reasons that respondents gave for the discontinuation were that the variety was taking long time to mature (35.4%); susceptible to drought and pests and diseases (16.7%); low yielding (27.1%); hard to mill (2.1%) and that the cob easily rots due to rainfall while in the field (2.1%) (Refer Table 4.19).

STUKA variety was also mentioned as one of the varieties that respondents discontinued growing. Three percent of the respondents said that they were no longer using it. The variety is characterized by its white flint/dent kernels, early maturing, and moderate tolerant to maize streak virus diseases, leaf bright, grey leaf spot and grow in low soil fertility. The results show that the mean period of time that respondents used STUKA was 1.44 year with standard deviation of 0.527. The shortest and longest periods of time for using STUKA before discontinuing were 1 and 2 years, respectively (Table 4.18). The results in Table 4.19 show that respondents discontinued using this variety for the

following reasons: pests and diseases attack (56%); affected by drought (11.1%); small cobs (11.1%) and low yield (22.2%).

**Table 4.18** Discontinued maize varieties before 2010/ 2011

Maize varieties	Adopters of maize varieties (n=286 )		Discontinued use of maize varieties (n=286)		Number of years before discontinuation of the variety			
	Frequency	Percent	Frequency	Percent	Mean value	S.D*	Minimum	Maximum
STH	141	49.1	39	13.6	2.13	1.321	1	6
STK	51	17.8	9	3.1	1.44	0.527	1	2
TMV	82	28.7	35	12.2	2.37	1.573	1	6
PAN	6	2.1	3	1.0	2.67	0.577	2	3
SDC	12	4.2	8	2.8	3.00	1.512	1	6
LV	112	39.2	56	19.6	3.07	1.935	1	6
ICW	3	1.0	3	1.0	4.00	2.000	2	6
KIT	2	0.7	2	0.7	1.50	0.707	1	2
KAT	10	3.5	8	2.8	3.88	2.357	1	6
H	4	1.4	3	1.0	4.67	2.309	2	6

Keys S.D\*= Standard deviation, STH= STAHA, STK= STUKA, TMV= TMV1, PA= PANNAR, SDC= SEEDCO, LV= local variety, ICW= Ilonga Composite White, KIT= Kito, KAT= Katumani, H= H4142; Frequency= Respondents' response

Furthermore, the results show that 12.2% of the respondents said they discontinued using TMV1. This variety has intermediate maturing, shiny with white flint, resistant to maize streak virus disease, good for green maize (rousting) and moderate tolerant to leaf rust characteristics. The mean period of time for discontinuing TMV1 variety was 2.37 years with standard deviation of 1.573, and a minimum of 1 and maximum of 6 years (Table 4.18). The results in Table 4.19 show that respondents discontinued using this variety for

the following reasons: low yields (26.2%); pest and disease attack (14.3%); susceptibility to drought (19%); hard to mill (2.4%); less tolerant to drought (19.0%); small kernel (19.0%); hard to shell (7.1%); light grain (4.8%); and small cobs (4.8%).

The proportion of respondents who discontinued using PANNAR was 1%. The variety has white flint, resistant to stalk borers, big cob, large kernel and medium late maturing characteristics. The mean period of time for discontinuing use of this variety was 2.67 years, with a standard deviation of 0.557. The minimum and maximum period of time that respondents took to discontinue using PANNAR variety was 2 and 3 years, respectively (Table 4.18). The respondents were further asked why they discontinued growing PANNAR variety. The following reasons were given for discontinuing growing the variety: seeds not easy to get (66.7%); and the variety is affected by pests and diseases (33.3%) (Refer Table 4.19). Another variety which respondents reported that they discontinued growing was SEEDCO. The results show that 2.8% of the respondents discontinued growing SEEDCO. The variety is characterised by its high yield, late maturity and excellent resistant to grey leaf spot. The results show that the mean period of time that respondents took to discontinue growing SEEDCO was 3.00 year, with standard deviation of 1.512. The minimum and maximum period of time for discontinuation of SEEDCO was 1 year and 6 years, respectively (Table 4.18). The results in Table 4.19 show that respondents discontinued growing the variety because it was affected by pest and disease (87.5%) and late maturing variety (12.5%).

**Table 4.19** Reasons for discontinued use maize varieties before 2010/2011

Reasons for discontinued use of a variety	Maize varieties									
	STH (n=39)	STK (n=9)	TMV (n=35)	PA (n=3)	SDC (n=8)	LV (n=57)	IWC (n=3)	KIT (n=2)	KAT (n=8)	H (n=3)
Low yielding	13(27.1)	2(22.2)	11(26.2)	x	x	27(39.7)	1(33.3)	x	3(30.0)	1(25.0)
Late maturity	17(35.4)	x	1(2.4)	x	x	17(25.0)	1(33.3)	1(50.0)	1(10.0)	2(50.0)
Affected by drought	8(16.7)	1(11.1)	8(19.0)	x	2(22.2)	8(11.8)	x	x	1(10.0)	x
Affected by pest and disease	8(16.7)	5(55.6)	6(14.3)	1(33.3)	7(77.8)	9(13.2)	x	x	2(20.0)	x
Small kernel	x	x	8(19.0)	x	x	x	x	1(50.0)	1(10.0)	x
Small cob	x	1(11.1)	2(4.8)	x	x	2(2.9)	x	x	1(10.0)	x
Hard to mill	1(2.1)	x	1(2.4)	x	x	x	x	x	x	x
Hard to shell	x	x	3(7.1)	x	x	x	x	x	x	x
Light grain	x	x	2(4.8)	x	x	x	x	x	x	
Not easy to get the seed	x	x	x	2(66.7)	x	4(5.6)	1(33.3)	x	1(10.0)	1(25.0)
No marketable	x	x	x	x	x	1(1.5)	x	x	x	x
Rots in the field	1(2.1)	x	x	x	x	x	x	x	x	x
<b>Total</b>	<b>48(100)</b>	<b>9(100)</b>	<b>42(100)</b>	<b>3(100)</b>	<b>9(100)</b>	<b>68(100)</b>	<b>3(100)</b>	<b>2(100)</b>	<b>10(100)</b>	<b>4(100)</b>

Keys x= no responses, numbers in bracket are responses percentage; Keys STH= STAHA, STK= STUKA, TMV= TMV1, PA=PANNAR, SDC= SEEDCO, LV= local variety, IWC= Ilonga Composite White, KIT= Kito, KAT= Katumani, 205, H= H4142

Respondents said that they discontinued growing local variety. The results show that 19.9% of the respondents were no longer using local variety; the variety has 2 cobs, big cobs and late maturing characteristics. The minimum period for local variety was 1 year while the maximum period of time was 6 years (Table 4.18). Reasons given for discontinued growing the local variety were that the variety was affected by pest and disease (13.2%); it is affected by drought (11.8%); low yield (39.8%); not marketable, (1.5%); not easy to get seed (5.9%); and small cob size (2.9%) (Refer to Table 4.19).

The other variety which was no longer grown by respondents was Kito variety. The variety is characterised by its early maturing, resistant to maize streak stalk virus and suitable to dry area. The results show that 0.7% of the respondents discontinued growing the variety. The mean period of time that respondents took to discontinue using Kito variety was 1.50 years, with a standard deviation of 0.707. The minimum and maximum period of time that respondents took to discontinue using the variety was 1 year and two years, respectively (Table 4.18). This variety did not take long time to be discontinued because the variety took long time to mature (50%) and it had small kernel (50%) (Refer to Table 4.19).

Katamani is one of the maize varieties that were no longer grown by respondents. This variety has short maturing period, resistant to maize streak stalk virus, suitable for area with short rainfall and white in colour characteristics. About 3% of the respondents said that they stopped growing it. The mean period of time for using the variety was 3.88 years, with a standard deviation of 2.357. The minimum and maximum period of time that respondents grew the variety before discontinuing it was 1 year and 6 years, respectively



(Table 4.18). Just like other varieties mentioned above, respondents gave reasons for discontinued using that variety, which were as follows: pests and diseases (22.2%); drought intolerance (11.1%); low yields (44.4%); late maturity (11.1%) and not easy to get the seed (11.1%).

Respondents (1%) also discontinued using Ilonga Composite White variety. The variety is characterized by medium maturity, suitable in the dry area, big grain and white in colour. The mean period of time that respondents used the variety before discontinuing it was 4 years, with the standard deviation of 2. The minimum and maximum period of time that respondents used the variety before discontinuing it was 2 years while the maximum period of time was 6 years (Table 4.18). The results in Table 4.19 show that respondents discontinued growing the variety because it was low yielding (33.3%); late maturing (33.3 %) and the seeds were not easy to get (33.3 %).

Lastly, one percent of the respondents reported that they discontinued growing H4142 maize variety. The key informant interview revealed that the variety has intermediate maturing, 2cob/plant and large grain characteristics. The average period of time that respondents reported growing the variety before discontinuing was 4.67 years, with a standard deviation of 2.309. The minimum and maximum period of time for growing this variety was 2 years and 6 years, respectively (Table 4.18), while results in (Table4.19) show that respondents discontinued growing the variety because it was late maturity (50%); low yields (25 %) and the seeds were not easy to get (25%).

#### **4.7.7 Summary**

Respondents discontinued growing some maize varieties because of losing some preferred attributes which contribute its continuous utilization, or maize variety attributes were becoming to be not in harmony with the condition in which farmers are exposed. Additionally, most of reasons given by farmers for the discontinuation of maize varieties were based on agronomic basis which included low yielding, late maturity, affected by drought, pest and diseases, small cobs, small kernel, hard to shell. Additionally, some varieties were discontinued just because the availability of the seed became a problem. These results entail that discontinuation of improved maize seed variety here is inherently influenced by the characteristic of the technology with slight influence from external factors. However, during the focus group discussion participants mentioned the opposite of these reasons for the continued use of the varieties, therefore warrant little attention in discussing them.

To sum up, the section presented respondents characteristics, maize varieties grown in the study area, order of importance preference ranking and evaluation criteria used by farmers to make decision to continue or discontinue using the adopted improved maize variety. The following section presents the relationship of the extent of production of the selected improved maize varieties.

#### **4.8 Effects of changes in the significant explanatory variables on extent of production of selected improved maize varieties**

This section dealt with the decision on the level of, intensity of, or the extent of production of technologies (in this case the improved maize varieties); given that farmers have made

their decision to use the varieties continuously. Table 4.20 presents the maximum likelihood estimates of the Tobit model for factors influencing the extent of production of STAHA variety. The fit of the model was acceptable. The estimated coefficients for the likelihood ratio chi-square were significant ( $P < 0.000$ ), with chi-square value of 39.11. The model accounted Pseudo  $R^2 = 1.9\%$  of the variation between continued users and discontinued users of STAHA improved maize. This shows the dependence of the extent of production of STAHA variety on the predictive variables.

**Table 4.20** Tobit output on the extent of production of STAHA maize variety

Variable	Coefficient	Marginal effect	P- value
High yield	1008.003	641.0034	0.012**
Early maturity	-621.7538	-438.3511	0.068*
Tolerant to drought	-386.6395	-267.6838	0.264
Age	10.9955	7.710349	0.381
Land	423.7138	297.1198	0.004***
Extension service	-763.4427	-552.5026	0.032**
Hired labour	711.2411	528.6973	0.164
Household labour	144.455	101.5242	0.697
Number of observation= 156 LR $\chi^2(8) = 39.11$ Prob> $\chi^2 = 0.0002$ ***, Log likelihood= -1004.1455 Pseudo $R^2=0.0191$			

Note \*\*\*, \*\* and \*represents 1%, 5% and 10% level of significance

The results in Table 4.20 show that, if farmers continue to perceive STAHA variety as high yielding; their yield is likely to increase by 641.00kg/ha. This implies that improved maize

variety with high yield attribute has a positive impact on influencing farmers from increasing the extent of production. In the same vein, Ransom et al., (2003) argued that farmer will maximize their production as such the yield attribute of a variety continue to take advantage over other varieties. Moreover, high yielding variety could be a significant incentive for farmers to continue using varieties. Additionally, if farmers perceive STAHA variety as early maturing, their yields are likely to decrease by 438.35kg/ha. This is implying that early maturity attribute have no positive impact to influence farmers from increasing their yields, also it suggests that STAHA variety is not preferred for its early property for influencing farmers from increasing their extent of production. However, this is a counter-intuitive expectation because an early maturing variety would increase the extent of production as far as improved maize variety attribute is concerned (Timu et al., 2012).

Furthermore, the results show that a unit increase in hectare of land allocated for improved maize variety is likely to increase yields by 297.12kg/ha. The result implies that farmers will increase their extent of production if they have enough land. This view is supported by Tshikala et al., (2015) who reported that farmers who are satisfied with the higher yields allocated more land to improved maize varieties. Furthermore, access to extension services to farmers will decrease the expected yield of STAHA maize variety by 552.50kg/ha. This is counter-intuitive results, because access to extension services was expected to increase the extent of production in terms of yield. Access to extension services has been reported to be positive significantly influence agricultural technology productivity (Neill and Lee, 2001 and Tura et al., 2010). During the focus group discussion, participants reported that

even though they have access to extension services, much of it does not add new agricultural practices on the variety as they have been using the variety for a long period of time. In some cases, participants reported that extension service has been coming from different sources, which in one way or another confuse them on what to follow. Furthermore, other hypothesized variables from empirical studies were not statistically significant in influencing the extent of production of STAHA maize variety.

**Table 4.21** Tobit output on the extent of production of STUKA maize variety

Variable	Coefficient	Marginal effect	P -value
High yield	-561.5487	-387.3077	0.053*
Early maturity	932.8802	574.0564	0.004***
Tolerant to drought	846.9804	585.2672	0.002***
Age	-20.06866	-13.66042	0.088 *
Land	137.4452	93.5568	0.299
Extension service	362.1362	236.2055	0.294
Hired labour	571.5031	411.1342	0.146
Household labour	-734.2471	-488.9401	0.011**
Number of observation = 119 LR $\chi^2(8) = 29.70$ Prob> $\chi^2 = 0.0002$ *** Log likelihood = -777.71652 Pseudo $R^2 = 0.0187$			

Note: \*\*\*, \*\* and \*represents 1%, 5% and 10% level of significance

Considering farmers who actually continued to use STUKA maize variety (Table 2.21) for the period of five years, the presented Tobit model was statistically significant at a P-value

= 0.0002 and explained 1.87% of the variation (Pseudo  $R^2$  of 0.0187). The results in Table 4.21 show that if farmers perceive STUKA maize variety to be a high yielding, their yield is likely to decrease by 387.31kg/ha. This indicates that high yield attribute has no positive impact on influencing the extent of production in this variety perhaps there are other attributes that could be of more important than this attribute. Similarly, Timu et al., (2012) found that yield is negative and statistically significant to influence the extent of production when farmers' preference is on other attributes. Furthermore, if farmers perceive STUKA variety to take short period to mature, significantly increase yield by 574.06kg/ha. This implies that as the variety is much embedded with early maturing attribute the better the extent of production. According to Tshikala et al., (2015) asserted that farmers' decision to maximize their production in a season, it is influenced by the results realized or obtained earlier. Sinja et al., (2004) concluded that use of technology depends on users' judgments of the value of the technology in term of utility and efficiency of the technology.

The computed results in Table 4.21 also show that if farmers perceive STUKA maize variety to be drought resistant, their yield is likely to increase by 585.27kg/ha. This implies that a variety with drought resistant attribute is likely to increase the extent of production. Farmers who affirmed having severe drought in the past years are more likely to increase their production if the variety withstands drought (Tshikala et al., 2015). A year increase in the age of the farmer, significantly decrease yields by 13.66kg/ha. This implies that as farmers get old they will reduce the level of production. Ng'ombe et al., (2014) stated that there is a time in life of the household head, when age would no longer positively affect adoption process of agricultural technologies but negatively, the relationship that relates to

the life cycle hypothesis in economic theory. On the other hand, the literature suggests that as farmers get older they become more conservative and less open to new ideas (Tshikala et al., 2015).

Further results analysis in Table 4.21 show that, if farmers depend solely on household labour for their farming activity, significantly decrease their yield by 488.94kg/ha. This implies that, other source of labour is required for farmers to attain maximum production. Labour supply from the family level has been dwindling considerably over the past years due to a number of factors, some of which are related (Omotesho et al., 2014). The achievement of the international labour organization in child labour prevention, together with the increasing awareness of the prominence of education even in the rural areas has increased the proportion of children in schools hence reducing time available to work on the farm (Diallo et al., 2013). Rural-urban migration and the more attractive off-farm labour requirement have left predominantly the aged and less mobile farmers to work on the farms therefore reduce their extent of production (Oluyole et al., 2013). Beckmann, (2003) pointed out that although household labour is most desired by peasants because of its lower transaction cost, household labour is gradually becoming recognized as unsustainable hence the need for alternative source of human power. Additionally, both Extension services and hired labour were positive but not statistically significant as it was expected in the signs of coefficient in affecting the extent of production of STUKA variety.

As far as continued use of TMV1 variety is concerned, Table 4.22 shows that, the likelihood ratio ( $\chi^2$ ) value was 43.35 and this was significant at 1% level of probability.

This test shows that the Tobit mode was statistically significant and it was explained by the variation of Pseudo  $R^2$  value = 0.0356 which is an indication of that the explanatory variables are significant in explaining the extent of production of TMV1 variety. The results in Table 4.22 show that a perceived high yielding attribute of TMV1 variety became positive but not statistically significant in increasing yields. Meanwhile if farmers perceive TMV1 early maturing variety, their yield decreases by 511.16kg/ha. This implies that early maturity attribute has no positive impact on influencing the extent of production. Unlike Timu et al., (2012) argued that the effect of early maturing attribute is expected to increase the extent of production of the variety.

Furthermore, if farmers perceived the variety to be drought resistant, their yield is likely to increase by 537.86kg/ha. This implies that if a variety is set in with a drought resistant attribute the better the extent of production is expected. According to Timu et al., (2012) farmers prefer drought resistant variety partly because of its desirable attribute in terms of production during adverse condition. Additionally, the demand for variety specific agronomic attributes emanates from the need for farmers to maximize returns from production as well as stabilize income from utilizing a variety (Timu et al., 2012). Any increase in hectare of land reserved for improved maize variety, farmers are likely to increase their yield by 1000.10kg/ha. This implies that farmers will maximize TMV1 variety extent of production as long as more land is put aside. This finding is in agreement with Langyintuo and Mekuria, (2008); Tura et al., (2010) findings which showed that households with larger land holdings allocated more land to improved maize so as to maximize the production.



**Table 4.22** Tobit output on the extent of production of TMV1 maize variety

Variable	Coefficient	Marginal effect	P- value
High yield	489.6171	340.3109	0.217
Early maturity	-700.1317	-511.1629	0.086 *
Tolerant to drought	759.6469	537.8611	0.046**
Age	9.595518	6.825852	0.547
Land	1405.903	1000.101	0.000***
Extension service	-480.5414	-352.2446	0.319
Hired labour	1394.467	1099.75	0.025**
Household labour	706.9043	508.5602	0.126
Number of observation = 90 LR $\chi^2$ (8) = 43.35 Prob> $\chi^2$ = 0.0000*** Log likelihood = -586.69645 Pseudo $R^2$ = 0.0356			

Note: \*\*\*, \*\* and \*represents 1%, 5% & 10% level of significance

Furthermore, if farmers depend on hired labour for their farming activities, their yield is likely to increase by 1099.75kg/ha. This implies that as farmers hired labour from out of their household the more the likelihood of increasing production. Some agricultural technologies are heavily labour- intensive with farmers relying only on their households for labour supply to attain maximum productivity (Omotesho, 2014). Amsalu et al., (2013) asserted that shortage of farm labour at production peak seasons, may be a reason for households to hire farm labour. In addition, vulnerable households such as female headed

or orphaned households are usually unduly disadvantaged on family labour availability and productivity (Babatunde et al., 2008). Hired labour is not only relevant where family labour is inadequate, the much desired transition from small-scale farming to commercial level production definitely requires outsourcing for additional labour (Omotesho, 2014).

#### **4.9. Summary**

The computed results from the Tobit model indicated that all eight (8) hypothesized variables in the model, significantly influenced the extent of production in terms of quantity of yield harvested at 1%, 5% and 10% probability levels. Accordingly, high yield attribute increased the extent of production in STAHA, early maturity and tolerant to drought in STUKA; while tolerant to drought and early maturity has positive and negative impact on TMV1 variety, respectively. Accordingly, the model results show that, size of land, access to extension service influenced negative significantly the extent of production of STAHA variety, while age of the household, household labour affected negatively the extent of production of STUKA variety. Furthermore, tolerant to drought, size of land allocated for improved maize varieties, hired labour, and access to extension services, positive and negative significantly affected the extent of production of TMV1 variety, respectively.

## **CHAPTER FIVE**

### **CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Introduction**

This study was conducted to assess factors influencing the use of improved maize seed technology among farmers in Kilosa district. Specifically, the study set out to address three objectives namely: (i) identifying factors which influence farmers to continue or discontinue utilization of selected adopted improved maize seed varieties; (ii) assessing the evaluation criteria that farmers use to make decision to continue or discontinue using the adopted improved maize seed varieties; and (iii) assessing the extent of production of the selected adopted improved maize seed technologies. This chapter presents the conclusions and recommendations based on the findings obtained from the mentioned objectives.

#### **5.2 Conclusion**

##### **5.2.1 Factors which influence farmers to continue or discontinue utilization of selected adopted improved maize seed varieties**

From objective number one, in terms of high yield attribute, the study found differentials in many farmers by the choice of the variety (s) in that, those who chose STUKA; high yield prospect did not have a positive impact on their productivity relative to those that chose TMV1, while early maturity had a positive impact on the choice of STUKA variety relative to farmers who chose TMV1. Furthermore, age, membership in cooperatives, access to extension services household labour, hired labour and education have a variedly statistically significant contribution to promote farmers' choice of maize varieties. The logit results for STUKA and TMV1 continued use by farmers, reported to have a consistently

outcome of high yield to have a positive impact to influence farmers from adopting the varieties. Additionally, farmers reported to have a consistently outcome of high yield not have a positive impact on continued use of STUKA variety. Further, farmers reported to be variedly impacted for their continued use of varieties with resistant to pest and disease, total farm size, experience in farming, household labour, hired labour, education level, and extension service contact.

### **5.2.2 Evaluation criteria that farmers use to make decision to continue or discontinue using adopted improved maize seed varieties**

Farmers may have different but similar combinations of criteria in evaluating maize seed variety. On the question of evaluation criteria used by farmers in the study area, this study found that high yield and early maturity were the two major criteria in most of the varieties, followed by large grain size, tolerant to drought, resistant to pest and diseases for farmers to make utilization decision of the variety in the subsequent farming season. This implies therefore that, for sustainability of the adopted maize variety by farmers, there is a need for the variety to be set in with attributes that meet these criteria otherwise discontinuation of variety will occur.

### **5.2.3 Assessing the extent of production of the selected adopted improved maize seed technologies**

From this objective the study found that high yield, early maturity, resistance to drought, age, size of land, access to extension services, household labour, and hired labour demonstrated to be major factors which contributed to the extent of production of improved

maize variety. It can be therefore, be concluded that, for farmers to increase their extent of production of the particular maize variety in their field, they are influenced by the perceived attributes of the variety, age, and size of land, access to extension services, household labour, and hired labour. However, the magnitude of the effect varied across different selected improved maize varieties. For instance, high yield and early maturity attributes impacted positively STAHA and STUKA extent of production, respectively; while tolerant to drought have a positive impact on STUKA and TMV1 varieties.

### **5.3 Recommendation and implication**

This section presents recommendations and implications, which seek to give a framework on how to ensure that farmers will continue using adopted improved maize seed variety technology and lastly, highlights future research areas to be conducted as follow-ups.

Maize evaluation criteria and desired quality attribute should be guided by farmers' views in relation to their prevailing local context. When designing improved maize seed technology, breeders and researchers should consider farmers' views about the technology in relation to their local context. Further, evidence from the finding suggests that there is a need to have an efficiency and effective extension system so as to ensure the continued utilization of adopted technology. There is, therefore, a definite need for the government of Tanzania to reform extension service in the way it is delivered to farmers, for example making it demand driven, and farmers need to be educated on the importance of financing extension services. Although this study was conducted only in Kilosa district, this can also

be applicable in other developing countries where government extension institutions are believed to be weak and constrained with resources.

Lastly, generally when any intervention is sought to address farmers' felt need, farmers' characteristics and perspectives should be considered by policy makers, researchers/breeders and extension workers.

### **Future research areas**

This section highlights areas that future studies need to be conducted as follow ups so as to provide answers on issues which were observed in the study:

Future studies should shed a light on conducting longitudinal study to assess farmers' dynamic evaluation criteria and preference of the desired improved maize varieties' attributes. The current findings suggest subjective evaluation criteria and preference of the desired maize attributes among farmers. Although this study assessed factors which influence the use of improved maize varieties, more work need to be done to analyse the dynamic continuation and discontinuation process of improved maize seed technology among farmers in rural community.

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## APPENDICES

**Appendix 1** Order of importance preference ranking and the most reasons for ranking maize varieties grown by respondents for the past five year's period

Variety		Attributes reported frequencies																							RANK			
	Farmer's order of importance preference																											
		HY	EM	TD	R P& D	LG	GC	BC	SG	HGP	HNC	GT	A	EGS	GS	GCQ	LM	LY	SCDP	SGR	ADR	SCB	EGS2	GGF	2C	SCORES	Ranking (inter-variety)	Utilization rank
STAHA	1 <sup>st</sup> most important	43	2	10	3	12	0	5	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1	0	79	2	
	2 <sup>nd</sup> most important	5	9	9	3	1	0	8	0	0	0	0	0	0	0	0	11	4	4	0	4	0	0	0	0	58		
	3 <sup>rd</sup> most important	1	0	4	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	3	0	0	1	0	0	12		
	4 <sup>th</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2		
Total score STAHA		49	11	23	7	13	0	14	0	0	0	0	2	0	0	1	13	4	5	3	4	0	1	1	0	151		1
STUKA	1 <sup>st</sup> most important	31	43	15	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	92	1	
	2 <sup>nd</sup> most important	2	17	5	1	0	0	0	0	0	1	0	0	1	0	0	0	1	4	0	0	1	0	0	0	33		

	3 <sup>rd</sup> most important	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	6		
	4 <sup>th</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Total score STK		33	62	22	2	1	0	0	0	0	1	0	1	1	0	0	0	1	4	1	1	1	0	0	0	131	2

TMV1	1 <sup>st</sup> most important	19	3	7	4	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	37	3	
	2 <sup>nd</sup> most important	3	13	3	1	0	0	0	0	0	0	3	0	0	0	0	0	5	1	1	1	0	0	0	0	31	
	3 <sup>rd</sup> most important	2	2	1	1	0	0	1	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	11	
	4 <sup>th</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
Total score TMV1		24	18	11	6	1	0	2	0	0	0	3	0	1	0	0	1	8	2	1	1	0	0	0	1	80	4

Katumani	1 <sup>st</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2 <sup>nd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	3 <sup>rd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
	4 <sup>th</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total score KAT		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	3	8

PANNA R	1 <sup>st</sup> most important	7	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	<b>6</b>
	2 <sup>nd</sup> most important	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
	3 <sup>rd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	4 <sup>th</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Total score PANNAR</b>		<b>7</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>11</b>	<b>6</b>
SEEDCO	1 <sup>st</sup> most important	8	1	2	3		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	<b>5</b>
	2 <sup>nd</sup> most important	2	3		1	1		0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	12	
	3 <sup>rd</sup> most important	0	0	0	0	0	1	0	0	0	0	0	0	0		1	0	0	0	0	0	1	0		3	
	4 <sup>th</sup> most important	0	0	1	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		1	
<b>Total score SEEDCO</b>		<b>10</b>	<b>4</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>5</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>2</b>	<b>31</b>	<b>5</b>
DELCAL B 803	1 <sup>st</sup> most important	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	2 <sup>nd</sup> most important	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	3 <sup>rd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	

[illegible]

[illegible]



NATA 205	1 <sup>st</sup> most important	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	<b>9</b>
	2 <sup>nd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	3 <sup>rd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	4 <sup>th</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Total score NATA 205</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>10</b>
TANH25 0	1 <sup>st</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	2 <sup>nd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	3 <sup>rd</sup> most important	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	
	4 <sup>th</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Total score TAN250</b>		<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>9</b>
TANH	1 <sup>st</sup> most important	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	<b>8</b>	
	2 <sup>nd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	3 <sup>rd</sup> most important	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

[illegible]

**Appendix 2** A checklist for key informant interview DAICO, DAEO  
**Lilongwe University of Agriculture and Natural Resources**

**Faculty of Development Studies**

**Department of Extension**

**Informed consent**

Hello, my name is..... one of the assistant researchers on the study which is assessing the factors influencing the continued use of improved maize seed technology here in Kilosa district. The main objective of the research is to identify the factors which influence the continued or discontinued use of improved seed technology in the household and come up with appropriate interventions to improve the promotion of continued use of improved maize seed technologies.

Kilosa district has been chosen as the area for the study because the use of improved maize seed varieties has been practiced for a relative longer period of time compared to other district in the country. You have been sampled because we have learnt that you have knowledge and necessary information on the continued or discontinued utilizing improved maize seed varieties among farmers in the area.

I am, therefore, going to ask you some questions regarding the use of improved maize seed technologies. Your participation in this interview is voluntary and you are free to participate. However, I will be grateful to have your participation. Your answers will also remain confidential and will not be disclosed in any way that you can be identified.

Do you wish to participate? Yes ..... No .....

**Date**.....

**Time: from ..... to: .....**

**Interviewee:** .....

**Position of interviewee in society/organization:** .....

**Name of the organization/Social status**.....

**Interviewer:** .....

1. What improved maize varieties do farmers grow in the district now and why do they grow them?

2. Which IMV did farmers stop to grow in the district and why did they stop?
3. Why do you think that it takes a long time for farmers to stop growing some improved maize varieties? Give examples of these IMVs
4. Why do you think it takes a short time for farmers to decide to discontinue growing some IMV? Give examples of these IMVs
5. What criteria do men and women farmers use to decide to continue growing or discontinue growing these IMVs?
6. What are the challenges that men and women farmers experience in continuing to grow IMVs (Remarks: *we want to see the differences between men and women*)?
7. How can the challenges be addressed? By whom?
8. What can be done to promote continued use of improved maize seed variety in the area and how?
9. What are the perceptions of men and women farmers on improved maize seed varieties usage?
10. What factors have contributed to the adoption of these maize varieties?

**THANK YOU FOR YOUR COOPERATION**

### Appendix 3 Key informant interview checklist: WEO and VEO

Personal information	Identification information
1. Who are we and where we come from?	1. What is the name of the area?
2. Purpose of our visit and the study objective	
3. Issues with voluntary participation and confidentiality	

#### Background information on improved maize seed variety

1. Are farmers growing improved maize seed variety?
2. What type of improved maize varieties grown by farmers in this area? (differences in seed preference between men and women, and why)
3. Give examples of the type of IMV mentioned in question 2 above
4. What are the sources of seed in this area?
5. Is there any difference between improved maize seed varieties and local varieties in terms of production? Yes? /No why?
6. Are there any changes to farmers due to the use of improved maize?

#### Utilization of improved maize seed varieties

1. Do famers continue to grow the improved maize seed variety? Yes/No
2. If yes in question 1 what are the enabling factors for them to continue utilizing the varieties?
3. If No in question 1, what is preventing them to do so?
4. Do farmers follow the recommended agronomic practices of improved maize seed varieties? No/Yes and why?
5. What are IMV that are no longer grown by farmers? **Why?**
6. What characteristics of improved maize seed varieties do you think are more liked by farmers? Why? *Probe the difference in preferences between men and women*
7. What factors have contributed to the adoption of these maize varieties?

**THANK YOU FOR YOUR COOPERATION**

**Appendix 4** Semi structured group discussion guide for farmers  
**Lilongwe University of Agriculture and Natural Resource**

**Faculty of Development Studies**

**Department of Extension**

<b>Personal introduction</b>	<b>Identification information</b>
1. Who are we and where do we come from?	1. What is the name of ward and village?
2. Purpose of our visit and study objectives	2. What is the name of the ward executive officer?
3. Issues of voluntarily participation and confidentiality	3. What is the name of village executive officer?

**Date..... Time: From..... To .....**

**Adoption and continued use of improved maize varieties (IMV)**

1. What type of improved maize seed variety do you grow in this area?
2. Individually, for how long have you being continuing growing improved maize seed varieties?
3. Give examples of improved maize seed you grow in this area.
4. Among the varieties you are continuing growing which one do you think is the most preferred variety than the other? Rank them in order of preference.

<b>Name of the IMV</b>	<b>Order of preference (say 1-6)</b>	<b>Reasons for ranking</b>


**Remarks:** *Make sure that you have a separate focus group discuss for men and women*

5. Are IMV being easily accessible to you? Do you easily access IMV?
6. If the answer is YES in question 5 above, how do you access them?
7. What are the differences between IMV and local varieties in terms of production?
8. What factors have contributed to the adoption of these maize varieties?

### **Importance of IMV**

1. Are there any changes that have happened in this area since you adopted IMV If Yes, what are these changes?
2. Are there any changes that have happened in your life since you have been growing IMV If Yes, what are these changes?
3. In your view why do you think you the Agricultural extension officers recommend the continued use of IMV?
4. Who are the people in your area who seem to be benefiting from use of IMV? Why?

### **Farmers' perception on IMV**

5. What are the perceptions of men and women farmers on improved maize seed varieties usage?

	<b>Men</b>		<b>Women</b>
Variety	Perception on IMV	Variety	Perception on IMV

Remarks: we want to see the differences in perception between men and women on the usage of IMV

**THANK YOU FOR YOUR COOPERATION**



**Appendix 5** Household questionnaire  
**Lilongwe University of Agriculture and natural Resource**  
**Faculty of Development Studies**  
**Department of Extension**

**Informed consent**

Hello, my name is..... one of the assistant researchers on the study which is assessing the factors influencing the continued use of improved maize seed technology here in Kilos district. The main objective of the research is to identify the factors which influence the continued or discontinued use of improved seed technology in the household and come up with appropriate interventions to improve the promotion of continued use of improved maize seed technologies.

Kilos district has been chosen as the area for the study because the use of improved maize seed varieties has been practiced for a relative longer period of time compared to other districts in the country. Your household has been sampled because we have learnt that you continued or discontinued utilizing improved maize seed varieties.

I am therefore going to ask you some questions regarding the use of improved maize seed technologies. Your participation in this interview is voluntary and you are free to participate. However, we will be grateful to have your participation. Your answers will also remain confidential and will not be disclosed in any way that you can be identified.

Do you wish to participate? Yes ..... No.....

**Time: From..... To.....**

<b>MODULE 1: IDENTIFICATION AND INTERVIEW SUMMARY</b>
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<b>100</b>	Questionnaire number	
<b>102</b>	Name and signature of interviewer	
<b>103</b>	Date of the interview (dd/mm/yy)	
<b>104</b>	Name of researcher	
<b>105</b>	Date of supervision/checking questionnaire	
<b>106</b>	Date data entry completed	

<b>MODULE 2: HOUSEHOLD IDENTIFICATION AND DEMOGRAPHIC</b>
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<b>200</b>	Village	
<b>201</b>	Ward	
<b>202</b>	Division	
<b>203</b>	District	
<b>204</b>	Code number of the respondent	
<b>205</b>	Sex of the respondent [     ]	0= Male 1= Female
<b>206</b>	What is the marital status of the respondent? [     ]	1= single 2= Married 3= Divorced 4= Widow 5= Widower
<b>207</b>	How many people live in your household?       people	
<b>208</b>	What is the age of the household head?       Years, If Not known estimate Years.	
<b>209</b>	What is your level of education? [     ] 0=None 1= Primary, 2=Secondary, 3= Colleges, 4=University degree, 5= Adult literacy	
<b>210</b>	What is your main occupation? [ ] 1= Farming 2= Business 3= labourer 4= others (specify).....	

<b>MODULE 3 AGRICULTURAL PRODUCTION</b>
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<b>300</b>	What is the total size of your agricultural land? [     ] hectares	
<b>301</b>	How much land is allocated to improved maize seed varieties.....(in hectares)	
<b>302</b>	Who is the owner of the land? [     ]	1= Husband 2= Wife 3=other(specify)
<b>303</b>	How many years have you been involved in farming?       years	

<b>304</b>	What source of labour do you use in your farming activity? 0= Household labour 1= Hired labour 2=Both	[     ]
<b>305</b>	Do you engage in off farm income generating activity? 0= No 1= Yes <i>If Yes</i> what the name of that activity ..... And how much in TSH/year? .....	

<b>306</b>	Do you have access to credits/loan? 0= No 1= Yes If Yes, how much in TSH? ..... if No, go to questions <b>307</b>	<b>307</b> What are the challenges do you face in access the loan/credit? <b>code 1</b>
<b>308</b>	Are you a member in any cooperative/ farmer's organization? 0= No Yes= 1 if Yes go to Question <b>309</b>	<b>309</b> What are the reasons that made you to be a member? <b>Code 2</b>

<b>Code 1: challenges on credit/access</b>	<b>Code 2: Reason in cooperatives membership</b>
1=Lack of collateral	1=access to extension services
2=Absence of lending institutions	2=access to loans
3=High interest rates	3=access to help from peers
4= Low producer prices	5=access to land
5=Others(specify)	6=bargaining power
	7= other specify

#### MODULE 4 THE USE OF IMPROVED MAIZE SEED VARIETIES

**400** What improved maize attributes do you perceive important to you?

**401**What type of variety/ies did you grow last season, 2014/2015?

Variety (code3)	Type(Hybrid/OPV)	Size of land (hectares)	Fertilizer application Yes/ No	Type of fertilizer	Amount of fertilizer Kg/ hectare	Source of seed (code 4)	Reasons for choosing a variety


Code 3: Variety	Code 4: Source of seed variety
1=STAHA	1=Recycled
2= STUKA	2=Bought from local market
3= TMV1	3= Bought from fellow farmers
4= PANNAR	4=Bought from input supplier/ Agro dealer
5= SEEDCO	5=Given by a friend
6=DELCALB803	6=Given by a relative
7=local variety	7=Other (specify).....
8=Others (specify)...	
....	

**402** Which type of maize varieties have you been growing in the past five years and why?

<b>Year s</b>	<b>Variety (code 3)</b>	<b>Variety Type ) Hybrid/O PV)</b>	<b>Land allocated (hectare)</b>	<b>Fertilizer applicatio n (Yes/No)</b>	<b>Amount fertilize rs (kg)/hec tare</b>	<b>Source of seed (Code4)</b>	<b>Reaso n for choosi ng variet y</b>
2015							
2014							
2013							
2012							
2011							

**403** Rank the variety you have been growing for the past five years in question  
**402** above in order of importance

Variety (code 3)	Rank of variety	Most important reason for ranking

<b>404</b>	Are there any varieties which you are no longer growing them apart from the varieties in question 401 above? [     ] 1= Yes   No=2 if Yes go to questions <b>405, 406, 407</b>
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Variety	Characteristics of the variety	<b>405</b> For how long did you grow them?	<b>406</b> What was the production trend? (kg)	<b>407</b> Why did you stop growing them?


<b>408</b>		What is production trend of improved maize seed varieties (IMV)?	
	Year	Variety ( <b>code 3</b> )	Quantity harvested kg
	2015		
	2014		
	2013		
	2012		
	2011		

#### **MODULE 5: AGRICULTURAL EXTENSION SERVICE**

<b>500</b>	Do you have access to extension services? [     ] 1= Yes 0= No if Yes go to questions <b>501,502</b> and <b>503</b>		
<b>501</b>	How often did you access agricultural extension services in the last growing season?		
		Frequency of service ( <b>code 5</b> )	<b>502</b> What is the source of extension service ( <b>code 6</b> )

<b>Code 5: Frequency of extension service</b>	<b>Code 6: Source of extension service</b>
1=Once a week	1=Government extension officers
2=Once in a fortnight	2=NGO extension officers
3= once a month	3=News paper
4= Once a year	4=TV
5=Cannot remember	5= Farmer to farmer
6=Never	6=Other (specify).....
7= Other (specify).....	

<b>503</b>	What extension messages did you receive the last growing season	
	<b>Extension messages</b>	<b>tick</b>
	1=land preparation	
	2=seed rate	
	3 use of IMV	
	4=weeding	
	5=plant spacing	
	6=fertilizer application	
	7=post-harvest management	
	8=Pesticide and disease control	
	9= Others (specify)	

<b>MODULE 6: FARMERS PERCEPTION ON IMV</b>
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<b>600</b>	If you are still growing the following improved maize seed varieties what is your perception on them?	
	Varieties	Farmers perception
	STAHA	
	STUKA	
	TMV1	
	PANNAR	
	SEEDCO	
	DELCALB803	
	Others(specify)	



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<b>602</b>	What are your perceptions on the following improved maize varieties which you stopped growing?	
	STAHA	
	STUKA	
	TMV1	
	SEEDCO	
	DELCALB803	
	Others (specify)	

*REMARKS: Ask famers how and why think like that on the varieties (**Probe more**)*

**THANK YOU FOR YOUR COOPERATION**