SMALLHOLDER FARMERS' ADOPTIONAND FOOD SECURITY CONTRIBUTION OF IMPROVED CASSAVA VARIETIES: A CASE OF NASE 14 CASSAVA VARIETY IN EASTERN UGANDA

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DECLARATION

I Dugo Amina do affirm that, this thesis composition is maiden and has not previously been presented to either university or tertiary academy for any award. All the support acquired in its preparation is fully recognized and revealed, citing the authority from which I used the ideas or words, either referenced, paraphrased or quoted directly.

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DUGO AMINA

APPROVAL

I hereby confirm that this dissertation has been compiled with my guidance and is now ready for further examination.

Signed ………………………… Date…………………10/09/2024

DR. MARTIN MUTAMBUKA

DEDICATION

This dissertation is dedicated to my Mother, Nabwami Aisha for her continuous encouragement and interest she had in my studies.

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LIST OF ABBREVIATIONS

CBSD	Cassava Brown Streak Disease
CMD	Cassava Mosaic Disease
FAO	Food and Agriculture Organization
Ha	Hectare
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MFI	Micro Finance Institution
NAADS	National Agricultural and Advisory Services
NARO	National Agricultural Organization
NGO	Non-Governmental Organization
NUSAF	Northern Uganda Social Action Fund
PMG	Production and Marketing Grant
VSLA	Village Savings and Loan Associations

ABSTRACT

Cassava is among the three significant food crops in the tropics ranking third to rice and maize. It is consumed by a considerable number of people (approximately one billion) in Africa. In Uganda, it has been a food security crop but recently the cassava brown streak disease (CBSD) struck the zone where it's mostly grown affecting most of the varieties.

NASE 14 is an improved cassava variety tolerant/resistant to the diseases (CMD, CBSD) and is high yielding. Despite all the efforts by government in promoting tolerant varieties, adoption at farmer level is low. The main objective of the study was to establish the factors responsible for adoption of cassava varieties resistant to Cassava brown streak virus disease and its contribution on food security in Eastern Uganda.

A Cross section design was used and a random sample of 240 respondents were taken from three districts of Tororo, Butaleja and Bugiri. Data were subjected to descriptive and inferential statistics such as frequencies, means, T-test and multiple logistic regression. The results revealed that Membership to a group ($P = 0.046$), Land size owned ($P=0.002$), access to inputs ($P<0.0001$), credit ($P<0.0001$) and experience ($P<0.001$) had a positive and significant influence on the uptake of NASE 14 cassava variety. In relation to gender the coefficient was positive and statistically significant ($P = 0.025$), implying that the males were more likely to take up NASE 14. Farmers preferences of NASE 14 cassava variety that enhanced adoption included; high yield and ability not to rot. The findings further disclosed that majority (71.1% and 81.9% adopters and non-adopters respectively) of the household reported having food deficits in a certain period of the year with a greater proportion reported among the non-adopters. The T –test showed that there was no significant difference in the contribution of adoption of NASE 14 to food security between the adopters and non-adopters ($P=0.245$). Conversely, off farm income had a negative and significant influence on the uptake of NASE 14 ($P <0.0001$) indicating that the likelihood of adopting NASE 14 decreases with increase in the off farm income. It is therefore recommended to give much attention to the socio economic and demographic characteristics as they portray a significant part in influencing adoption of NASE 14.

CHAPTER ONE

1.0. INTRODUCTION

1.1. Background

Agriculture has remained one of the most important sectors in Uganda's economy as it employs the largest proportion of the population estimated to be over 60 percent (UBOS 2020). Uganda has a relative advantage in food production and has the ability to produce enough food for the region. In recognition of this potential, Government has devoted itself to increase investments that would lead to increase in agricultural production and productivity. Progress in increasing crop yields especially for cassava has been made in a number of areas including availability of improved disease resistant varieties. This initiative can yield good results if the farmers consistently use the improved varieties.

Cassava (*Manhot esculanta)* is an excellent continuous storage root crop grown in most African countries. It is a predominant food crop for over 800 million people globally and provides opportunities for income for small holder farmers along the value chain (Abdoulaye et al, 2014; FAO, 2016).The benefits of cassava are divided into local staple foods, Agricultural industrial products and industrial raw materials (Rozi et al. 2023). Cassava is among the three most important food crops in the tropics, the first two being rice and maize. About one billion people, most of them in Sub Sahara Africa consume it daily (Eugene and Otim, 2012) and for Uganda approximately 14 million people depend on it (Kizito *et al. 2006*). Cassava is next to bananas as regards food security and household incomes *(*Nakabonge *et al. 2018)* and provides a basic daily source of dietary energy to the small holder farmers and income from processed products (Njine 2010). In Uganda, although many crops are cultivated for food, food availability remains worrying as a result of the harsh weather and declining soil fertility. However, cassava has for many years been the food security base of the country and regarded the most vital food crop among small holder farmers because it can thrive in low fertility soils, can be harvested piece meal for a stretched period, and has the ability to produce more starch per unit area compared to other starch crops (Tonukari, 2004). Uganda produces over five million tons annually covering 500,000 Ha and ranks sixth in Africa after Nigeria, Democratic republic of Congo, Mozambique, Ghana and Angola (FAO 2017).

The eastern region in Uganda is the major producer of cassava estimated at 37%, followed by northern Uganda at 34% and Bunyoro at 15% (UBOS 2020). At the time of the study, there were several varieties grown in Eastern Uganda which included NASE 14, Akena, TME 204, TME 14, NASE 14, Migyera and Magana. Cassava has been mostly grown for home consumption and on small scale (less than 5 acres) but now many farmers are embracing commercial cassava growing due to the high demand on the market (Akongo et al, 2021). In Eastern Uganda cassava is mixed with millet and or sorghum to make the staple food consumed by over 85% of the inhabitants and regarded as the most important cheap source of staple food and cash crop.

For over a decade in Uganda, approximately 2.8 million Tons have been produced from 0.7 million hectares of land (FAO, 2016). Cassava crop yield per unit area on farms is still low, on average a Ugandan farmer harvests approximately 20% less cassava per hectare than the world average of 12.2 MT ha^{-1} and yet there is potential for higher yields of between 10 – 40 $MTha^{-1}$(Fermont et al, 2009). This low productivity could be attributed to poor cassava yielding varieties, pests and diseases especially those transmitted by viruses.

The area under cassava in Uganda reduced to 852,829Ha in 2011 compared to 871,389 Ha in 2008 and consequently production of cassava decreased to 2,729,260 tons compared to

2,875,584 tons (UBOS 2018). This was mostly attributed to the cassava diseases especially cassava brown streak disease (CBSD) which had led to abandonment of cassava growing by some farmers (*Kumakech et al 2013*).

Previously, the threat to cassava production was cassava mosaic virus pandemic with a mean loss of over 70%, but this was managed due the wide spread initiation and use of resistant varieties (Fermont*et al*., 2009). Investment in cassava research and technology transfer resulted into an observable improvement on cassava yield in the country (Root Haert and Magodo 2011)

Recently the cassava brown streak virus disease (CBSD) hit Eastern Uganda, which is among the main cassava growing regions in the country. The disease is next to cassava mosaic among the constraints to cassava production in East Africa (Winter et al 2010) and has been spreading at an alarming rate threatening the food security of cassava farmers (Legg et al 2014). It affects cassava and no alternative crop or weed hosts have been reported (Mbanzibwa et. al 2011). It is spread both by planting infected cuttings and a whitefly vector, *Bemisia tabaci*. But, unlike the mosaic symptoms of CMD, the foliar symptoms of CBSD are less conspicuous and farmers are often unaware of the problem until the roots are harvested and the corky, yellow-brown necrotic rot becomes evident (Alicai et. al 2007). A number of released varieties before 2015 including Akena, TME 14, TME 204 and NASE 3 among others which were grown in Eastern Uganda succumbed to the Cassava viral disease and this had devastating effects on cassava production by the smallholder farmers and greatly affected the food security situation in the region. (Okao – Okuja et al. 2017)

Management of CBSD at the moment in Eastern Uganda is through the promotion of integrated management of CBSD which include field hygiene, planting disease free vegetative materials and planting resistant / tolerant varieties. Field hygiene and planting disease free vegetative materials require collective action by all cassava farmers. This requires farmers to grow cassava in close proximity to cooperate in implementing the measures, however due to the individualistic nature of the farmers and land fragmentation in Eastern Uganda this is limited to small areas leaving the option of uptake of improved cassava varieties like NASE 14 as an easier and achievable alternative. “The speed of uptake of a new innovation is subject to how gainful it is, risk level associated with it, resource needs, agricultural policies and socioeconomic characteristics of farmers” (Nata et. al. 2014). Some of the parameters critical to the adoption of new cassava varieties are level of education of the farmers’, availability of extension services and marital status (Oryema et. al. 2021, Langetet et. al 2013).

NASE 14 was developed at the National Crops Resources Research Institute (NaCCRRI) Namulonge and released in 2011 when CBSD had attacked most of the resistant varieties resistant to CMD like Akena, TME 14, TME 204 and NASE 3. The Variety is high yielding (33.97 t/ha) and tolerant to both CMD and CBSD (Abaca et al 2021).

Adopting improved varieties in agriculture is an important way of increasing productivity for small holder farmers as this fosters improved welfare. In contrast, there is limited reporting on who is adopting improved cassava varieties and who is not and making it difficult to formulate policies aimed at increasing adoption in order to improve agricultural productivity. Studies focusing on agricultural improvement evidenced that adopting agriculture technologies can reduce food insecurity and ultimately increase house hold incomes. (Shifrew et al. 2014, Khoje et al 2018). Although yield is high from the improved cassava varieties, the challenge is the limited knowledge on the extent to which these varieties translate into improving the farmers’ food security at the house hold level.

1.2 Problem statement

Most farmers in Uganda and more so in Eastern Uganda rely upon local varieties with low productivity and are susceptible to pests and diseases. The same varieties such as Magana NASE 3 and TME 204 are preferred for various reasons (Iragaba *et. al*. 2020), this puts the food security situation in the region at stake, as it depends largely on cassava for its food security. Uptake and constant use of improved technologies is a more promising approach to improve food security and house hold incomes.

Despite the new improved cassava varieties developed and distributions made to the farmers, adoption on farms is still low in Uganda and especially in Eastern Uganda (Iragaba *et. al* 2020). Furthermore, the reasons associated with low/ high adoption of the new improved cassava varieties are limited and in other areas no study has ever been conducted to assess the underlying factors responsible for adoption and the contribution of improved cassava technologies to food security in Eastern Uganda, particularly in the districts of Butaleja, Tororo and Bugiri**.** Therefore, this study sought to examine the factors that explain the adoption of NASE 14 variety and its contribution to food security among small scale farmers in the Districts of Butaleja, Tororo and Bugiri.

1.3 General objectives

The main objective of the study was to establish the factors responsible for adoption of cassava varieties resistant to Cassava brown streak virus disease and its effect on food security in Eastern Uganda

Specific objectives

1. To determine the factors that influence uptake of NASE 14 cassava variety among households in Eastern Uganda
2. To determine the effect of adoption of improved cassava varieties on small holder household food security in Eastern Uganda

1.4 : Hypothesis

1. At least one factor influences the uptake of NASE 14 in Eastern Uganda
2. There is no difference in food security between NASE 14 adopters and non-adopters in Eastern Uganda.

1.5 Scope of Study

This study was limited to determining the socioeconomic characteristics of the cassava farmers, their perception of the new cassava variety (NASE 14), factors influencing famers to continuously use improved cassava varieties and the effect of improved cassava varieties on the food security of farmers' households in Eastern Uganda. The study covered farmers who had received improved varieties of cassava NASE 14, from the various programmes within selected Districts in Eastern Uganda between 2010 –2017 as well as farmers who didn't.

1.6 Justification for the study

Cassava adoption studies conducted concentrated on all the improved varieties released in Uganda but it has been found evident that most of the earlier varieties developed and released are also susceptible to the brown streak so there is need to investigate up take of the varieties resistant to cassava brown streak that the Country has been promoting.

This research sought to generate more knowledge and provide information on the up take status of the Cassava Brown streak tolerant varieties in Eastern Uganda which can be used for planning purposes. The findings of this study will also benefit different stakeholders such as farmers, traders, industries and consumers in the study area to understand the key attributes possessed by NASE 14. The research will also add to the pool of information specifically existing on adoption of NASE 14 cassava variety so as to improve its dissemination to the communities. The study findings will also be used to guide policy on the distribution of cassava planting material intended for consistent use. The findings will assist in providing feedback to breeders on the attributes that need to be improved for increased acceptance.

1.7 Conceptual frame work

Figure 1.1 below shows the conceptual frame work which illustrates the variables responsible for the uptake of the upgraded varieties

Technology adoption is influenced by a number of factors which include among others; socio-economic characteristics and those of institutional, psychological and technological nature. Lepar and Ehui (2004) explained that for a new technology to be ably utilized by small holder farmers, fulfillment of certain parameters like socio-economic, institutional, psychological and technological conditions must be observed. The speed at which a new technology is acquired and used by farmers is stimulated by the farmers' perception of the traits of the technology introduced which must as well be accurately and easily managed by smallholders. The new technology must be available, compliant to the socio cultural environment and all the other necessary inputs should be accessible at the right time, place, in the right quantity and quality to warrant adoption of the technology. For this study it is presumed that for a farmer to make a resolution to adopt NASE 14 must have scrutinized the gain attainable from adoption and that from non-adoption.

In the context of the study the conceptual frame work assumes that for sufficient adoption to take place, it will be dictated by several factors (the independent variables) which include;

i. Social as well as economic variables which comprise of age, educational status, household size, gender, experience in farming and income availability.
ii. Institutional variables comprising of membership to a group/organization, access to credit, access to information,
iii. Technological variables which comprise of access to cassava improved varieties and technical knowledge.

The dependent variable is the uptake of the improved CBSVD tolerant variety NASE 14. The model shows how the predictor variables (X) would influence the response variable(Y) and the observable effect for the adoption of NASE 14 cassava variety would be increased food security. However the intervening variables which are government policy, research and development would help to explain the link between the predictor variables and the response variable.

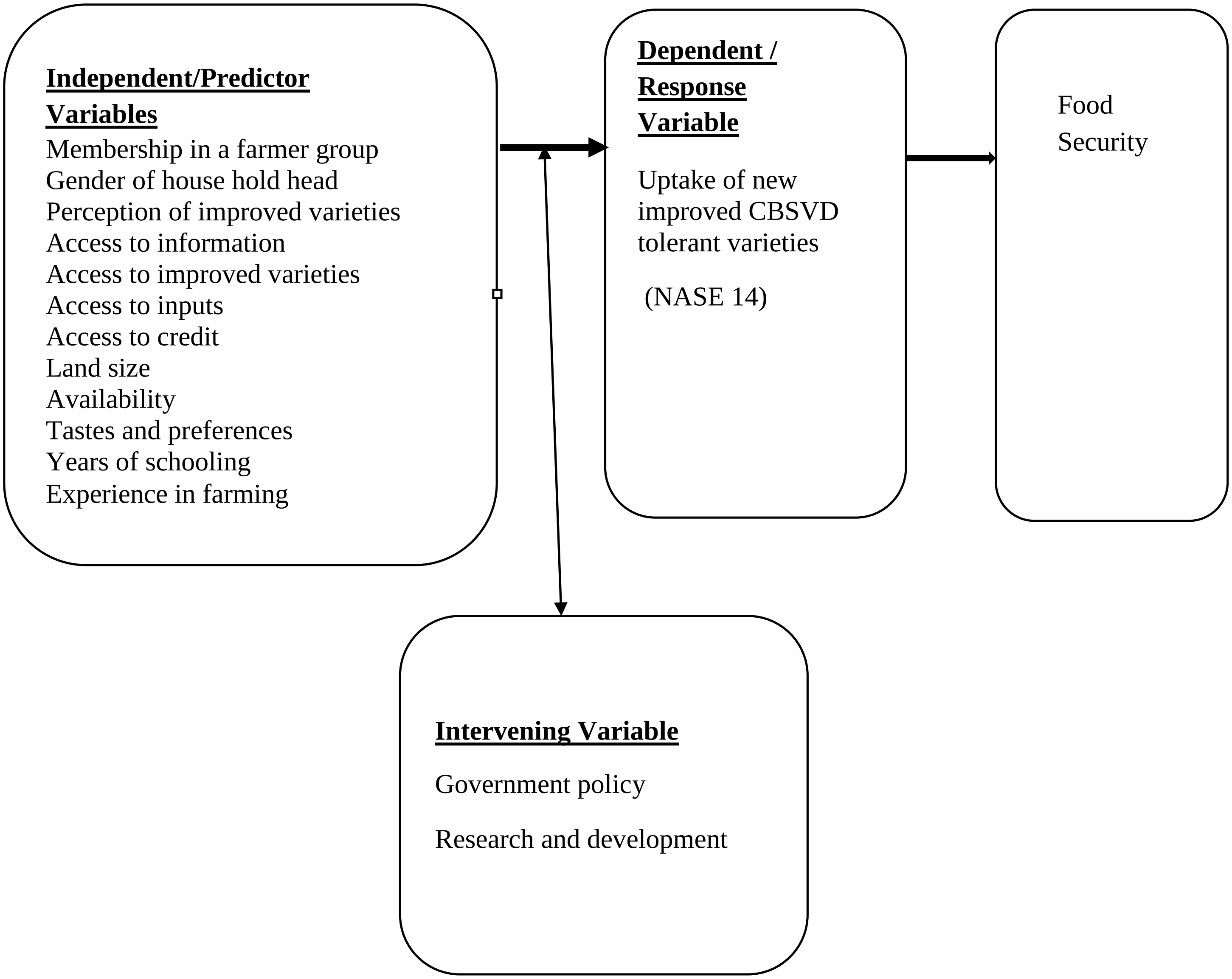

Figure 1.1: Illustration of the variables that are responsible for the uptake of the new improved varieties

CHAPTER TWO

2.0: LITERATURE REVIEW

2.1. Key Concepts of adoption.

2.1.1. Adoption

Adoption is defined as a pathway where by a person or institution identifies and accepts a new technology or innovation (Mitropoulos and Tatum 2000). Adoption in this study is defined as acceptance by farmers to use and integrate an improved technology in the farming system. A farmer who was found to have grown NASE 14 for a season prior to 2017 (the year the data of study was collected) and had the variety on his farm in the year 2017 was considered to be an adopter. Additionally, adoption refers to a course of action which starts from acknowledgement of the technology to constant use of the innovation; the process has been explained to result into unsatisfactorily relationship between intention and behavior of adoption (Gollwitzer 1999 and Doss, 2003). In a study conducted by Karanja et al (2020) on farm-level technology adoption in east Africa, a farmer was described as an adopter, if they were found using any improved material and a distinction between discrete and continuous technology adopters among typical farmers who use either unimproved or improved inputs was spelt out. Discrete adoption refers to use of an improved variety without going back to the local or traditional ones where as continuous adoption refers to situations where farmers increasingly plant more acreage to improved varieties, while continuing to grow some local varieties (Lopes, 2010).

2.1.2. Adoption of Agricultural Technologies

“Extensionists and economists have had interests in the significance of farmer’s adoption of new agricultural technologies for some time” (Oladele2005) and a number of parameters have been identified as influencing the adoption action of farmers from qualitative and quantitative models for the exploration of the subject (Asfaw Solomon and Shiferaw Bekele 2010). Evidence from social scientist who investigated farmers adoption behavior has shown that demographic variables, technology characteristics, information sources, knowledge, awareness, attitude and group influence affect adoption behavior (Oladele, 2005).

Van den Ban and Hawkins (1996) explains that innovations can be adopted rapidly when they have a high comparative advantage to the farmers; consistent with the farmers' values, proficiencies and requirements. However, technology adoption includes the element of embracing a technology by individuals and its implantation in society (Baron et al., 2006), cited by Deligiannaki and Ali, (2011). Apparently technology adoption involves diverse choices and phases. This is likely to arise because of variation in the environment, goal and circumstances the farmers are experiencing. With this synopsis, it may be anticipated 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).

2.1.3. Categories of Adopters

Adoption studies identified and described five categories of adopters in a social system. The categories included innovators, early adopters, early majority, late majority, and laggards (Mosler *et al*. 2001 and Rogers, 1995). Furthermore, Rogers 1995, pointed out that majority of early adopters are expected to be younger, more educated venturesome and willing to take risk. In contrary to this group the late adopters are expected to be older, less educated, conservative and not willing to take risks. However, a study by Rundquist (1984) acknowledged the functional aspect of the categorization of adopters into five groups (innovators, early adopters, early majority, late majority and laggards) is pertinent to intentional or programmed introduction of the innovation.

2.2. Socio-economic and demographic characteristics of households

It is essential to possess a crystal notion of the socio economic surrounding of the farm house holds because a number of studies indicate that the social and demographic details of the study could explain the mindset of farming population on adoption of modern technologies. The socio economic characteristics such as family size, dependency ratio, age, sex and literacy level affect economic conditions and in turn affect the socioeconomic conditions. A study by Azadeh *et al.* (2009), found out that the socioeconomic characteristics that contributed towards adoption of a technology were income, level of mechanization, crop yield, social participation and social status. This is in agreement with a cassava adoption study carried out by Akullo and Bua (2004) which suggested that farmers who adopted the new variety had reported high yield of the varieties and belonged to farmer organizations of different categories.

In a study by Oryema et al. (2021), the factors that were found to be positive and statistically significant to influence adoption of improved cassava varieties were farmers' level of education and access to extension services. Farming experience had a negative influence on the adoption of the cassava varieties disagreeing with the findings of some scholars like Johannes et al (2010) and Kudi et al (2011) who indicated that farming experience had a positive contribution towards the adoption of improved technologies. Also key to note is the finding of Kolady et al (2021) where education was insignificant in adoption of Agricultural technologies in a study of the determinants of adoption of agricultural technologies in South Dakota.

A number of scholars (Akullo and Bua 2004, Azedah et al. 2009, Adongo et al. 2012,) found out that households which had a family member participating in group or association activities were more promising to adopt a new technology. Adong et al. (2012) emphasized the need for farmers to be in groups as they are avenues through which farmers can access market and credit information as well as other important Agricultural information like new technologies. This may explain why group membership is crucial in technology adoption. Farmer associations are communal arrangements where fruitful combined interventions are promoted by use of group property, frame work and construction (Barham and Chiten, 2009).

Farmer groups should be identified with similar intensions, assignments, group identities, neighborhood and mutual trust, only such groups would serve as a podium of problem solving, increased social interaction, quality input sourcing and advanced production technology (Swaminathan *et al.,* 2013)

In a study conducted by Langet *et al*. (2013), a number of causal factors for adoption of tissue culture among small holder famers were identified of which extension services and access to tissue culture plantlets were among those which had significant influence on adoption. With reference to adoption of cassava improved technologies in Uganda, access to the cassava stems, age of household head, house hold size and extension services to popularize its uptake are very paramount (Steffen Abele eta al 2007). Aboudalaye *et al*. (2014), suggested that farm house holds which get primary information from researchers and advisors employed by government or non-state actors are more knowledgeable about the innovations and utilization of all new technologies.

Empirical studies(Langet *et al.*(2013), Aboudalaye *et al.* 2014) considering individual households indicated gender of the head of household, education level , non-farm income, land size and house hold belonging to an association had a notable effect on adoption.

Ryo *et al*. (2015) noted an increased likelihood of 25% for farmers to adopt the improved varieties where they were involved in a farmer research group, which suggest that farmer's group networks can play a critical role in their adoption behavior and participatory approaches have a better potential in the adoption of new crop varieties through social networks**.**

Umunakwe *et al.* (2015) also indicated that most of the farmers (92.7) obtained improved cassava varieties through farmer groups and only about 19% obtained improved cassava varieties through extension agents and this confirms the rising importance of farmer groups in dissemination of improved Agricultural technologies including varieties. The author further pointed out that unfamiliarity for improved cassava varieties, insufficiency of propagation material and relatively unknown processing qualities by farmers hindered the adoption of some varieties.

2.3. Farmers perception on improved varieties

Manyon *et al.*(2000) states that formal cultivar selection and crop programmes often focus on a few economically important traits such as yield or disease resistance but there are a number of potentially important traits related to culture and consumption preference that need to be considered for the acceptance of technologies. This is similar to the finding of Otim *et al.* (1994) which showed that farmers were not concerned with improved yields as it is often assumed but instead considered resistance and taste of the tuberous roots and are able to accept varieties with apparent limitations such as low yields if what they perceive as the priority constraints have been overcome.

Njukwe (2013), found out that generally farmers preferred early maturing varieties with high yields, resistant to pests and diseases. Other attributes associated to cultural value in the same study were sweetness, surface color, length of the stem, root system, simplicity of removing the peel and plant height for inter cropping . Although some of them may not apply to the Bugiri, Tororo and Butaleja farmers but it is important to identify those that are specifically important for use in those Districts.

In a study by Akullo and Bua (2014), use of the different varieties of cassava in eastern Uganda was dependent on the Variety characteristics and improved varieties were adopted because they were high yielding. Also in a similar study by Idrisa *et al*. (2010), the results showed that utilization of soy beans at house hold level, maturity period and yield influenced the decision to adopt improved soy bean variety which concurs with various studies which cite increased yield influencing adoption of new varieties.

2.4. Role of cassava in food security

Food security in this study is the availability of food and its accessibility to an individual or group. Availability is determined by the level of food production or stock levels while accessibility is measured in terms of beliefs by a family to afford food items including the ability to eat a reasonable amount. The concept of food security is elaborated as a condition that prevails when the population at all times have physical, social and economic access to sufficient safe and nutritional foods that must meet their dietary needs and food preferences for a healthy life by the world food summit (Barett 2010). The inhabitants of a household should not live without meals for it to qualify to be food secure. Considering that food is a fundamental human right, food security has remained an issue in this present time and the cassava crop can be identified with the four features of food security(i.e. availability, accessibility, utilization and stability). In a study by Izumi et al. fruits and vegetables were considered available if a single portion of the item was present in a ready to eat form. Nepper et al. (2014) defined availability as the existence of food in different locations regardless of either its visible or accessible by an individual while Boles et al 2013 defined availability as when food is physically available at home. Food access refers to a food item that is retrievable and ready to eat in a location where it is easy for anyone to reach it (Hearst et al 2013). On the other hand, food utilization is the ability of individuals to absorb and effectively use the nutrients for normal body functions (Jef et al. 2015). Food stability is a cross cutting dimension that refers to food being available, accessible and utilization being adequate at all times (Jef et al. 2015)

Cassava yields relative to other crops is high making it superior for food security and house hold income generation. It's a significant and strategic crop for Uganda because of its adaptability to prolonged dry spells and low nutrient soils compared to other staples. It also has adjustable planting and harvesting periods, making it a famine reserve crop (Okao - Okuja, et. al.2017).

Tropical Plant Biology revealed that temperatures for the two major cassava growing regions (East and West Africa) are predicted to increase by about 1.8 degrees Celsius by 2030, but it is anticipated that the cassava plant will thrive and likely to be exceptional while the rising temperature will affect the suitability of food staples like beans, bananas and sorghum (FAO 2012, Ypard 2019). This implies that Cassava in this changing climate will be a key crop that provides food to close to 500 million that consume cassava globally. Improved Agricultural technologies adoption like in this case 'NASE 14' is important to enhance yield per unit area which is fundamental for universal food availability (Flibert Guira et al 2012).

2.5. Empirical studies on factors determining adoption of technologies

A bivariate probit model was used in the study of Adoption and constant use of improved maize seed by Motuma et.al (2010), the findings showed that human capital, assets availability (land size), institutional and policy variables all strongly influenced farmers' decision to adopt improved maize varieties while Yenealm *et al*. (2013) used a logistic regression in the study on determinant of use of improved maize varieties for male headed and female head household in West Harerghe zone in Ethiopia and the results revealed that cultivated farm size, number of Livestock Units and extension services favorably and substantially affected the likelihood of taking up the improved maize varieties. In a similar study on the "determinants of adoption of improved maize technology in Damot Gale Wolaita, Ethiopia", among the variables used in the logit model to estimate the effect of the hypothesized explanatory variables on the probability of adoption, eleven were significant and these included; Oxen availability, livestock units, availability of cash, distance to markets, credit and radio availability, farm size, farm experience, input price, participation in demonstrations and fertilizer availability (Gecho and Punjabi 2011)

Sall *et al.*(2000) in their study on Quantitative determination of improved rice variety adoption using Tobit regression found out that what farmer perceive, including the socio cultural characteristics were found to be critical in determining the choice to adopt and the concentration of adoption of the improved rice varieties. It was further reported that the perception of farm house holds on upgraded rice varieties were quantified using a quasi-arbitrary ordinal weighting system, based on a methodology used in industries. Studies in central Nepal by Ghimire *et al.* (2015) on factors affecting adoption of improved rice varieties among rural farm households, using probit model (plot-level analysis), results indicated that education, extension services and seed access play significant roles in adoption decisions. Furthermore, farm and field characteristic variables such as farm size, endowment of favorable land type (e.g. lowlands), and animal power (e.g. oxen) are the key factors influencing the probability of adopting.

Khonje *et al*. (2015) applying regression showed that uptake of modern cassava varieties leads to meaningful increase in productivity, farmer earnings, and food availability.

Household gender has both a plus and minus sign on adoption because with females accessing assets to use in adoption of technologies, they can equally adopt the technologies whereas in a situation where they are limited from accessing the resources, the probability of adopting the technologies is low, thus a negative sign.

Membership to a group makes it possible for farmers to access advisory and marketing services which encourage and quicken adoption. Also when a farmer has a little more information there is a higher likelihood for him/her to adopt because they are aware of the benefits and costs associated with use or adoption such technology.

Availability of credit increases the possibility of embracing technologies because credit facilitates purchase of upgraded cassava varieties and complementary inputs thereby increasing the likelihood of adopting a particular technology as individuals are able to get the inputs required to promote the technologies. ‘’ Education can increase the ability of farmers to use their capital assets competently, while giving them bargaining power on adequate information assessment and judgment’’(Oluoch Kosura, Marenya and Nzuma 2004) Therefore, it is expected to positively influence adoption of improved cassava varieties.

The higher the land size, the higher the likelihood to adopt a particular technology because with a large size, an individual or a household can adopt various technologies on their farm without foregoing some.

Off farm income has both negative and positive sign on influencing adoption. With off farm income, the households are able to access some of the input they purchase from off farm income whereas as the off farm income becomes high than the on farm income, the households are likely to abandon farms to engage in other activities thus decreasing the likelihood of adoption.

Initial studies have shown that household size can positively or negatively influence technology adoption (Oluoch Kosura, Marenya, and Nzuma, 2004; Bekele and Drake 2003). On the positive side, a sizeable family is normally linked with a bigger labor force available for prompt farm operations including activities relating to improved cassava varieties. More labor hours are likely to be spent on the use of improved technologies during labor-slack seasons because of the low opportunity cost of labor in rural areas. The negative relation of this variable may be due to the expanded consumption burden associated with a large family. It is therefore difficult to prior predict the direction of influence of this variable on adoption.

Experience is associated with acquiring more knowledge in working with a particular enterprise/technology and thus increases the likelihood of adopting such related technology.

The attributes of a new variety desirable by farmers such as high storage root yields and short maturity period compared to the local varieties can motivate the households to take up that variety and thus a higher likelihood to adopt.

2.6. Analysis of factors that determine the adoption of new cassava varieties

The econometrics models normally used in analyzing uptake or adoption decision are the choice models (Tazeze *et al.*, 2012). There are various models that are used when the dependent or response variables are dichotomous in nature which include logit, probit, and tobit models (Gujarati 2004), whereas Tazeze et.al (2012) identified Multinomial probit and logit models as most commonly used models in uptake or adoption studies. The choice of whether to use a probit or logit model, both widely used in economics, is a matter of computational convenience (Greene, 1997).

Where adoption/uptake of NASE 14 cassava variety is considered to be a binary outcome, the Logit model can be adopted for the analysis according to Kansiime *et al.* (2014).The logistic coefficient that is calculated compares the possibility of an incident occurring with that of it not occurring. (Appendix iii)

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Area of the study

The study was conducted in three selected districts of eastern Uganda comprising of Butaleja, Bugiri and Tororo. These were selected because they are among the main cassava producing districts in Eastern Uganda. In addition they were previously struck by the Cassava Brown streak virus disease that greatly reduced cassava production and are some of the districts that are promoting NASE 14 as one of the varieties tolerant to the disease.

Figure 3. 1: Map showing Location of Butaleja, Tororo and Bugiri in Eastern Uganda

Butaleja lies on coordinates 0056N, 3367E.It only became its own District in 2015. Its borders are the districts of Budaka, Mbale, Bugiri and Namutumba (Figure 3.1). It has a land area of 653.1Square Kms and a population of about 221,000 (2012 population census). The population distribution is 338.5 persons per square km. The annual population growth was estimated to be 3.5% in 2012. (Butaleja District Development Plan 2010/15)

Bugiri district is situated between longitude 33010' east, 3400 East and latitudes 00 6' north and 1012 North. The district borders include Tororo, Iganga, Namutumba, Mayuge and Busia (Figure 3,1). The district also stretches to the Uganda/Kenya border in the south east and in the waters of Uganda/Tanzania border in the South. The district has a population as of 390,076 (Bugiri District Development Plan 2015/2020)

Tororo district neighbours are the districts of Pallisa, Mbale, Iganga, Bugiri and the republic of Kenya (Figure 3.1). It lies between latitude 0045' (0.750) North and Longitude 340 5' (34.08330) East. The elevation is 1,142 meters. The district had a population of 517,080 as of 2014 (Tororo District Development Plan 2015/2020).

The major economic activity in the three districts is subsistence farming and it is the fundamental contributor of sustenance in these districts. The crops cultivated include rice, maize, cassava, millet, Sorghum, sweet potatoes, Groundnuts, and cotton. The populations in these districts also keep some livestock such as goats, cows, and chicken to supplement their livelihoods. Some non-farm activities engaged in include small scale businesses like retail shops, produce buying and selling, tailoring, bricks and mat making.

To support the communities in these districts, a number of programs supported by the Government of Uganda and Nongovernmental organizations like World Vision have supported the Districts with improved cassava cuttings (NASE 14) specifically for multiplication and up scaling in response to the CBSD.

3.2 Research Design

The study used a cross-section design within the general framework of a mixed methodology of qualitative and quantitative approaches to analyze the factors that influence adoption of NASE 14 cassava variety. Description of the characteristics was used to obtain exhaustive information about phenomenon which in this case is adoption of NASE 14.

3.3 Study Population

The study population comprised of small holder farmers, who had received NASE 14 since 2010 to 2015 as well as some who were not engaged in production of NASE 14.

3.4 Sample size and sampling procedure

The size of the sample used was 240 observations and was calculated using the formula (Slovin 2012)

$$a = \frac{N}{1 + N(e)^2}$$

Where

a = Sample size = 240
N= Total Population = 617
e = error tolerance which was calculated as 0.05

A multi stage sampling techniques was employed. In the first stage, 3 sub counties in each district involved in cassava production were purposively selected. The second stage, involved stratifying each sub county into two cassava production blocks that is one where NASE 14 is grown and the other where it is not grown and two blocks were purposely chosen as primary sampling units. In third stage, 3 villages from the 'NASE 14 block' and 3 villages from the ' Non NASE 14 block' were randomly selected.

In the fourth stage, 5 farmers engaged in NASE 14 were selected in a random manner from each village resulting into 15 respondents for each sub county and 45 for each district. This means that a sample of 135 respondents were selected from all the 3 districts and this sample was referred to as 'Adopters'. For the ' Non NASE 14 block', a sample of 4 respondents was selected at random from each village resulting into a sample of 12 per Sub County and a total of 36 respondents for each district. The overall total for the three districts was 108 respondents but because of data cleaning 3 respondents were not included in the analysis. As such a total of 105 respondents referred to as 'Non adopters' were used in the analysis. All together 240 respondents were used in analysis for this study.(Presented in the table 3.1)

Matata *et al.* (2001) reasoned that having 80 - 120 respondents was sufficient for most socio-economic studies in Sub-Saharan Africa household.

Table 3. 1: Table explaining the sampling process

Stages	Action	Selected units	
1	3 sub counties selected in each district	Mukujju, Kwapa, Merikit (Tororo) Busabi, Naweyo , Budumba (Butaleja) Bulidha ,Nankoma ,Nabukalu (Bugiri)	
2	Each sub county stratified into 2 blocks:	NASE 14 Block	Non - NASE 14 Block
3	3 villages from NASE 14 block randomly selected (a). Tororo	Kateki village Kanyoro A Akadot B Apuwai Komoli Osere Otirok East Paragang Abweri	Morwa Mukujju Atiri Kwapa Katek Chegen Kabosa Merikit central Seseme
	(b) Butaleja	Bulilo Bubaali Bubada Maluku Nambale Nakasanga Natooli Hisoho Nabuyanja	Lubangwe Malagha Habiga Highland B Mpolyabigere Kuweiti Dumbu Gombe Tambala

	(c) Bugiri	Mayoole Mufumi Itoolo Nawambwa Nankoma Bulyangada Buzika Nabuganga Nakakono	Kasozi Kibuye Namatu Matiki, Matovu Nampere Bulato Kakoge Bulanga
4	5 farmers engaged in NASE 14 from each village randomly selected	135 farmers (adopters)	
5	4 farmers not engaged in NASE 14 from each village randomly selected		108 but 3 were dropped during data cleaning

3.5 Data collection methods and instrument

3.5.1. Data collection methods

Primary sources were mainly used. District documents were also reviewed to easily map out sub counties and villages where NASE 14 was grown or not grown, while primary data was collected from the sampled farmers.

3.5.2. Data collection instrument

A questionnaire (Appendix i)was developed and pretested to see if it could collect the required information and once the pretest was conducted, the feedback was incorporated, which resulted into a final questionnaire that was administered. Interviews for farmers who could not read and / or write were conducted using the questionnaire, while for those who could read and write were requested and encouraged to fill the questionnaire with some support.

3.5.3. Validity and reliability

3.5.3.1. Validity

The questionnaire was tested in the field with farmers comparable to those in the study area and independent from the ones participating in the actual study. Modifications were made based on the responses given during field testing which helped to enhance the credibility of the questionnaire. Experts in this field from Uganda Christian University reviewed the instrument before testing. The prime threat for internal validity of this study was the interviewer effect; adequate training of the interviewer was done to control this threat.

3.5.3.2. Reliability

Farmers from different villages not among those in the inquiry exercise were selected and used to determine the consistency of the instrument.

3.5.4. Data collected

Data was collected in the year 2017 and during that period the major variety that was being promoted for its tolerance to the cassava brown streak virus disease was NASE 14. One was considered an adopter if they had grown NASE 14 variety for 2 years and more. While those growing varieties susceptible to Cassava brown streak virus disease like TME 204, TME 14, Magana were taken to be non- adopters. The demographic and socio economic data collected included; gender of house hold head, marital status, educational level, land size, income levels, membership of house hold head in a group and household size. Attributes of NASE 14(e.g. taste, peeling characteristics, maturity period), factors for adoption (resistance to disease, yield, access of planting material,), extension services received on cassava (access to information,) were also collected and these were used to determine the factors that influence the adoption of NASE 14 cassava variety. Data on contribution of NASE 14 on food security included Period in a year for which household has food (food availability), income from cassava and its products.

3.6. Data computation and analysis

Raw information in the questionnaires was given codes and entered into excel sheet. Analysis of data was done using the Statistical Package for Social Scientists (SPSS) Version 16.

Descriptive statistics like percentages, frequencies and means, were used to describe the social economic characteristics of the cassava farmers while inferential statistics (comparing means, P-Value) was used to find out the relation between adoption of NASE 14 and food security. In addition, tables and charts have been used to display the farmer's characteristics.

A multiple logistic regression was applied to determine factors that influence adoption of NASE 14 cassava variety.

The calculated logistic coefficient compared the probability of an event occurring with the probability of it not occurring.

The likelihood of adopting NASE 14 cassava variety is stated as

$$Pi = f(X, \varepsilon) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (1)$$

Where Pi is the probability of adopting NASE 14 cassava variety, X is a vector of explanatory variables and ε is an error term with logistic distribution.

The conceptual model is given as

$$In\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ji} + \varepsilon \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (2)$$

Where Pi = prob (y=1) is conditional probability for Adopting; (1-Pi) = prob (y=0) is conditional probability for not adopting NASE 14; Xjis are the set of explanatory variables; β_0 and βj are the coefficients that were estimated, and ε is the error term.

The estimated coefficients (β_0 and βj) are measures of the changes in the ratio of the probabilities, termed as the odds ratio. The logistic prediction equation for this study was:

$$Y = In(odds(events)) = In(\frac{prob(event)}{prob(nonevent)}) = In(\frac{prob(event)}{(1-prob(event))}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The empirical model specifying Adoption of NASE14 is stated in equation 4

$$In\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_n X_n + \varepsilon \ldots\ldots\ldots\ldots(4)$$

Table 3.1 explains the model in relation to uptake of NASE 14 cassava varieties

Table 3. 2: Variables explaining the multiple logistic model for uptake of NASE 14

Variable	Variable	Variable definition/ description	Type of variable	Expected effect
X1	GenderHH	Gender of the head of the household (1=Male, 0= Female)	Dummy	±
X2	Mmgroup	Membership to a farmer organization (1=Yes, 0= No)	Dummy	+
X3	AccessInfo	Access to information (1=Yes, 0= No)	Dummy	+
X4	AccessCredit	Access to credit (1=Yes, 0= No)	Dummy	+
X5	AccessInput	Access to inputs (1=Yes, 0= No)	Dummy	+
X6	LogSchool	Log of years of schooling	Continuous	+
X7	LogHHSize	Log of household size	Continuous	±
X8	LogOffarmIncom	log of total off farm income in Ugandan shillings	Continuous	±
X9	Loglandsize	Log of total land size in acres	Continuous	+
X10	LogExperience	Log of experience in years	Continuous	+
X11	Attributes	Attributes of NASE 14 (1=Sweet when fresh , 0= Otherwise)	Dummy	+

Table 3. 1Variables explaining the multiple logistic model for uptake of NASE 14

CHAPTER FOUR

4.0 RESULTS

4.1. Household socio economic characteristics for the respondents of NASE 14 adopters and non-adopters in Eastern Uganda.

Table 4.1 shows the distribution of cassava farmers in relation to selected social and economic characteristics of the adopters and non-adopters of NASE 14 cassava variety in Eastern Uganda.

Table 4. 1: Distribution of cassava farmers in relation to selected socio economic characteristics in Eastern Uganda

Variable	Adopters (a = 135)	Non adopters (a = 105)	P value
Gender of house hold head (%)			
Male	83.7	85.7	0.67
Female	16.3	14.3	
Marital status %			
Married	80.0	74.3	0.273
Single	8.9	7.6	
Widow/Widower	7.4	15.2	
Separated	3.0	1.9	
Divorced	0.7	1.0	
Membership of household head to a group (%)			
Yes	55.8	51.1	0.046
No	44.2	48.9	
Access to information (%)			
Yes	65.7	62.2	0.579
No	34.3	37.8	
Access to credit (%)			
Yes	61.9	36.3	0.001
No	38.1	63.7	
Access to farm inputs-overall (%)			
Yes	94.7	81.6	0.023
No	6.3	18.4	

*: T test

4.1.1. Socio-economic characteristics by gender and marital status

Table 4.1 shows that majority of the respondent households were headed by men for both the adopters (83.7) and non-adopters (85.7), while 80% of the adopters and 74.3of the non-adopters respectively were married. The least respondents for both categories were the divorced. There was no significant difference between the gender (P=0.67) and marital status (P=0.273) of the adopters and non-adopters. The variables that showed statistically significant difference at 5% among the adopters and non-adopters were house hold belonging to a group, access to credit and access to farm inputs

4.1.2. Household head belonging to a group

The results indicate a significant difference in membership to a group (P=0.046) between the adopters and non-adopters. The percentage of farmers in groups is higher for the adopters than the non-adopters that is 55.8% and 51.1 % respectively (Table 4.1). Also as indicated in the figure 4.1 below, the adopters had higher numbers of members who belonged to cooperatives and Village Saving and Loans Association (VSLA) than the non-adopters. Both categories that is adopters and non-adopters had members belonging to self-help groups with the non-adopters having a higher number.

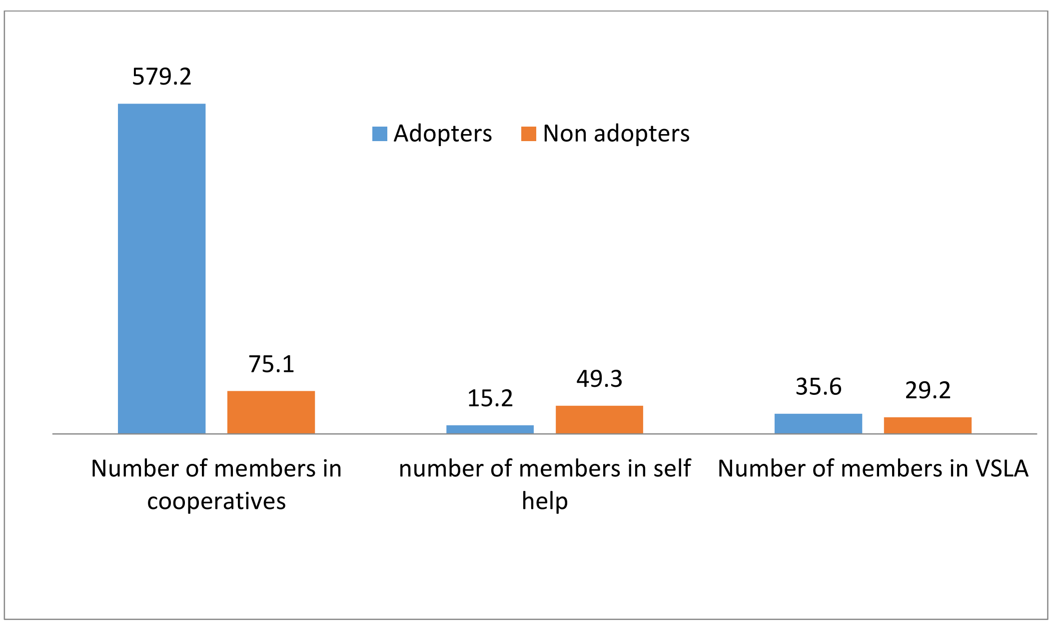

Figure 4. 1: socio economic characteristic by member ship to groups/ organization

4.1.3. Access to information on NASE14 Variety by farmers in Eastern Uganda

Access to information is an important element in technology uptake where farm households usually get information about the availability, proper use and benefits of a new technology. From table 4.2, the results indicate that 65.7 percent of adopters of NASE 14 cassava variety and 62.2 percent of non-adopters had access to information on NASE 14 even though the difference is not significant between the two categories (P=0.579). Information pertaining to farming activities is mainly obtained from two sources that is Government (District local government extension workers and Ministry of Agriculture and Animal fisheries) and Non-Government Organizations like World vision, a little bit of hope and Community based groups (Figure 4.2). The findings demonstrate that all the production information is mainly provided by government while NGOs provide all the information on credit access. It is in marketing where information is provided by the different sources but overall the major provider of marketing information is NGOs.

As regards frequency of accessing information, results from table 4.2 indicate that there is no significant difference among the two groups when it comes to receiving production information on a weekly basis (P=0.237), however a significant difference exists between the adopters and non-adopters when it comes to receiving marketing information for NASE 14 cassava variety on a weekly basis (P=0.006).

Table 4. 2: Access to production, Marketing and credit information by the cassava farmers and the nature of information accessed (%)

Variable	Category	Adopters (a = 135)	Non adopters (a = 105)	P value
Access to information	No	37.8	34.3	0.579
	Yes	65.7	62.2	
Production frequency of meeting	Weekly	32.9	30.9	0.237
	Monthly	43.9	61.8	
	Quarterly	23.2	7.3	
Production challenges	Language issues	12.2	1.8	0.161

	Poor time management	14.6	7.3	
	Service is expensive	50	76.4	
	Services are irregular	23.2	14.5	
Marketing frequency	Weekly	52	25	0.006
	Monthly	4		
	Quarterly	44	31.2	
	Annually		43.8	
Marketing challenges	Language issues	18.8	32	0.165
	Poor time management		24	
	Service is expensive	68.8	28	
	Services are irregular	12.5	16	

*: T test

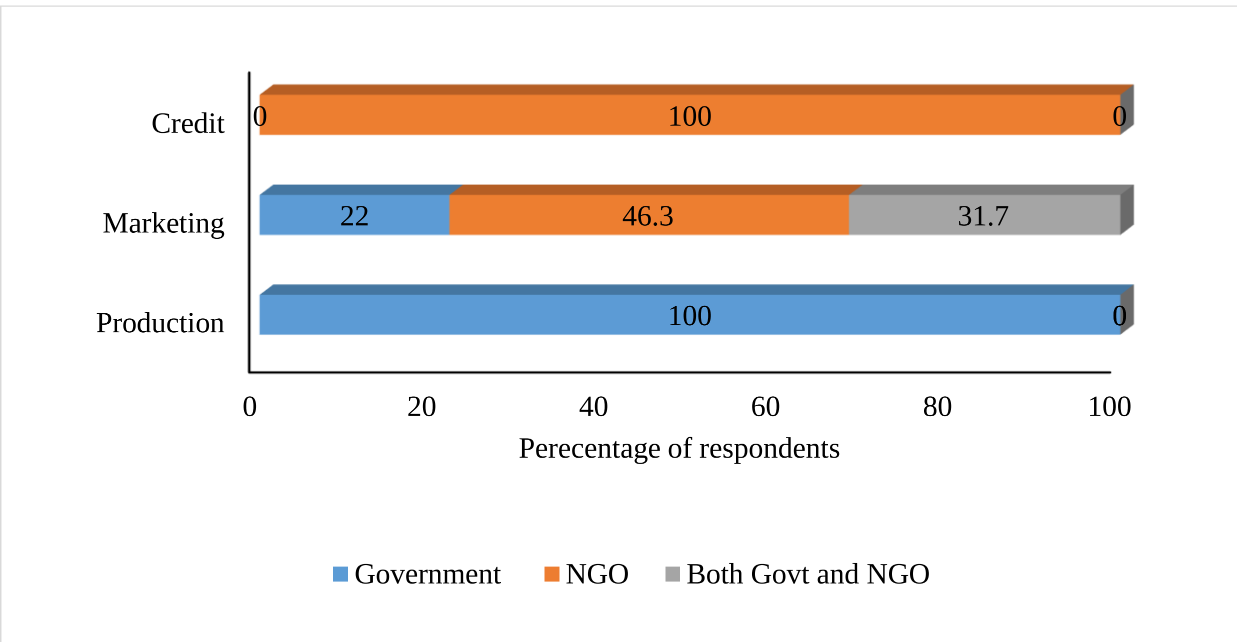

Figure 4. 2: Providers of NASE 14 production, Marketing and credit information accessed by the respondents

4.1.4. Assets owned by the cassava farmer respondents in Eastern Uganda

Table 4.3 shows that both adopters and non-adopters of NASE 14 had assets they used in conducting various activities including cultivation and marketing of cassava. Among the assets owned by the respondents, that is both Adopters and non-adopters, in terms of numbers; it is only the number of hand hoes and bicycles that have a statistically significant difference between adopters and non-adopters at 1% level.

Table 4. 3: Average number of assets owned by the respondents

Asset	Number		P value
	Adopters	Non adopters	
Hand hoe	5	4	0.003
Panga	1	1	0.322
Slasher	1	1	0.477
Oxen plough	1	1	0.296
Wheel barrow	1	1	0.558
Oxen	2	2	0.172
Rake	1	1	0.534
Watering can	1	1	0,897
Motor cycle	1	1	0.598
Bicycle	3	1	0.002
Television	1	1	0.555
Radio	1	1	0.786
Phone	1	1	0.678

*: T test

4.1.5. Socio economic characteristics of the respondents by house hold size, years of schooling and household incomes.

The household size on average for the adopters and non-adopters is 7.5 and 6.9 members per household respectively (table 4.4), in both cases this is above that of the national average of 4.7 (UBOS, 2016).The average house hold size of the adopters was higher than that of the non-adopters by 0.6 members, as illustrated in table 4.4.The results also indicate number of years of schooling for adopters being lower (7.9) than that of non-adopters (8.5).

Table 4. 4: Average of selected Socio economic characteristics

Variable	Adopters	Non adopters
Household size	7.5	6.9
Number of years schooling	7.9	8.5
Income from cassava in UGX	1,537,000. (USD 439.14)	885,470.(USD 252.99)
Income from on farm activities UGX	2,824,600.(USD 807.03)	2,027,600.(USD 579.31)
Income from off farm activities UGX	2,701,500.(USD 771.86)	1,924,600.(USD 549.88)

Members in farmer group	120.4	136.0
Members in VSLA	35.6	29.2
Number of members in Cooperatives	579.2	75.1
Number of members in Self help	15.2	49.3

All the households interviewed had their incomes from more than one single source, namely cassava sales, other farm activities like livestock and their products sales and off farm activities (Retail shops, Produce buying and selling). Across the board, farm activities was the main source of household income, followed by off farm activities while cassava fetched the least income as illustrated in the table 4.4

However, the average income from cassava for adopters was more than that of the non-adopters by 651,530 UG shillings. Also the average income from farm activities other than cassava and off farm activities for adopters was still above that of the non-adopters.

4.1.6.0: Land ownership and tenure

The agriculture land in this study area is mainly comprised of miniature land dispersed in several plots or parcels. This could be attributed to the population growth that has led to land fragmentation and on average majority (85%) of the households had three fragments of land. The total land owned was higher among the adopter that is 4.8 acres compared to 3.7 acres of non-adopters (Fig 4.3).

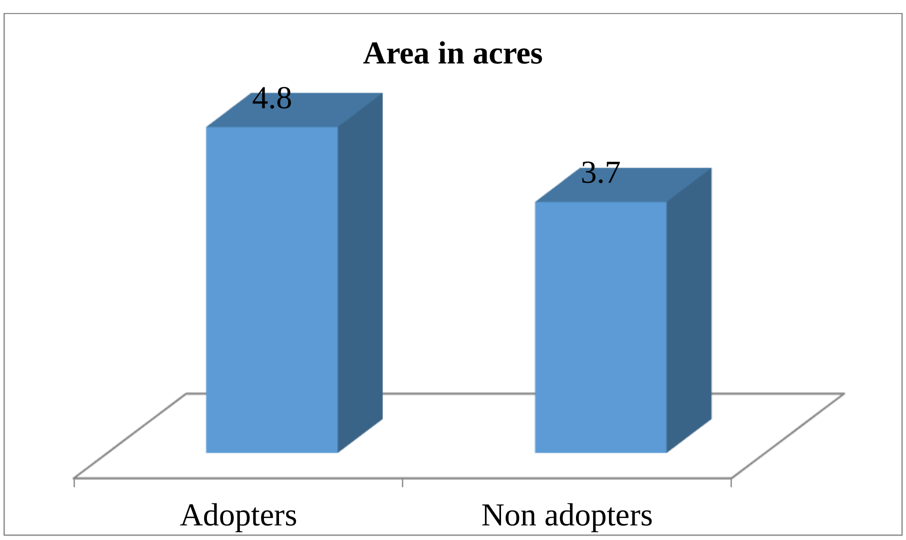

Figure 4. 3: Average land size owned by the farmers

Figure 4.4 reveals that majority (83.7%) of the respondents interviewed owned land while a small proportion hired and or borrowed land representing 11.7% and 4.6% of the respondents respectively. The major form of land tenure prominent in the study area is customary land tenure as indicated by 91.7% of the respondents. This is followed by private titled land tenure and Squatting land tenure representing 5% and 3.3% of the respondents (Fig 4.7). Customary land tenures pose challenges especially to women who are in most cases not allowed to access land

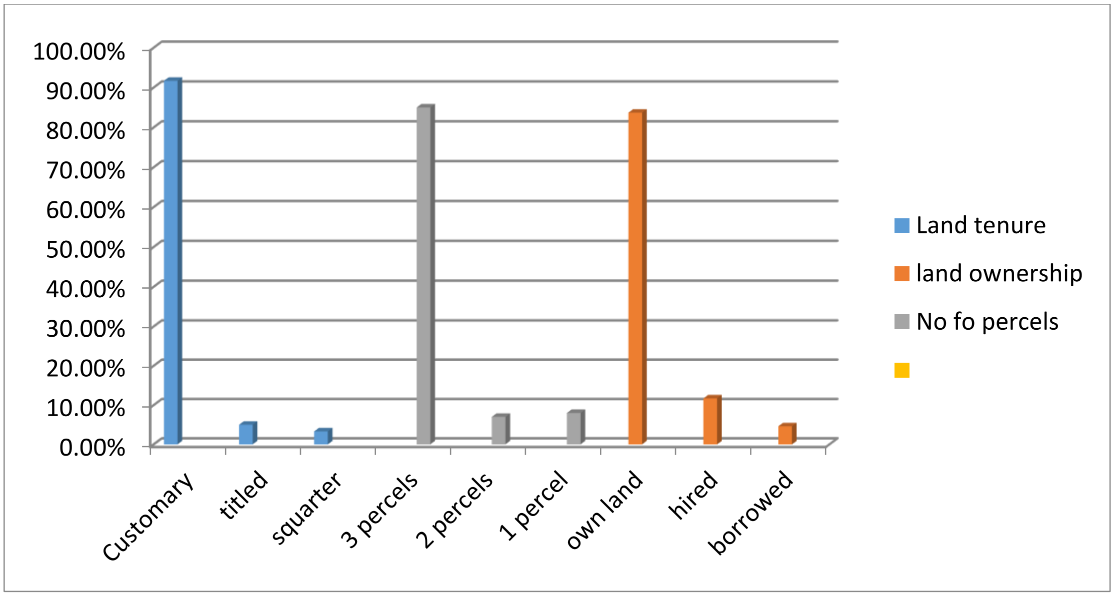

Figure 4. 4 ; Land ownership and tenure status for the cassava farmers in Eastern Uganda.

4.1.6.1 Restrictions on using land for cassava farmers in Eastern Uganda

Majority (89.2%) of the respondents reported that they did not have any restrictions on using land for various activities including growing NASE 14. A small proportion (5.8%) of the respondents reported that they do not allow use of chemicals on their land (Fig 4.5).

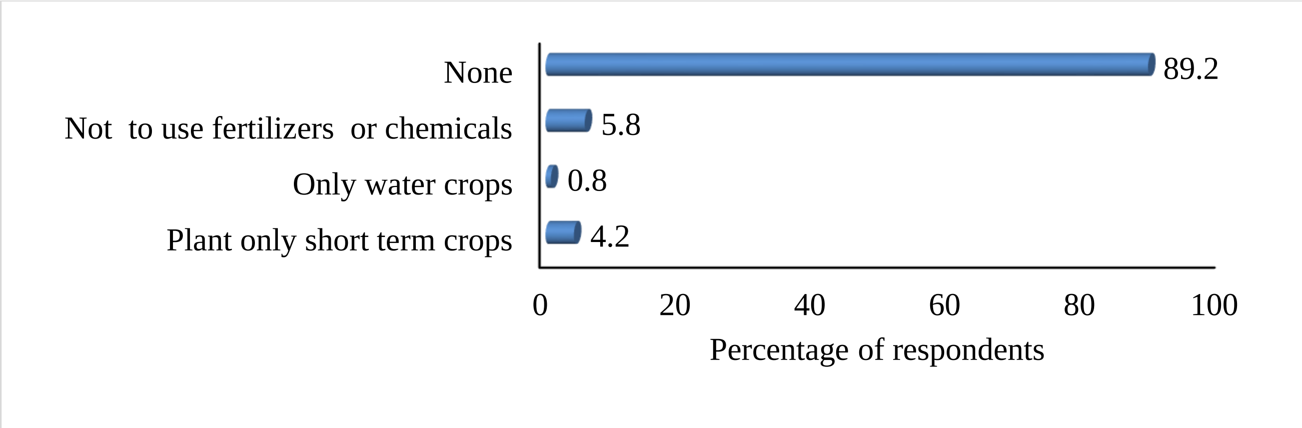

Figure 4. 5: Restrictions on land in Eastern Uganda

4.1.7. Access to credit by farmers in Eastern Uganda

Figure 4.6 reveals that 61.9 of the adopters accessed credit compared to 36.3% of the non-adopters. This implies that adopters have more access to credit than their counterparts and the difference was statistically significant at 1% level (table 4.1)

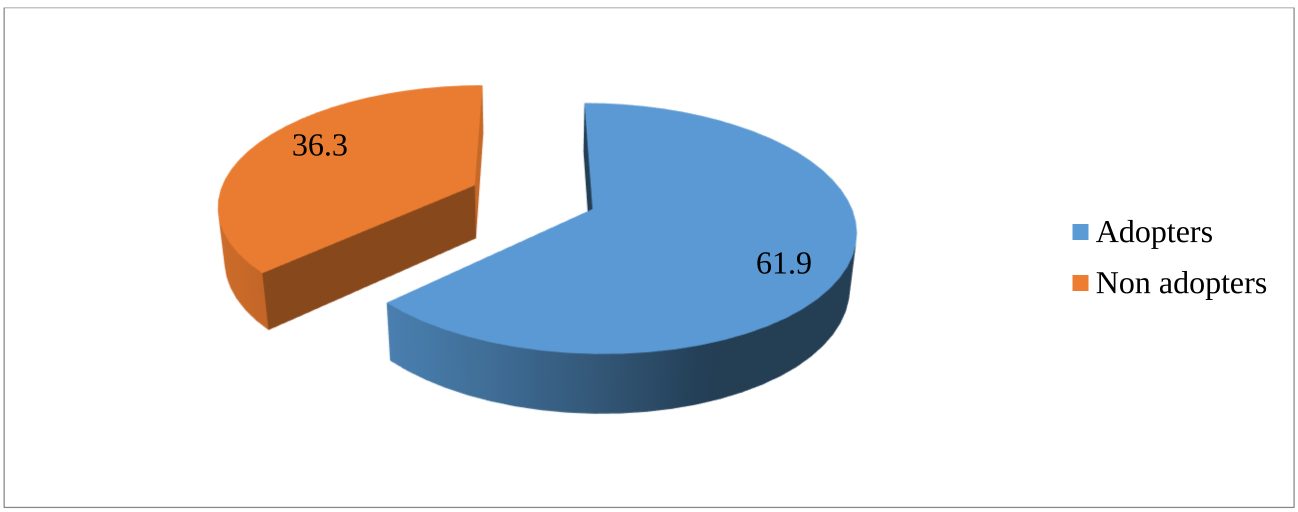

Figure 4. 6: Access to credit for cassava farmers in Eastern Uganda

The major source of credit among the adopters of NASE 14 is VSLA and MFI as reported by the 51% and 39% of the respondents respectively (Figure 4.7). Whereas the main source of credit among the non-adopters is VSLA and friends accounting for 52% and 23% of the respondents respectively. Generally it is clearly indicated that VSLA is the main source of credit among the respondents that is both adopters and non-adopters.

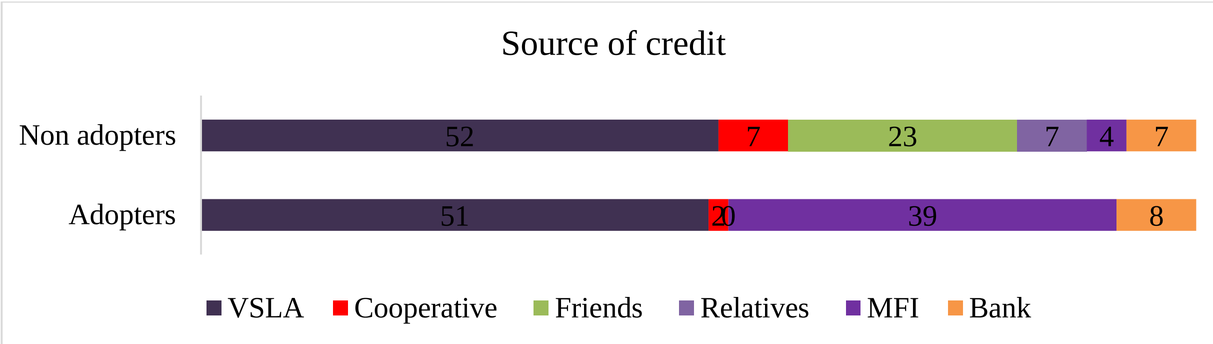

Figure 4. 7: Source of credit

The major three challenges (Table 4.5) faced in accessing credit among the respondents are high cost of credit, provision of small amount of money and limited availability of credit institutions. Among the adopters of NASE 14, they faced high cost of credit and access of small amounts of money. The major two challenges faced by the non-adopters are high cost of credit and unavailable credit as reported by 41.4% and 29.3% respectively.

Table 4. 5: Challenges faced in accessing credit

Challenge	**Adopters (a = 135)**	**Non adopters (a = 105)**	**Overall**
High cost of credit	43.3	41.4	42
Sometimes credit is not available	0	29.3	19.3
Less funds provided	40	22.4	28.4
Require collateral	13.3	6.9	9.1
Need guarantor	3.3	0	1.1
Total	**100**	**100**	**100**

4.1.8: Access to farm inputs

Input availability in technology adoption is paramount as it supports the production of agricultural commodities such as cassava. The findings indicate that NASE 14 adopters have more access to inputs than their counterparts (Fig 4.8)

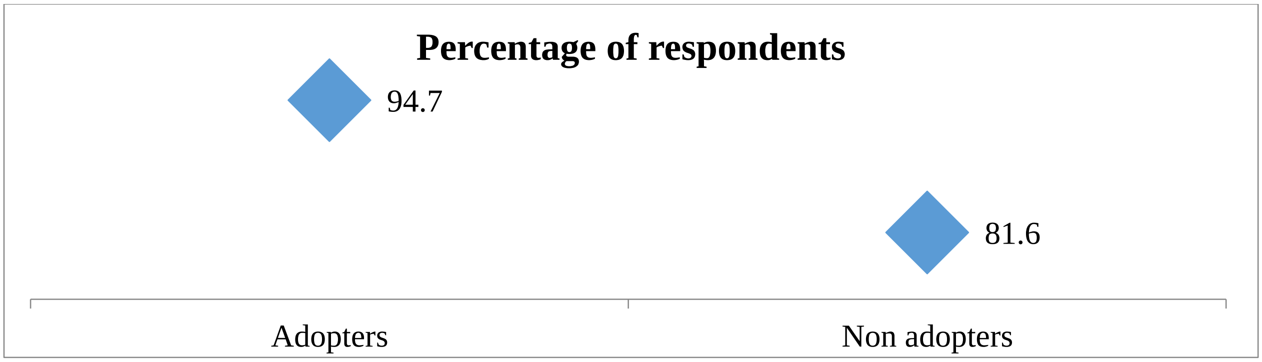

Figure 4. 8: Access to inputs by the cassava farmers in Eastern Uganda

In this study area, the inputs accessed by respondent in the descending orders are cassava cuttings (37.8%), maize seed (36.4%, fruit seedling (13.4%) and bean seeds (12.4%) as shown in Figure 4.9. The results indicate that more than half of the respondents accessed non cassava inputs which affects the adoption of NASE 14

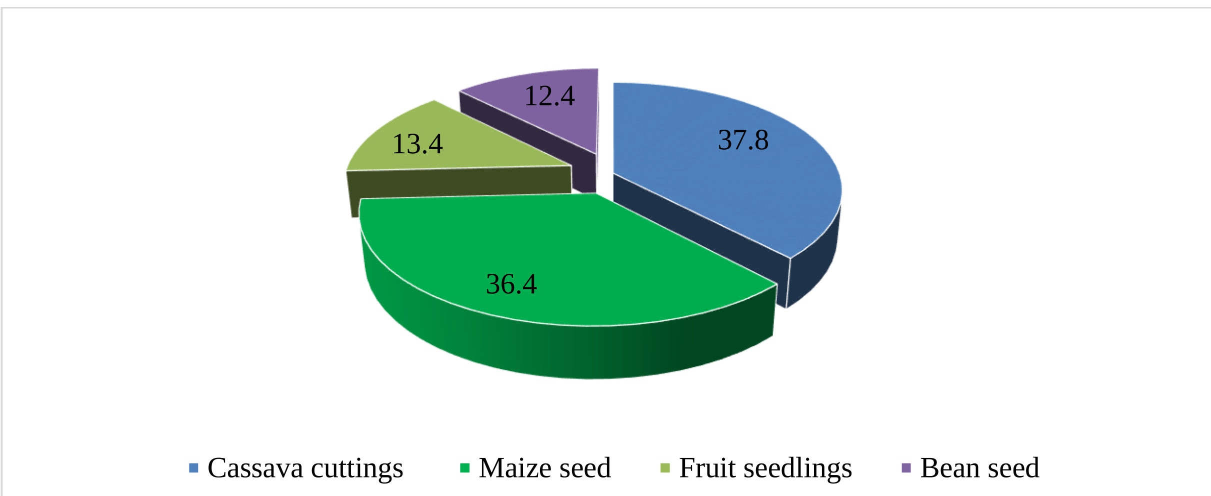

Figure 4. 9: Types of farm inputs accessed by the respondents

Table 4.6 indicates that adopters accessed 7.5 bags of cassava cuttings and non-adopters accessed 6.1 bags of cassava cuttings. It was also noted that the adopters accessed more quantities of fruit tree seedlings than the non-adopters, this has no direct relationship with the adoption of NASE 14 cassava variety but can be attributed to the fact that there is wide campaign on increasing tree coverage and more so fruit trees which can complement the nutritional status of the families, since many belong to farmer groups, they are more likely to receive such information during their group meetings. The non-adopters of NASE 14 accessed more quantities of maize seed and bean seeds.

Table 4. 6: Average quantities of inputs accessed

Input	Mean	
	Adopters	Non adopters
Quantity of cassava stems in bags	7.5	6.1
Quantity of maize seed in Kg	8.6	8.7
Number of fruit tree seedling	20.2	10.1
Quantity of bean seeds in Kg	6.7	10.8

Figure 4.10 shows that the major suppliers of the agricultural inputs are OWC (50.3%) followed by NGO (42.5%), NARO (6%) and friends (1.2%).

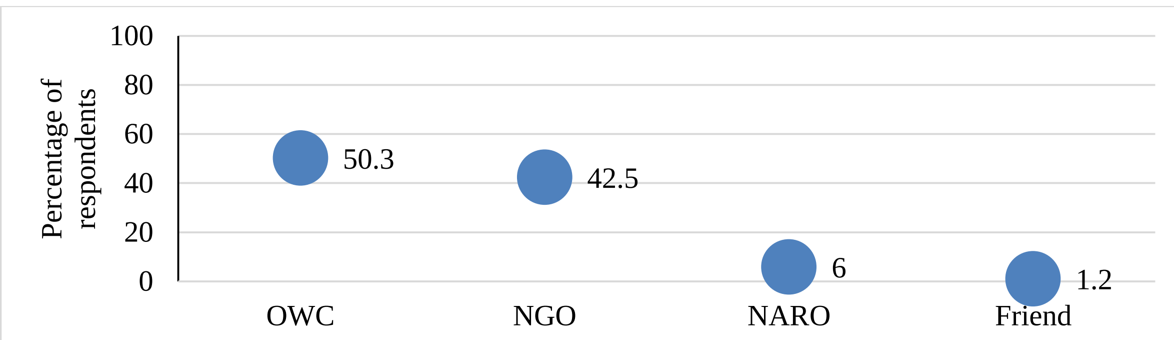

Figure 4. 10: Providers of inputs to the cassava farmers in the area

Table 4.7 displays a higher percentage of adopters being satisfied about the input access than their counterparts. Also among the non-adopters, a greater proportion reported that they were dissatisfied compared to the adopters.

Table 4. 7: Level of satisfaction about input access by cassava farmers in Eastern Uganda

Level	Adopters	Non adopters
Extremely satisfied	0.1	4.7
Satisfied	35.8	31.4
Neutral	45	45.3
Dissatisfied	10.8	16.3
Extremely dissatisfied	8.3	2.3
Total	100	100

Table 4.8 shows that more than 75% of the respondents disclosed that they had varieties they were no longer growing and the years they stopped growing those varieties varying from variety to variety and the category of the respondent that is whether adopter or non-adopter (Table 4.8). For instance, 35.4% of the non-adopters had stopped growing NASE 14 in 2016, while the rest had stopped growing it in 2017.

Table 4. 8: Period the varieties were stopped from being grown

Year stopped growing variety	**NASE 3**		**Magana**		**Local**		**NASE 14**	
	Adopters	**Non adopters**	**Adopters**	**Non adopters**	**Adopters**	**Non adopters**	**Adopters**	**Non adopters**
2009	0	0	0	0	18.5	0	0	0
2010	0	0	0	0	8.7	26.1	0	0
2011	0	0	0	0	7.6	30.4	0	0
2012	0	0	0	0	17.4	17.4	0	0
2013	0	21.1	20	0	12	2.2	0	0
2014	16.7	73.7	45	0	20.7	15.2	0	0
2015	83.3	5.3	35	0	8.7	8.7	0	0
2016	0	0	0	100	6.5	0	0	35.4
2017	0	0	0	0	0	0	0	64.6

*: descriptive statistics (percentage)

The major reason for not adopting NASE 14 among the non-adopter is its propensity to rot as reported by 87.5% of the respondents. Other varieties like Magana was stopped from being grown because of its low yield as reported by 45% of the adopters and 100% for the non-adopters (table 4.9)

Table 4. 9: Reasons for stopping growing varieties (%)

Reasons	**Cassava varieties**							
	NASE 3		**NASE 14**		**Magana**		**Local**	
	Adopters	**Non adopters**	**Adopters**	**Non adopters**	**Adopters**	**Non adopters**	**Adopters**	**Non adopters**
Rots	0	26.3	-	87.5		0	27.2	0
Succumbed to diseases	0	73.7	-	12.5	55	0	14.1	58.7
Low yield	41.7	0	-	0	45	100	55.4	41.3
Not available	58.3	0	-	0	0	0	0	0
Existence of new varieties	0	0	-	0	0	0	3.3	0

4.1.9: The attributes of NASE 14 cassava variety that enhance its adoption by farmers in Eastern Uganda

Figure 4.11shows that 44% of the respondents growing NASE 14 reported that they consider high yield in growing NASE 14, 35.2% reported NASE 14 doesn't rot, 8% said it has a sweet taste when fresh while 2.4% said it was easy to peel.

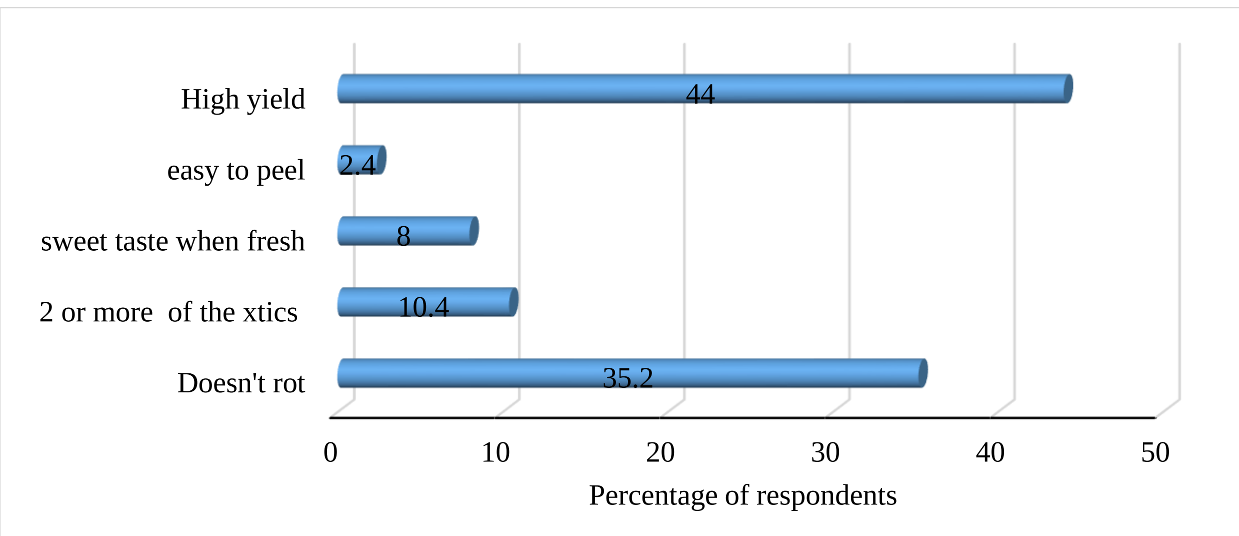

Figure 4. 11: Attributes of NASE 14 cassava variety that enhance adoption by farmers in Eastern Uganda

The results from table 4.10 display more of the adopters (68%) using cassava as a source of food for the family as compared to the non-adopters (51.04%) and there was a statistically significant difference between the two groups. On the other hand, more of the non-adopters (48.96) use cassava to make alcohol than the adopters (31.2%) and there was a significant difference among the two categories.

Table 4. 10: Purpose for growing NASE 14

Purpose	Frequency		Percentage		P- Value
	Adopters	**Non adopters**	**Adopters**	**Non adopters**	
Provide food	85	49	68	51.04	0.035
Source of income	1	-	0.8		a
Used in making alcohol	39	47	31.2	48.96	0.034
Total	**125**	**96**	**100**	**100**	

a: t cannot be computed because at least one of the group is empty

4.1. 10. Factors determining adoption of NASE 14 cassava variety among farmers

The multiple logistic regression results of factors influencing adoption of NASE 14 is given in Table 4.11. The variables in the model that were statistically significant at 1 and 5% level were, household head gender, membership to a farmer organization, credit availability, total off farm income, total land size experience in growing cassava and access to inputs. The factors had their *a priori* anticipated signs correctly and with an exception of total income outside the farm, the rest of the variables in relation with the likelihood to adopt NASE 14 cassava variety was positive.

Table 4. 11: Multiple logistic regression explaining factors that determine uptake of NASE 14 in Eastern Uganda

Variables	Coefficient	Standard Error	P- value
Gender of the household head (1=Male, 0= Female)	1.409**	0.629	0.0250
Membership to a farmer organization (1=Yes, 0= No)	0.311**	0.421	0.0460
Access to information (1=Yes, 0= No)	0.382	0.396	0.3350
Access to credit (1=Yes, 0= No)	2.278***	0.452	<0.0001
Access to inputs (1=Yes, 0= No)	2.39***	0.648	<0.0001
Log of years of schooling	0.811	1.06	0.4440
Log of household size	0.848	1.126	0.4520
log of total off farm income in Ugandan shillings	-2.397***	0.648	<0.0001
Log of total land size in acres	2.442***	0.776	0.0020
Log of experience in years	2.484***	0.669	<0.0001
Perception about NASE14 (1=Sweet when fresh , 0= Otherwise)	0.081	0.527	0.8770
Constant	9.101***	3.826	0.0170

Significant level * = 10% ** = 5% * = 1%**

Gender has a positive coefficient in relation with adoption of NASE 14 variety and is statistically significant at 5%. This suggests that the odd ratio of gender increases the likelihood of males adopting NASE 14 Cassava variety as the men have control and access to the resources of production like Land. Table 4.11 further reveals that there is a positive association between membership to an organization with adoption of NASE 14 which is significant at 5% level. This means that as farmers join membership organizations, their likelihood of adopting NASE 14 increases. Access to credit has a positive sign on its coefficient indicating that the likelihood of adoption NASE 14 cassava variety increases with accessibility to credit and is scientifically significant at a 1% level. This is because with credit, farmers are able to get capital that enables them access productive assets such as land and improved inputs which are used to boost production. In regard to access to inputs, findings (Table 4.11) reveal that inputs accessibility increases the chance of adopting NASE 14 cassava variety. With availability of input such as cassava stem cuttings, households will be motivated to engage in production of NASE 14.

The coefficient for off farm income in relation to adoption of NASE 14 is negative and the results show that it is statistically significant at 1% level, which means that increase in the off farm income decreases the likelihood of households to up take farming activities like production of NASE14.

Land is among the key production factors which must be given first priority if agricultural production must take place. The finding (Table 4.11) reveal that increase in land size will increase the possibility to adopt NASE 14 and this is statistically significant at 1% level. Whereas for experience of growing cassava varieties, a positive and statistically significant relationship exists between experience and the probability of adopting NASE 14. This means that as the experience of growing cassava increases the odd ratio of adopting NASE 14 increase. Thus, farmers with more experience are likely to adopt NASE 14 easily than those who do not have experience in growing cassava.

4.2. Food security and adoption of NASE 14

Table 4.12 discloses that majority (71.1% and 81.9% adopters and non-adopters respectively) of the household reported having shortage of food in some months of the year which suggests that both the adopters and non-adopters were not food secure throughout the year. A greater proportion was reported among the non-adopters although the results showed no statistically significant difference at a 5% level.

Table 4. 12: Food security status and adoption of NASE 14

Variable	Category	Adopters (a = 135)	Non adopters (a = 105)	P value
Experience food shortage in month	No	28.9	18.1	0.054
	Yes	71.1	81.9	
Coping mechanisms	Buy food	50.0	67.4	0.016
	Provide farm labour	15.3	8.1	
	Ask friends and relatives	11.2	4.7	
	Get credit	14.3	22.1	
	Reduce number of meals	9.2	5.4	
	Buying and foregoing meals	0.0	2.3	
Level of satisfaction of food security	Extremely satisfied	3.7	1.9	0.001
	Satisfied	35.6	50.0	
	Neutral	24.4	32.7	
	Dissatisfied	26.7	15.4	
	Extremely dissatisfied	9.6	0.0	

With respect to the coping mechanisms (Table 4.12), the major two food security coping mechanisms among the adopters of NASE 14 were buying food and providing family labor as reported by 50% and 15.3% whereas the coping mechanisms among the non-adopters were buying food and getting credit as reported by 67.4% and 22.1% respectively.

Table 4.13 shows that apart from cassava, there were other food items that contributed to the food security of the small holder households which included maize, rice, millet, beans, matooke, sorghum and sweet potatoes for both the adopters and non-adopters. There was a significant difference among the adopters and non-adopters as regards the quantities for rice (P≤0.027) and sweet potatoes (P≤0.045) which suggests that these items contribution towards food security among the adopters in comparison with the non-adopters was more important than the cassava. The NASE 14 adopters had a higher quantity of food for the following items; cassava flour, maize flour, rice, sorghum and sweet potatoes than their counterparts the non-adopters. Whereas the non-adopters had higher quantities than their counterparts in the following items; millet, beans, and Matoke.(Table 4.13).

Table 4. 13: Average food availability in household per month

Variable	Adopters	Non adopters	Pvalue
Quantity of Cassava flour(Kg)	52.9	47.8	0.245
Quantity of Maize flour (Kg)	40.8	37.8	0.381
Quantity of Rice (Kg)	21.8	16.9	0.045
Quantity of Millet(Kg)	14.2	24.2	0.084
Quantity of Beans(Kg)	8.7	9.9	0.276
Number of Matoke(bunches)	4.3	8.2	0.429
Quantity of sorghum(Kg)	10.0	9.3	0.566
Quantity of sweet potatoes (Kg)	79.4	48.7	0.027

CHAPTER FIVE

5.0: DISCUSSION

5.1: Factors that influence the uptake of NASE 14 in Eastern Uganda

In this study, the factors that determine adoption of improved cassava varieties which are resistant to the brown streak virus disease in Eastern Uganda districts of Butaleja, Bugiri and Tororo were investigated. The results indicated a higher percentage of adopters (55.8%) belonging to a group than the non-adopters (51.1%) and a significant difference between the adopters and non-adopters at a 5% level (P = 0.0460). This finding is concordant with the findings of (Bamire et. al. 2002), who reported that social capital boosts positive adoption decisions as it is linked with providing effective platform for interaction and discussion of ideas on farming related activities. Farmer organizations provide avenues for farmers to access market and credit information as well as other important Agricultural information like new technologies (Adong 2012). Groups also predispose members to extension information and developmental initiatives, stimulating adoption. Furthermore, the more information the farmer has on a particular technology the more likely he/she is to adopt because they are informed of the benefits and costs related with use of such a technology.

The average house hold size of the adopters was greater than that of the non-adopters by 0.6 members. Steffen et al. (2007) reported that house hold size was very influential in farmers' adoption behavior where larger household size were more likely to adopt improved varieties faster than the smaller ones because the improved varieties are high yielding and disease resistant therefore able to meet the demands of the larger farmer households.

The average income from cassava was greater for the adopters as compared to that of the non-adopters by 651,530Ug shillings ($187.283) (Table 4.4). This can be comparable to what Azadeh et al. (2009) stated that crop yield and incomes significantly influence a farmer's adoption of different cassava varieties. Income is essential for technology uptake because it enables farmers to source the technology of their interest. Rogers (2003) noted that wealthier farmers can have the money to purchase the new modern technology than those with lesser income.

Results showed 61.9% of the adopters accessed credit as compared to only 36.3% of the non-adopters and there was a statistically significant difference among the two categories ($P \leq 0.001$). This implies that the adopters had more access to credit than their counterparts. Access to credit enables farmers to purchase the required inputs to adopt modern agricultural technologies. It is not surprising that Obisesan (2015) noted that new technologies aimed at improving farm productivity may require additional finances through credit facilities for their effective implementation. Also the average number of members in cooperatives and VSLA for the adopters was more than that of the non-adopters. Cooperatives and VSLAs are known to offer credit facilities to their members implying that the adopters had avenues for accessing credit than the non-adopters. Abdoulaye et al. (2014) and Mutoma et al. (2010) indicated that availability of credit and membership in cooperative organization influence farmers' adoption of new innovations. The study postulates that availability of credit increases the likelihood of adopting technologies because credit facilities can be used to purchase improved cassava varieties and complementary inputs. In addition to offering credit facilities, cooperative also offer trainings, provide market information and give subsidies to farmers hence triggering adoption.

Gender has a positive coefficient in relation with uptake of NASE 14 variety and is statistically significant at 5%. This implies that male headed households have a likelihood of adopting NASE 14 cassava variety. This finding is in agreement with a study by Obisesan (2015) on adoption of technology who found out that, gender had a significant and positive influence on adoption of improved cassava production in Nigeria. This study postulates that male gender in most cases is better informed on the agricultural technologies and the benefits of adopting them. Also male gender is more empowered financially and majority of male have land which is a serious factor of production.

Results further reveal that the association between memberships to an organization with adoption of NASE 14 had a positive coefficient and statistically significant at 5% level. This means that as farmers join membership organizations, their likelihood of adopting NASE 14 increases because they are able to access information which increases their awareness about the benefits derived from NASE 14. This finding conforms to that of Sall et al. (2000) which recognizes membership of a village-level organization as being persuasive, implying that they have communication networks in which farmers have substantial influence on adoption decisions. Nchembi (2017) on a study of the elements that determine use of improved maize seed technologies in Tanzania asserted that as farmers stop being group or organizational members, the probability for taking up a new improved variety reduces as they stop receiving information to help them produce, market collectively and also benefit from the economies of scale in production activities like post-harvest handling, transportation, and purchase of inputs.

Furthermore, the results show that access to credit has a positive sign on its coefficient, indicating that the probability of adoption of NASE 14 cassava variety increases with availability of credit, because the credit enables farmers to get capital that enables them access productive assets such as land and improved inputs which are used to boost production. Credit availability has been reported to stimulate technology adoption (Mohamed & Temu, 2008). It is believed that access to credit promotes the adoption of risky technologies through relaxation of the liquidity constraint as well as through the boosting of household's-risk bearing ability (Simtowe & Zeller, 2006). This is because with an option of borrowing, a household can do away with risk reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments (Simtowe & Zeller, 2006). However, access to credit has been found to be gender biased in some countries where female-headed households are discriminated against by credit institutions, and as such they are unable to finance yield-raising technologies, leading to low adoption rates (Muzari et al., 2012). The relation between credit availability and adoption of NASE 14 is statistically significant at 1% level.

In regard to access to inputs, findings reveal that this increases the probability of adopting NASE 14 cassava variety. With availability of input such as cassava stem cuttings, farm implements, and fertilizers, households will be motivated to engage in production of NASE 14. Nchembi et al. (2017) asserted that the adoption rate for modern maize varieties had been modelled through the intervention by government of the input subsidy program to the farmers.

The relation between off farm income with the probability of adopting NASE 14 is negative and statistically significant at 1% level. This indicates that an increase in the off farm income decreases the likelihood of households to up take farming activities like production of NASE 14. This- is because high off farm income will attract individuals who will abandon on farm activities to seek for better income generated from off farm activities. Contrary to this finding, is the finding by Chilot et al. (1996) and Obisesan, (2015) who noted that income outside the farm activities can support farmers to pay for the costs associated with purchase of inputs, search of information for markets, getting advisory services and labour hire. This means that accessibility to such finance will increase the likelihood of adoption. In support of a positive relationship, Ellis & Freeman (2004) also reported that income from off-farm activities act as a replacement for borrowed capital in rural economies where credit markets are either missing or dysfunctional. Furthermore, Diiro (2009) also asserted that off- farm income is believed to provide farmers' alternative source of liquid capital for buying improved inputs such as seed and fertilizers. Mwangi and Kariuki (2015) noted that all technologies do not necessarily have to show a positive relation between nonfarm income and their adoption. The author further demonstrates that some studies on technologies that are labour intensive have shown negative relationship between off-farm income and adoption. According to Goodwin and Mishra (2004) the pursuit of off-farm income by farmers may undermine their adoption of modern technology by reducing the amount of household labour allocated to farming enterprises.

Land is a key factor of production which must be given first priority if agricultural production must take place. The finding reveals that as the land size increase, there is an increase in the likelihood to adopt NASE 14 and the results obtained is statistically significant at 1% level. This is justified because a large land size provides an ample space that will enable households to take up various technologies. This finding is in conformity with a study by Kimwe and Noordin (1994) in Western Kenya, who reported that Agro-forestry adoption was influenced by farm size and local planting practices. Acreage of the farm can arouse adoption but can also be affected by the other factors influencing adoption (Lavison, 2013). Some innovations are referred to as scale-dependent because of the effect of farm size on their adoption (Bonabana- Wabbi , 2002). Farmers with bigger acreage are likely to take up innovations as they can dedicate a section of their land to have a trial for the new technology which is different with those with smaller acreage (Uaiene et al., 2009).

As far as experience of growing cassava varieties is concerned, the relationship between experience and the probability of adopting NASE 14 is significant at a 1% level and the coefficient is positive which indicates that as the farming experience of growing cassava increases, the odd ratio of adopting NASE 14 increase. This could be due to the fact that experience is equated with mastering the enterprise you are dealing in and this increases the efficiency in the way you manage such enterprise. Thus, experienced farmers are likely to adopt NASE 14 easily compared to those who do not have experience in growing cassava. This finding corroborates with the finding by

Johannes et al. (2010) and Kudi et al. (2011) who noted that experienced farmers are able to assess the importance of a new technology which increases their adoption rate. For the adoption of NASE 14 cassava variety; farmers can use this experience and determine its utilization which is backed by Edeoghon (2008) who reported that the more the farmers get engaged in practices, the more they become more familiar with those practices than those who have not been engaged with the practices.

5.2: Adoption of NASE 14 variety and food security in Eastern Uganda

Both adopters and non-adopters experienced food shortages within the year but the adopters of NASE 14 had more quantities of cassava flour for food than their counterparts although the results were insignificant at a 5% level. Surprisingly the results indicate that the adopters had more quantities of rice and sweet potatoes and there was a significant differences among the adopters and non-adopters as regards the quantities of rice (P=045) and sweet potatoes (P=0.027). The non-adopters had more quantities of Beans, Millet and Matoke but there was no significant difference at a 5% level among the adopters and non-adopters. The study confirmed the hypothesis speculated that there was no difference in food security among the adopters of NASE 14 and the non-adopters. This is because there are a variety of food crops on which the small holder farmers depend on in the districts of Tororo, Butaleja and Bugiri.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

Improved cassava varieties like NASE 14 improve the yield per unit area for the small holder farmers there by improving the efficiency of the farming operations. Using a cross sectional data, the factors that influence the adoption of NASE 14 and its contribution to food security particularly in the districts of Butaleja, Tororo and Bugiri were examined, There was no significant difference as regards gender and marital status between the adopters and non-adopters of NASE 14 cassava variety. However the significant difference was observed in access to credit, access to inputs and house hold head being a member of a farmer's organization. The results revealed that the factors influencing the probability of adoption of NASE 14 cassava variety are membership to group/organisation, access to farm inputs, land size owned, access to credit and experience in cassava growing, The technology specific variables were resistance to disease (ability not to rot), high yield. The other factors though not significant that increase the likelihood of adopting NASE 14 are the years of schooling, household size, perception about NASE 14 and access to information.

There was no significant difference between the adopters and non-adopters of NASE 14 in relation to food security as both groups experienced food shortages in certain months during the year.

6.2 Recommendations

The socio economic characteristics like membership to groups/organizations, access to credit and gender should be given much attention because of their contributory role in influencing adoption of NASE 14. This requires project implementers, decision makers, government and other relevant authorities to scrutinize aspects such as membership to group and gender of the target group before any programme or project can be enrolled.

There is need to organise cassava farmer households in groups as this significantly influenced adoption because of the benefits members get from the groups. The groups can be a centre for increased information dissemination, extension demonstration and farmers' participatory research and training programmes to popularize the improved cassava varieties in order to enhance adoption.

As regards gender, it was noted that the male were more likely to take up improved cassava varieties as compared to the women, this calls for deliberate policies which enable the female gender to access resources like land to enable them take up improved cassava varieties.

Financial institutions should develop more credit products that cover and support adoption or promotion of various technologies as they require finance to facilitate activities in technology adoption. The development of the credit products should be coupled with easing access to credit, for instance the process of accessing credit products should not be too bureaucratic and the length of the loan should be within the means the households can afford.

Given the significant role played by access to inputs and related variables, there is need to ensure that all actors along the value chain are brought together so that the input dealers/providers location and terms for access are known to the farmers. This becomes easy for them to interact at any moment when need arises and this can be achieved through formation and popularisation of Multi stakeholder innovative platforms.

There is need to encourage households to have family enterprises so that they can consolidate their land to do various on farm operation which in turn will increase the likelihood of technology adoption.

Lastly, there is need to have adequate Agriculture extension workers to provide information on improved technologies which will subsequently enhance adoption of improved Agriculture technologies.

6.3 Limitations for this research

The study acknowledges the limitations associated with measuring food security by only the quantities of food stuffs available per month, this could be non-exhaustive of the phenomena leading to inaccurate representation of the reality. Some households may have smaller quantities but when they have the economic strength to purchase and access the required quantities and quality of the food items, therefore more indicators need to be considered like the number of meals per day, nutrient intake and income to purchase the food items.

Income from cassava was calculated from crop yields that were based on farmers recall. In some cases farmers do not have / keep records and are not sure of their production data, in this case the interviewer used were skilled extension agent who probed farmers to develop the estimate.

The survey was designed to gather relatively simple indicators that are comparable among the adopters and non – adopters of improved NASE 14 cassava variety therefore the information gathered on food security was not as in depth as it should have been

6.4 Areas for future research

Future studies should shed a light on profitability of improved agriculture varieties like NASE 14. Although this study assessed factors which explain adoption of NASE 14, there is need to figure out the changing continuance and discontinuance practices of modern cassava varieties technology within small holder farmers in the agrarian communities.

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Appendix (i)

QUESTIONNAIRE

INTRODUCTION

This questionnaire is designed to collect information on improved cassava varieties in 3 Districts of Eastern Uganda (Butaleja, Tororo and Bugiri). The information collected will remain confidential and will not be disclosed to any third party whatsoever. It is intended to be used for academic purposes and also give feedback to cassava researchers for continuous improvement. The questionnaire will take about 30 minutes and therefore I request for your time to fill it.

Thank you in advance.

1.0 Identification of questionnaire

1.1 Name of interviewer ……………………………………. 1.2 Date ………………

1.3 Respondent Name (Optional) ……………………………………

1.4 Relationship to Household head …………………………………………

1.5 District …………… 1.6 Sub County …………………1.7 Parish ………….

1.8 Village ………………………

2.0 Household Socio economic Characteristics

2.1 Name of household head ………………………………

2.2 Gender of household head………………..

(1)Male (2) Female

2.3 Marital status of house hold head of the household head……………

(1)Married (2) Single (3) Widow/Widower (4) Separated (5) Divorced

2.4 Number of years of Schooling………..

2.5 Household Size: (1) Adult Female……….. (2) Adult Male……… (3) Children…………

2.6.1 Does the house hold belong to a farmer's organization (1) yes (2) No

2.6.2 If yes answer the following.

Type	Purpose	Frequency of meetings	No of members	requirements
Farmer group	1=collective marketing 2=get knowledge 3 = get inputs 4 = support in farming	1= weekly 2 = biweekly 3 = monthly		1=weekly attendance 2 = member ship payment
VSLA	1 = collective marketing 2= get loan 3= saving 4 = saving & loaning	1= weekly 2 = monthly		1 = weekly attendance 2= member ship payment 3 = both 1& 2
Cooperative	1 = collective marketing 2= bulk production 3 = access farming services 4 = production and marketing)	1= weekly 2 = monthly 3 = quarterly 4 = once in a year		1 = weekly attendance 2= membership payment 3 = share capital and membership fee
Self-help (Nigiina)	1 = collective marketing 2= get knowledge 3= build team spirit)	1 = weekly 2 = monthly		1 = regular attendance 2= membership payment 3 = both 1& 2

2.7: Access to information and extension service

2.7.1: Do you receive information on the farm/farming activities (1) Yes (2) No

Type of information	Funder	Frequency (how often)	Challenges
Production 1 = yes 2 = No	1= Gov't 2 = Ngo 3 = both NGO &Gov't	1= weekly, 2= monthly, 3= quarterly 4= once in a year	1 = language 2=poor time mgt 3= service is expensive 4= services are irregular 5= poor mobilization
Marketing 1 = yes 2=No	"	"	"
Credit: 1 = yes 2=No			
business skills: 1 = yes 2=No			

2.7.2: What is your level of satisfaction with the information / Extension services received?

(1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

2.8 Source of income for the family

S /No	Farming	Amount
1	Maize	
2	Cassava	
3	Rice	
4	Millet	
5	Sorghum	
6	Milk	
7	Eggs	
8	Chicken	
9	Others (specify)	
	Non farm	
1	Trader	
2	Provision of farmlabour	
3	Carpenter	
4	Nurse	
5	Teacher	
6	Others (specify)	

3.0: Assets

3.1: Farming Assets

S/No	Type	Number	Value
1	Hand hoes		
2	Pangas		
3	Slashers		
4	Ox plough		
5	Wheel barrow		
6	Oxen		
7	Rake		
8	Others (specify)		

3.2 Nonfarm assets

S/No	Type	Value
1	Motorcycle	
2	Bicycle	
3	Television set	
4	Radio	
5	Others (Specify	

3.3 Houses

Type	Walls	Number	Value
Living house	1.Bricks 2.Mud & wattle 3.wood poles 4. other (specify)		
Kitchen	1.Bricks 2.Mud & wattle 3.wood poles 4. other (specify		
Farm structures 1. Poultry 2. cattle shade 3. Store 4. others (specify)	1.Bricks 2.Mud & wattle 3.wood poles 4. other (specify		

3.4 What is your level of satisfaction with the assets?

(1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

4.0: land ownership and accessibility

Portion/ fragment	ownership	Land tenure	Type of land	Size of land	Restriction
1	1= own, 2= borrowed, 3= hired	1=customary, 2= titled, 3= squatting	1= swampy 2= upland 3= both swamp and upland		1= plant only short term crops 2= only water crops 3=not to use fertilizer or chemicals, 4= none
2					
3					
4					

4.2: What is the level of satisfaction with the land ownership and accessibility?

(1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

5.0: Access to credit

5.1: Do you access any credit? (1) Yes (2) No

5.2 if yes answer the following

S/No	Source	Period How long	Amount	Repayment terms	Interest rate % per year	Other costs	Use for credit
1	Friend			(1= weekly, 2= monthly 3= seasonally 4 = all at once		1= credit fees 2 = none	1= food, 2= business, 3= farming, 4 = visitors
2	Relative			1= weekly, 2= monthly 3= seasonally 4= all at once		1= credit fees 2 = none	1= food, 2= business, 3= farming, 4 = visitors
3	VSLA			1=weekly, 2= monthly 3= seasonally		1= credit fees 2 = none 3= takes a long time to get	1=food 2= business, 3= farming 4= school fees
4	Farmer cooperative			1=weekly, 2= monthly 3= seasonally		1= credit fees 2 = none	1 = business, 2= farming
5	Micro Finance institution			1=weekly, 2= monthly 3= seasonally		1= processing fees 2 = none	1= business 2=farming 3= home consumption
6	Bank			1=weekly, 2= monthly 3= seasonally		1= credit fees 2 = none	1= business, 2= farming 3= Property acquisition

5.3: what challenges do you face?

5.4: What is your level of satisfaction with the credit services?

(1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

6.0: Farm Inputs

6.1: Do you receive any farm inputs (i) Yes (ii) No

Type of input	Period	Variety / type	Quantity	Source
Cassava stems		1=Nase 3, 2=Nase14, 3=Narocas1, 4= magana 5= ogaro, 6= yellow		1 = OWC, 2= NGO, 3 = NARO, 4 = Friend
Maize seed		1= improved, 2= local		
Fruit tree seedlings		1= Mangoes , 2= oranges		

Bean seed		1= improved, 2= local		
fertilizer		1= inorganic 2= organic		
coffee				

6.2: What is your level of satisfaction with the assets?

(1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

7.0: Cassava Production

7.1 Do you grow cassava? (1) Yes (2) No

7.2 If yes, answer the following

S/No	Variety	How long have you grown the variety	Acreage Season A 2017	Qty planted (bags)	Source of planting material
1	NASE 3				1=OWC, 2= NGO, 3= NARO, 4= friend, 5= Own.
2	NASE 14				
3	Narocas 1				
4	Magana				
5	Local				

7.3 How long have you grown cassava?

7.4 Are there varieties you used to grow and stopped

7.5 If yes which ones?

7.6Why did you stop growing them

7.7 Describe the characteristics of the varieties grown

Variety	Attributes	Purpose	Challenges
NASE 3	1= sweet taste when fresh, 2= good milling ability, 3= easy to peel, 4=high yield, 5=doesn't rot, 6= 2 or more of the x-tics listed)	1=Food, 2 = Income 3= alcohol, 3= both food & income.	1= rots, 2= low yield, 3= bitter when fresh, 4= succumbs to disease 5 = lack clean planting material 6 = lack land)
NASE 14			1= rots, 2= low yield, 3= bitter when fresh,

			4= has succumbed to disease
NAROCAS 1			1= rots, 2= low yield, 3= bitter when fresh, 4=succumbs to disease, 5 = none 6=lack planting
MAGANA			1= rots, 2= low yield, 3= bitter when fresh, 4= affected by disease
LOCAL			1= rots, 2= low yield, 3= bitter when fresh, 4= succumbed to disease

7.8: What is your level of satisfaction with the Cassava varieties grown?

(1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

8.0 Cost of production & Marketing for cassava.

8.1List the costs incurred in the production and/or marketing of cassava at your farm

Activity	Total cost
Land preparation	
Planting	
1^{st} Weeding	
2^{nd} weeding	
Harvesting	
Drying	
Packaging	
Transportation	

9.0: Marketing and Sales for Cassava

9.1: Do you sell any cassava? (i) Yes (ii) No

Payment mode	Variety	Qty sold	Type of buyer	Unit price	Total amount	Place of sale
1.Cash 2. credit 3. cheque			1.Bicycle buyer 2. wholesaler			1.Home 2.Market 3.Other

9.2 What challenges do you face in selling the cassava?

1= cheating by middle men, 2= price fluctuations 3 = low price

9.3 What is the level of satisfaction with the sales and marketing of Cassava?

1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

10.0: Food Security

10.1: Do you experience any month with food shortage during the year? (1) Yes (2) No

10.2: How many moths in a year?

10.3: how do you cope?

1=buy, 2= provide farm labor 3= ask friend and relatives, 4= get credit, 5 = reduce on number of meals 6= buying and foregoing a meal

10.4 House hold food consumption quantity in a month

Food item	Quantity used

What is the level of satisfaction with the food security level?

1) Extremely satisfied (2) Satisfied (3) neutral (4) dissatisfied (5) extremely dissatisfied

END; Thank you for your time

Appendix ii

Figure 1.0: Cassava Brown Streak Disease symptoms on cassava roots (showing root constriction, dry hard rot when the root is cut)

Appendix iii

Logit Model

Let Pi be the probability of adopting NASE 14 cassava variety and X is a vector of explanatory variables. The likelihood of adopting NASE 14 cassava variety is specified as

Pi = f(X, ε)………………………………………… ………………………..…….. (1)

Where ε is an error term with logistic distribution.

The conceptual model is given as

$$In\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ji} + \varepsilon \quad \text{……….………………………..…………….. (2)}$$

Where Pi = prob (y=1) is conditional probability for Adopting; (1-Pi) = prob (y=0) is conditional probability for not adopting NASE 14; Xjis are the set of explanatory variables; β0 and βj are the coefficients that were estimated, and ε is the error term.

The estimated coefficients (β_0 and βj) are measures of the changes in the ratio of the probabilities, termed as the odds ratio. The logistic prediction equation for this study was:

$$Y = In(odds(events)) = In(\frac{prob(event)}{prob(nonevent)}) = In(\frac{prob(event)}{(1-prob(event)}) \quad \text{…………….….. (3)}$$

The empirical model specifying Adoption of NASE14 is stated in equation 4. Thus, the logistic prediction equation for the study is modeled as: Y is the logit for the dependent variable (Adopting to NASE 14) = PiY; (1 = Household Adopting NASE 14, 0 = otherwise).

$$In\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_n X_n + \varepsilon \text{..........…(4)}$$

Appendix iv

Results from the multiple logistic regression explaining factors that determine uptake of NASE 14 in Eastern Uganda

Number of observations	=	240
LR $chi^2(14)$	=	94.4
Prob> chi^2	=	0.0000
Pseudo R^2	=	0.41
Log likelihood	=	-207.99507

UGANDA CHRISTIAN UNIVERSITY

COMPLIANCE REPORT IN RELATION TO COMMENTS MADE BY INTERNAL / EXTERNAL EXAMINERS AND DURING VIVA

TOPIC: SMALLHOLDER FARMERS' ADOPTION AND FOOD SECURITY CONTRIBUTION OF IMPROVED CASSAVA VARIETIES: A CASE OF NASE 14 CASSAVA VARIETY IN EASTERN UGANDA

BY

DUGO AMINA

REG NUMBER: S16M43/004

SUPERVISOR;

DR. MARTIN MUTAMBUKA

SEPTEMBER 2024

Compliance report in relation to the comments made by the internal /external examiners/viva

Internal /external examiners			
SN	Section	Issues	Action made
1	Overall structure and presentation	1. Grammatical error and typing mistakes in the overall structure and presentation. 2. Abstract lacks the purpose, objectives, methods and findings	1. Corrections and editing made all through as per the comments given in the examiners track copies. 2.Improvement made on the abstract to include objectives, methods and findings
2	Chapter one Introduction	1. Introduction does not provide sufficient information about key concepts in the title of the study 2. introduction does not follow step by step from global to local	Key concepts on adoption and food security have been added (Pages 3-4) Improvement made in the introduction pages 1-2
3	Chapter two: Literature Review	1. Need to use recent studies to support the work 2. Make academic analysis of literature to justify the choice of variables 3. Reveal the void in literature that the study addresses 4. Literature more than 10 years	Some recent research has been included in the literature review. (pages 12 - 1
4	Chapter three: Methodology	1. Need to be precise in some areas	Used a table to be precise, pages 24-25
5	Chapter four: Presentation and analysis of data	Results not of good quality and well presented with appropriate analyses	Included the t- tests to compare the adopters and non-adopters as suggested by the external examiner in the track copy. The results have been revised.
6	Chapter five: Discussion of results	1.Moderate discussion and generic, discussion detached from study area 2, session needs to be reviewed.	There is no indication on where the improvement should be done, however there has been adjustment in the section (pages 49 -51)
7	Conclusions and recommendations	1.Session needs to be reviewed	Session was revised (pages 54-56) and also included the limitations of the study.
8	References and appendices	1.Some citations not included	The citation that was missing (Abdoulaye et al 2013) has been corrected, it was (Abdoulaye et al

		2.Some citations are cited different from the pattern they are listed in the references	2014). The citation, cited different from the pattern (Adong 2012) has been corrected (Adong et al 2012 – page 12) Also the working papers have been removed.
Viva			
1	Background did not give proper picture about cassava production and its contribution to socio economic development and food security.		The main contribution of cassava production has been food and incomes for the small holder farmers in Uganda and this has been included in the background (pages 1-2)
2	Need to address choice of words, technologies differs from cassava varieties		Technologies has been replaced by varieties in the title as observed during the viva
3	Need to show the Practical Contribution of cassava to the area of study		This has been included on page 2 paragraph 2.
4	should remove the blue colors in the conceptual frame work and draw it better		The blue color was removed. Frame work has been improved by removing all colors (page 9)
5	Why include intervening variables when there is no investigation on it		Intervening variables were included to show that they can affect the relationship between the independent and dependent variable, therefore they need to be put at the back of our mind.
6	Using two words interchangeable(Coefficient and correlation)		This was noted during the presentation and was corrected
7	Title need to be changed(The topic is not about technologies but cassava varieties)		The topic has been changed and technologies has been replaced with varieties
8	The background need to be detailed		A paragraph has been included on cassava production in Eastern Uganda page 2 , paragraph 2
9	How many cassava varieties do we have (talk about others too)		The other cassava varieties included Akena, TME 204, TME 14, NASE 3, Migyera and Magana have been included in the document (page 2, paragraph 2 and page 3 paragraph 2)
10	If the study is a survey, why bring in observable effect		Observable effect has been removed from the conceptual frame work.
11	The dependent variable is about uptake, why bring in multiple regression		Multiple Logistic regression analysis used was appropriate because uptake is a dichotomous outcome (i.e. uptake or no uptake). The model can be extended to combine more than one independent variable which can be continuous or categorical. In this study

		there were continuous and categorical variables.
12	How did you come up with the sample of 240, you did not show the population	It was calculated using the formula $a = \frac{N}{1 + N(e)^2}$ From a population of 617. This has been indicated on page 23
13	Clearly show how you arrived at percentages in your results.	Percentages were calculated for each group independently. E.g. for the (i) adopters it was $\frac{\text{observation}}{\text{Sample size (135)}}$ (ii) Non adopters = $\frac{\text{observation}}{\text{Sample size (105)}}$ Sample size has been included in the tables page 28, 31,
14	The variable listed are not in the conceptual frame work	Made corrections on the naming of the variables (Page 9)
15	The results are not informing the recommendation, there should be a connection	
16	Should be mindful about the tenses, this is research not proposal, change will to was	This was noted and corrections made in the document.
17	Clearly discuss why the positive and negative in your results	This has been done under the discussion chapter pages 49-51
18	Clearly show how you analyze a dummy independent variable	Dummy independent variable takes on the value of either 1 or 0 as a numerical stand for a qualitative fact i.e. gender can assign Male = 1 Female = 0. Thereafter can be included in the regression analysis for measurement.
19	How did you measure adoption	Adoption was determined by use of the questionnaire and one was taken to be an adopter if he was found growing NASE 14 during that year 2017 and a had grown it for two years and more consecutively
20	Be consistent in using words like adoption, adopt and perception	This has been corrected throughout the document.
21	Need to bring out clearly in the background what this cassava variety has contributed to food security in your area of study.	This is indicated on page 4 paragraph 2 as high yielding and resistant to the cassava mosaic disease and cassava brown streak disease. Its contribution to food security was the second objective for the study
22	Clearly show how you measure food availability	Food availability in the study was measured by the quantities of food items available in the house hold

22	Re align availability, accessibility, utilization and stability in your work	This has been done under the literature review on page 15. However in the study the dimension of food security considered was availability
23	Instruments used in the study are so scattered, need to work on it.	There is no clear direction on how to work on the instruments
24	Need to repeat the analyses and use the right models and do a good discussion of the results in a scholarly way	The Multiple Logistic regression analysis used was appropriate because uptake is a dichotomous outcome (i.e. uptake or no uptake). The model can be extended to combine more than one independent variable which can be continuous or categorical. In this study there were continuous and categorical variables.

Signed: ……………………………………

Name: Dugo Amina/ Reg : S16M43/004

Date: 09/09/2024.

signed ……………………………

Name: Dr. Martin Mutambuka

Date: 09/09/2024