DETERMINANTS OF AWARENESS AND UTILIZATION OF GRADES AND STANDARDS AMONG SMALLHOLDER MAIZE FARMERS IN AMURU AND NWOYA DISTRICTS

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DECLARATION

I KALU NNENNA ONYINYECHI, attest that this dissertation is unique and has never before been presented to a university for a degree award.

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APPROVAL

This dissertation has been submitted with our approval as supervisors for this candidate.

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DEDICATION

This work is dedicated to God Almighty who has been my foundation of strength, to my parents, Mr. and Mrs. D.O. Kalu, for their support, prayers, and words of encouragement, as well as to my siblings, friends, and other family members

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LIST OF ACRONYMS AND ABBREVIATIONS

EAC	East African Council
EAS	East African Specification
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
IGC	Intergovernmental Committee
IITA	International Institute of Tropical Agriculture
UBOS	Uganda Bureau of Statistics
UNBS	Uganda National Bureau of Standards
USAID	United States Agency for International Development
WFP	World Food Programme

ABSTRACT

In Uganda, the low level of adherence to maize grades and standards has emerged as a significant challenge within the agricultural sector. Despite the existence of established grading and standardization guidelines by the East African Grain Council, compliance has been weak among smallholder farmers in the local markets. This study investigated the factors influencing farmers' awareness of recommended grades and standards for maize as well as the factors influencing farmers' decisions to utilize those grades and standards in the northern Ugandan districts of Nwoya and Amuru. Primary data were gathered from 270 randomly chosen maize farmers in study area following a cross-sectional approach. Descriptive statistics, probit regression model, and Heckman-two stage model were used to analyze the data. Findings show that farmers had limited awareness of recommended grading and standards, resulting in low adoption. Key factors that influenced awareness include education, access to extension services and credit, membership in farmer associations, and gender. Farmers' decisions to use the standards were positively shaped by their level of awareness on maize grades and standards and their access to extension services while their proximity to the market and membership to association negatively influenced their decision to adopt grades and standards. Additionally, the extent of grading was positively influenced by production scale, education level and awareness and negatively influenced by household size, and membership to cooperatives. The study recommends improving farmers' access to grading stations, enacting policies that enhance credit access, and tailoring extension services to focus on maize grading and standardization. These measures could increase awareness, encourage participation, and boost maize output

Keywords: *Smallholder farmers, Utilization, Maize grades and standards, Awareness, Northern Uganda*

CHAPTER ONE: INTRODUCTION

1.1 Background

Global production of maize has expanded significantly during the past ten years alone, reaching nearly 1.2 billion tonnes in 2020 (FAO, 2021). Maize is also one of the most significant food crops in the world, contributing a minimum of 30% of the calories in food to over 4.5 billion people in 94 developing nations (Shiferaw *et al.,* 2011).

Maize is one of the most important grain staple crops produced in Africa, particularly in East African nations like Uganda with daily consumption reaching 136g per person (FAO, 2019). Although the Ugandan government has made increasing maize productivity a top priority, maize production is still dominated small-scale farming households (Daly *et al.*, 2017), and over half of the annual crop is produced in eastern Uganda (USAID, 2010). After bananas and beans, the third-most grown crop in terms of land coverage is maize. The crop has now replaced commodities including sorghum, millet, cassava, and banana as a commonly consumed staple meal in several areas of the nation (Ahmed, 2012).

Despite being a crucial crop for food production, maize also contributes significantly to raising farmers' incomes. To make money and fulfill other financial obligations, an increasing number of maize farmers are selling their surplus harvest to millers (Midamba, 2022). Additionally, maize can be used to process a variety of value-added goods, including feed for animals, corn oil, corn flour, and others. In urban areas like Kampala, maize can be consumed as porridge, cake (Posho, or Ugali), grilled or whole, and more (M. Ahmed, 2012). However, the benefits of maize production in Uganda are not only experienced within the country but also at the East African

Community level as a result of the exportation to different neighboring countries such as Kenya, Tanzania, South Sudan and Republic of Congo.

1.1.1 Maize Markets and Exports in Uganda

In Uganda, 22% of the harvested maize is sold on the export market and 78% is sold domestically. 37% of the maize sold locally is converted into animal feed, 60% into flour, and 3% is sold to breweries (De Groote & Kimenju, 2012). According to Daly et al. (2017), there are four primary trader categories, including informal purchasers with no requirements for quality and large traders (40%) who sell to millers, and purchase grain from producers individually or through cooperatives. These buyers are: the large-scale millers/traders from Kenya (20%) who offer better prices, Institutional buyers dominated by World Food Programme (30%), and exporters/ large traders who sell to customers in countries like; Rwanda, South Sudan, or smaller mills in Kenya (10%) (Kilimo_Trust, 2018; IGC, 2017). Also, most large traders from places like Kampala, Lira, Gulu, Jinja and Mbale source maize from production areas such as Nwoya where they also buy and supply to millers. Given the increase in both local and international trade in maize, enforcement of standards has become critical in ensuring that the traded maize is safe for the purpose of trade. Ugandan smallholder farmers are thus expected to adhere to the grain standard set by the East African Grain Council and the Uganda National Bureau of Standards.

1.2 Statement of the problem

In the East African Community (EAC) of which, Uganda is a member, over 11 million farmers are involved in maize production and inter-regional export (IGC, 2017, FAO, 2014, National Bureau of Standards (NBS), 2012). In an effort to enhance intraregional trade in maize, the EAC harmonized the maize grain standards. This clearly stipulates quality and safety parameters and

their limits, some of which, with growing interest are total aflatoxins and aflatoxin B1 whose limits are at 10ppb and 5ppb respectively (Suleiman & Rosentrater, 2015). Despite the highlighted importance of adhering to the stated EAC maize gain standards especially with respect to food safety and inter-regional trade, compliance is said to be weak in domestic markets. This challenge, to a large extent, has restricted the trade of maize grains especially from Uganda to Kenya and other countries due to claims of higher aflatoxin content beyond the maximum allowable limits. For instance, according to the East African Grain Council, Kenya rejected 600,000MT worth USD 48.7 million of maize from Uganda due to non-compliance in October 2018 (Wang et al., 2021). Additionally, in early March 2021, Kenya imposed an import ban on maize from Uganda and Tanzania, citing a non-conformity to aflatoxin standard limits (Wang et al., 2021). This ban stalled maize exports and led to trickle-down effect in the value chain leading to reduced income, high post-harvest losses and poor livelihood of farmers. The pertinent question remains as to why farmers appear reluctant to adhere to the grades and standards of maize grains. This lack of compliance is largely attributable to smallholder farmers' subpar use of grades and standards. Actually, there hasn't been much research on how smallholder farmers in Uganda use these grades and standards, previous studies have focused mostly on identifying the opportunities as well as the challenges impacting the harmonization of the EAC standards, but none has focused on identifying the awareness of the smallholder farmers including their decision to adopt maize grades and standards. By comparing the socioeconomic features of the maize farmers, assessing their level of knowledge regarding grading and standardization, and identifying the variables influencing their choices to employ these practices, this research sought to close this information gap.

1.3 Objectives of the study

1.3.1 General objective

The goal of the study was to find out the awareness and how much maize farmers in Nwoya and Amuru districts utilized maize grades and standards.

1.3.2 Specific objective

The specific objectives of the study were:

1) To characterize maize farmers in Nwoya and Amuru by extent of awareness and utilization of grades and standards.
2) To examine the factors influencing farmers' awareness on the recommended maize grades and standards.
3) To ascertain the determinants of farmers' decision to utilize maize grades and standards.

1.4 Research Questions

1) What are the demographic characteristics of the maize farmers using grades and standards?
2) What factors influence the awareness of the recommended grades and standards among smallholder maize farmers in the study area?
3) Which factors influence the decisions to utilize and the extent of utilization of Maize grades and standards among the maize farmers?

1.5 Scope of the study

The scope of the study was divided into three categories: temporal, contextual, and geographic. It covered the months of August 2022 through April 2023. In terms of location, the study was restricted to Northern Uganda's Nwoya and Amuru districts. Contextually, the study focused on

identifying the factors influencing farmers' awareness and utilization of grades and standards among smallholder maize farmers. Also, information on the factors influencing the extent of utilization of the recommended maize grades and standards were captured.

1.6 Justification of the study

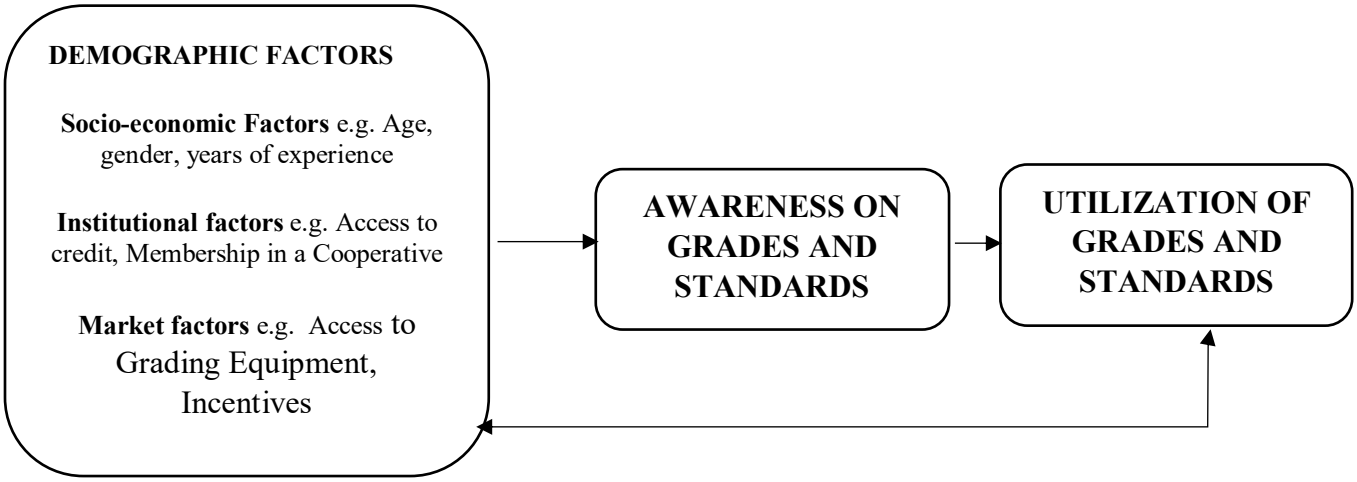
The findings of the study shall provide sufficient data to improve critical comprehension of how grades and standards are used in agricultural production and trade. It will add to existing literature on grading and standardization and enable farmers gain adequate knowledge needed to scale up their participation and conformity to the established grading and standardization by the East African Communities. This will in turn enhance the quality of the maize produced to increase farmers' income and general food security. Additionally, it will serve as a guide to the government of Uganda and its Ministry of Agriculture in formulating policies that will focus on creating sustainable measures towards the implementation of the established grades and standardization in Uganda.

More so, this study will serve as a body of knowledge to extension workers who teach farmers improved agronomic practices and post-harvest handling to increase their income while improving their livelihoods. Additionally, it will contribute to the body of knowledge on maize grain standardization and grading, as well as its effects on food quality and export, and it will serve as a resource for scholars interested in related fields.

Finally, this study is expected to stimulate interest in further research in unveiling the need for grading and standardization of agricultural products to allay future food safety concerns.

1.7 Conceptual framework

Figure 1.1 depicts the interrelations between the dependent and the independent variables in this study and how they are related. Socio-economic elements such as age, years of schooling, and gender; institutional and market factors such as market knowledge, marketing expertise, and proximity to the market are postulated to have an influence on the awareness of smallholder maize farmers on the recommended grades and standards. The demographic factors together with the farmers' level of awareness further influence their decision to utilize as well as the extent to which they are willing to utilize the recommended grades and standards.



Source: *Own Conceptualization*

Figure 2.1: Conceptual framework relating socio-economic factors, institutional factors, market factors with level of awareness and utilization of maze grades and standards

CHAPTER TWO: LITERATURE REVIEW

2.1 Maize

Maize (*Zea mays* L.) botanically known as corn, is among the three most cultivated crops globally and has been used for nutritional, medical as well as industrial uses (Adiaha, 2017). Maize which originated from Mexico and Central American tropics (Adiaha and Agba, 2016), is part of the *Maydea* tribe of the grass family *Poaceae* (Hossain *et al.,* 2016). In all ecological zones, the cultivation of maize has been strongly undertaken because of its ability to adapt to various farming areas. Hence several subspecies of maize have been categorized owing to the amount of starch contained in the maize (Piperno *et al.,* 2001).

Nutritionally, the crop has multiple uses for instance it is used as food for humans and feed for animals as well as serving as a raw material for several manufacturing processes (Hossain *et al.,* 2016). Adiaha, (2017) affirmed that the crop contains 80% carbohydrate, 3.5% crude fiber, 10% protein and 2% minerals and vitamins. Dilip and Aditya (2013) also reported that maize contains selenium which can stimulate the thyroid gland and also improve human body immunity. Maize has been utilized for several industrial applications such as the production of noodles and the high fructose content of maize is used for preservation of moisture in foods (Khawar *et al.,* 2007).

Ferris *et al.,* (2006) noted that maize is a widely cultivated staple crop that greatly contributes to the income of farmers in Northern, Northern-western, and Eastern Uganda. Owing to the multiple uses of maize in Uganda, the staple crop has become a strategic food security crop in the country (Okoboi, 2010) and been selected for planned government intervention in terms of plant breeding, provision of extension services, research and construction of warehouses (Okoboi, 2010). From breeding, planting, storage and processing of maize, the quality maintenance of the staple crop is

important to maintain its market quality as well as the nutritional content of the maize (Gyori, 2017).

2.2 Quality characteristics of maize

The quality of maize is measured in terms of the methods adopted in the production and processing of the crop. This is to determine the suitability of the crop, its soundness, and purity for human consumption (Gyori, 2017). The soundness of the grain in terms of its moisture content, crack or brokenness, density, color, odour, deterioration and insect infestation determine its quality while the purity of the grain involves the wholesomeness of the husks, seeds, stems, and stones (Shipman *et al.,* 2004).

The soundness and purity of maize governs to a large extent the marketing participants of the grain as the customers (both middlemen and direct consumers) would not want damaged, infested or dried maize (FAO, 2002). They desire homogenous batches of clean maize grain which will yield quality milled products. In most cases, the processors may accept broken or hulled grains that are free from impurities, insect infestation and parasitic odours (Maghala, 2011).

According to Aman and Maro (1992), the quality features of maize can be affected by two distinct characteristics; its variety (intrinsic) and the process-induced (extrinsic) characteristics from the environment as well as crop management techniques (Table 2.1). The intrinsic features are genetic and thus can hardly be modified. The environmental characteristics can be controlled by the maize farmers, hence the importance of the set standards and grades to guide in achieving the market quality and requirement (Bryceson, 1993). The environmental quality features of the maize grain are greatly impacted by climatic and soil conditions during the planting season. The quality can also be influenced by the method of cultivation, condition of the weather at harvest, harvesting

techniques and storage methods (Semple and Kirenga, 2002). The improper cultural practices and management can internally damage the prime quality of the maize, resulting into immature, damaged and infested crops with low moisture content and nutrients and thus can be rejected at the market (FAO, 2006)

Table 2.1: Factors that determine quality of maize grains

Genetic properties	Environmental effects	Crop management methods
Seed Varieties	Climatic condition	Soil cultivation
Hybrids	Soil condition	Sowing time
Open Pollinated	Water	Fertilization
		Irrigation
		Drying at harvest
		Storage

Source: Gyori (1999)

2.3 Maize grades and standards

Grades and standards are recognized as factors that group comparable products into categories and display them in a way that market players can easily comprehend. Standards specifically are classification and measurement guidelines created by reputable organizations for repeated usage or by law. Grades are particular classification schemes that reliably and uniformly indicate quantifiable and qualifiable characteristics (Giovannucci and Reardon, 2000).

Grading and standardization can also be seen as a marketing function that augments value to a produce along the value chain. Usually, grade and standards for commodities are outlined by an organization or a governing body before the commodities are graded according to the accepted standards mostly in terms of quality specifications including weight, size, color, appearance, texture, moisture content, staple length, amount of foreign matter, maturity, sweetness, flavor, and chemical content (Haantuba and Michigan, 2001). Thus, standardization encompasses creating

uniform quality specifications of the grades for buyers and sellers over time and space (Bizencyclopedia, 2019).

In East Africa, a widely accepted standard has been developed for maize grains to ensure inter-regional trade between countries; Maize - Specification (EAS 2:2017). The various standard grades include; Grade 1, Grade 2 and Grade 3 (Table 2.2) which are considered good for human consumption of which other grades lower than these are regarded unfit for human consumption (Ahmed, 2012).

The harmonization of the EAC standards has ensured implementation by various member countries such as Rwanda, Kenya and Uganda, thus this has increased attention towards food safety especially with regards to aflatoxins and other grain contaminants (De Groote and Kimenju, 2012).

Table 2.2: Maize grades in the East Africa standards

S/N	Characteristics	Maximum Limits			Method of test
		Grade 1	Grade 2	Grade 3	
i)	Foreign matter, %m/m	0.5	1.0	1.5	
ii)	Inorganic matter, %m/m	0.25	0.5	0.75	
iii)	Broken Kernels, % m/m	2.0	4.0	6.0	
iv)	Pest-damaged grains, % m/m-	1.0	3.0	5.0	
v)	Rotten and diseased grains, % m/m	2.0	4.0	5.0	
vi)	Discolored grains, % m/m	0.5	1.0	1.5	
vii)	Moisture, % m/m		13.5		ISO 711/712
viii)	Immature/shriveled grains, % m/m	1.0	2.0	3.0	
ix)	Filth, % m/m		0.1		ISO 605

x)	Total defective grains, % m/m	3.2	7.0	8.5	ISO 605
xi)	Total aflatoxin (AFB_1+AFB_2+AFG_1+AFG_2), ppb		10		ISO 16050
xii)	Aflatoxin B_1, ppb		5		
xiii)	Fumonism, ppm		2		AOAC 2001.04

NOTE The parameter, Total defective grains are not the sum total of the individual defects. It is limited to 70% of the sum total of individual defects. ppb -Parts per billion, ppm – Parts per million, mm – Millimeter

Source: Adapted from UNBS, (2016)

2.4 Maize grading and standardization

Grading is one of the essential procedures for categorization of products into different groups on their significant features such as size, quality etc. The process involves the sorting of different units of the maize into well-defined categories of quality (QS Study, 2022). This is essential due to the deficient methods adopted by most household farmers in the cultural methods of maize production. Grading and standardization have become the medium for buyers to communicate to their supplies their desired quality of the crop (FAO, 2006).

Jaffe and Henson (2006) affirmed that these standard measures aid in grain trading and marketing. The measuring standards are employed to manage the risk of affecting human health due to contaminants, pest and diseases of infested food crops (Ferris *et al.,* 2006). The grading and standardization are measured based on the tolerable limit of defects in the maize, clean state of the maize, weight of the maize and sorted level of the maize (Maghala, 2011).

2.4.1 Tolerable limit

The tolerable limit of defects provides the classified rule of measurement for the maize standards and quality to maintain uniformity and be consistent in identifying quality attributes of the maize (FAO, 2002). In 2005, the East African Community harmonized the standardization process to create quality standard for determining the safety of maize (EAC, 2005). The percentage by weight maximum defect tolerable in maize was described in Table 2.3.

Table 2.3: Percentage of weight of maximum defect tolerance in maize

Aspect	**Percentage by weight maximum defect limit**	
Defect	Grade 1	Grade 2
Foreign matters	0.50	1.00
Moisture content	13.5	13.5
Pest damaged grains	1.00	3.00
Inorganic matters	0.25	0.50
Rotten and diseased grains	2.00	4.00
Immature/chalky grains	1.00	2.00
Broken grains	2.00	4.00
Total defective grains	4.00	5.00
Discolored grains	0.50	1.00

Source: EAC (2005)

2.4.2 Cleanliness and sorting of maize

The maize grains are often traded in long distance markets where regulatory standards are set to protect the customer's interest hence operations and standards are adhered to in order to attain to the required quality. In order to adapt to the requirements for processing and consumption, maize grains should be cleaned after harvesting (Acharya and Bhatanagar, 2007). One of the simplest ways of cleaning maize grain is winnowing (FAO, 2006). Despite the tedious nature of the method, it reduces the impurities, molds, insects and foreign materials in the maize grain (Ferris *et al.,* 2006). The sorting of maize classifies the grains into different grades according to the market needs

and also aid the customers in finding a standard quality at a just price. Although the process of sorting is herculean, in most cases the traders engage in them to obtain better prices for their product (Maghala, 2011).

2.4.3 Weight of maize

Maize grains are packed in bags after sorting and cleaning. These bags are weighed according to specified sizes such as 25kg, 50kg, 100kg etc (Robbins *et al.,* 2005). The standard weights allow the buyers and sellers to easily negotiate being aware of the quantity at any specified price (Ferris *et al.,* 2006). It also prevents the search for physical confirmation of the quantity as the products flow through the marketing chain (Maghala, 2011). According to Hurburgh (2008), the weight standardization process if adhered to, provides several economic opportunities and benefits in the marketing of grains.

Acharya (2006) indicated that sorting, weighing and bagging of grains helps in reducing the unnecessary transportation of waste from the farms/barns to urban markets. These wastes in turn serve as organic manure and should be left to the rural farmers to replenish soil nutrient. These processes also serve as a source of employment in the rural areas (Acharya, 2006).

2.5 Benefit and cost implications of maize grading and standardization

Maize grades and standards are essential marketing features which aid in maintaining quality. According to QS study (2022), these market functions are beneficial as follows; they encourage the use of crop sample and descriptions in the buying and selling as the customers can buy the good effortlessly based on the samples given without insisting on detailed assessment of the crop.

The process also aids farmers to direct the crop to particular markets that desired the obtained quality of maize. This reduces the stress on the middlemen when conversing the crop characteristics to their customers. They are reassured of the particular market to obtain the customers' desired maize crop quality. Graded and standardized maize crops is beneficial to a wider market as apt buying decision can be made by customers through information such as price and durability. obtained from the standardized maize products.

Price comparison, hedging and future trading are facilitated by grading and standardization. Product exchange and trading of products can be easily improved. Grading and standardization results to consistent product quality which in turn aids in increasing finance and thus can serve as a collateral safety for agricultural loans. The price of standardized crops hardly change as the qualities, sizes and measures are known within the market. This quality aids in making assurance claims when there is loss or damage of goods when the business is insured.

2.6 Factors affecting grading and market participation

Numerous factors, such as socioeconomic factors, institutional factors, and other external factors, have an impact on farmers' engagement in maize grain grading, standardization, and marketing. Accordingly, the actions of the farmers may rise or decrease depending on the influence of these elements (Sigei et al., 2014). Age, education, gender, household size, land size, and experience are socioeconomic factors with a substantial bearing on the actions of farmers.

Young farmers, with longer planning horizons, can take risks and grade grains to expand their market opportunities. (Zegeye *et al.,* 2001), while the older farmers are usually dependents whose family may also depend on the proceeds of the farm for their daily feeding, grading may reduce the marketable grain available and thus reducing their daily income (Ehui *et al.,* 2009). In most

cases, the older farmers had greater available land, accumulated capital, long term client relationships as well as preferential access to credit. These result into easy decision making by the older farmers than it is for the young farmers who may be struggling on their own (Adegbola and Gardebroe, 2007).

Jagwe *et al*., (2010) highlighted that homes with female heads of household are easily impacted by marketing variables such as customer search, shipping to further markets, and in most cases, sales transactions. They are also constrained by resources which reduces their production output (Guiiterrez, 2003). In such low output, grading of the grains may also in turn reduce their products, hence they avoid such actions. Households headed by males are known to be more resource endowed, versatile and manage transactions effectively (Sigei *et al.,* 2014). Grading of their grain will be easier as they have larger output and also ready to seek for quality confirmation from customers.

The ability to understand the grading formula and standardization limits can only be effective due to the acquisition of formal education. This will also increase the market participation of the farmers in various markets (Sigei *et al.,* 2014). Similarly, the household size determines the amount of labour from family members as well as their consumption level of the products (Alene *et al.,* 2008). Positively, the family labour from large households will aid in the production process, grading and marketing of the products whereas the consumption level of the products will significantly reduce the marketable surplus (Sigei *et al.,* 2014). Key *et al.,* (2000) noted that availability of farmland to farmers is directly proportional to the marketable surplus available. When there is greater marketable surplus, the need for grading and standardization will arise as the farmers will seek for a better bargain through quality products.

Grading and standardization as well as market participation can be greatly influenced by institutional factors such as membership in cooperative groups, extension services as well as infrastructure. Being a member of a farmer's cooperative groups can aid in providing information on grading, standardization as well as marketing related decisions (Olwande and Mathenge, 2012). Membership also results in disagreements among members which can lead to grading distortions. In such cases, higher grading limits from national organization such as the East African Grain Council should be adopted by farmers to reduce distortions. Extension services aids in providing better grading and standardization skills and knowledge to farmers (Sigei *et al.,* 2014). Poor infrastructure such as roads decreases farmers' market participation and also reduce their efforts in grading as they can only sell within their locality due to high cost of transportation (Makhura *et al.,* 2001; Key *et al.,* 2002).

2.7 Utilization of grades and standards among farmers

Despite the enormous benefits of grading and standardization which include; enabling of better price quotation, simplification of the bargaining process, advance payment of agricultural products, maintenance of competitive market advantage and the reduction of low-quality products from the market (Omotesho *et al.,* 1995), most maize farmers do not engage in the proper standardization of grains which has resulted in the non-recognition of the quality of the food crop by customers. Hence appropriate premium is not accorded to encourage production. The utilization of the grading and standardization system have been effectual for the marketing of grains by farmers, hence various researchers have adopted various techniques for grading and standardization of grains (Siddagangappa and Kulkarni, 2014).

Omotesho *et al.* (1995) in their study of the relevance of standardization and grading in the marketing of grains revealed that most of the grain traders in selected Kwara state markets grade their grains based on size, colour, cleanliness, taste, and use. They combine these characteristics in their sorting process based on the customer's choice.

Majumdar and Jayas (2000) developed models for the classification of Canada Western Red Spring through the combination of various grain features such as colour, texture and morphological features. Anami *et al.* (2005) advanced a neural network algorithm to categorize various grains with respect to their colour, width and height. Zayas *et al.,* (1989) utilized image analysis for the discrimination of wheat and non-wheat components in a sample. They used structural prototype and multivariate discriminate analysis for their pattern acknowledgement. The techniques were developed for the grading of the wheat grain in order to eliminate the unwanted components or irregularly shaped stones which can be considered as wheat.

2.8 Theoretical framework

2.8.1 Utility maximization theory

This study is embedded on the theory of utility maximization which describes how smallholder maize farmers make decisions to maximize their satisfaction (utility) by utilizing grades and standards to enhance profitability. Farmers who are aware of the benefits of grading and standardization are more likely to adopt these practices to access better markets and command higher prices, even when it involves extra effort or costs. With better information, farmers can make informed decisions to improve their market position and economic returns, reflecting rational behavior based on utility maximization.

The utility theory was first proposed by a Swiss Mathematician Bernoulli Daniel in the 18th century. This theory which is also known as the consumer behavior theory evaluates the consequences of various decisions. It explains the observed choice and behavior of an individual in terms of perceived or actual economic benefits. It is a binary choice to participate in grading and standardization of maize grains by farmers. This can be attributed to the dichotomous nature of the dependent variables. It is also essential for-profit maximization of the products (Pryanishnikov and Katarina, 2003). The activities of the economic agent (medium-scale farmers) were observed through their choices of participating in the grading and standardization of grains. Where U_j and U_k represents a farmer's utility for two options, respectively denoted by Y_j and Y_k. Equation (1.1) can be used to specify the linear random utility model.

$$U_{ij}(\beta_j X_i + e_j) > U_{ik}(\beta_j X_i + e_k), k \neq \forall_i \quad (2.1)$$

U_j and U_k are the perceived utilities of the grading utilisation and non-grading utilisation choices, j and k, respectively. X_i is the vector of explanatory variables that affect the perceived desirability of each choice. β_j and U_k utility shifters. Equation (2) demonstrates that if a farmer decides to participate in grading, option j's apparent utility or benefit is greater than the utility of other options (such as decision k).

$$U_{ij}(\beta_j X_i + e_j) > U_{ik}(\beta_j X_i + e_k), k \neq \forall_i \quad (2.2)$$

The likelihood that a farmer will decide to utilize maize grades and standards, i.e. to select procedure j as opposed to k is defined in equation (3);

$$P(Y = 1|X) = P(U_{ij} > U_{ik})$$

$$P(\beta_j X_i + e_j - \beta_{\ k} X_i + e_k > 0|X)$$

$$P(\beta_j X_i - \beta_k X_i + e_j - e_k > 0|X)$$

$$P(X^* X_i + e^* > 0|X = F(\beta^* X_i) \quad (2.3)$$

Where P is a probability function U_{ij}, U_{ik} whereas X_i well-defined in equation (3),

$e^* = e_j - e_k$ An error term,

The net effect of the vector of explanatory variables impacting involvement can be represented as $\beta_j^* = (\beta_j - \beta_k)$ a vector of unidentified parameters, and the cumulative distribution function F $(\beta^* X_i)$ of e^*. is evaluated at $\beta^* K_i$. The distribution of the random disturbance term, e^*., is a key factor in determining the precise distribution of F. The calculation of several qualitative choice models is possible because of the random disturbance distribution that is assumed by Greene (2000).

CHAPTER THREE: METHODOLOGY

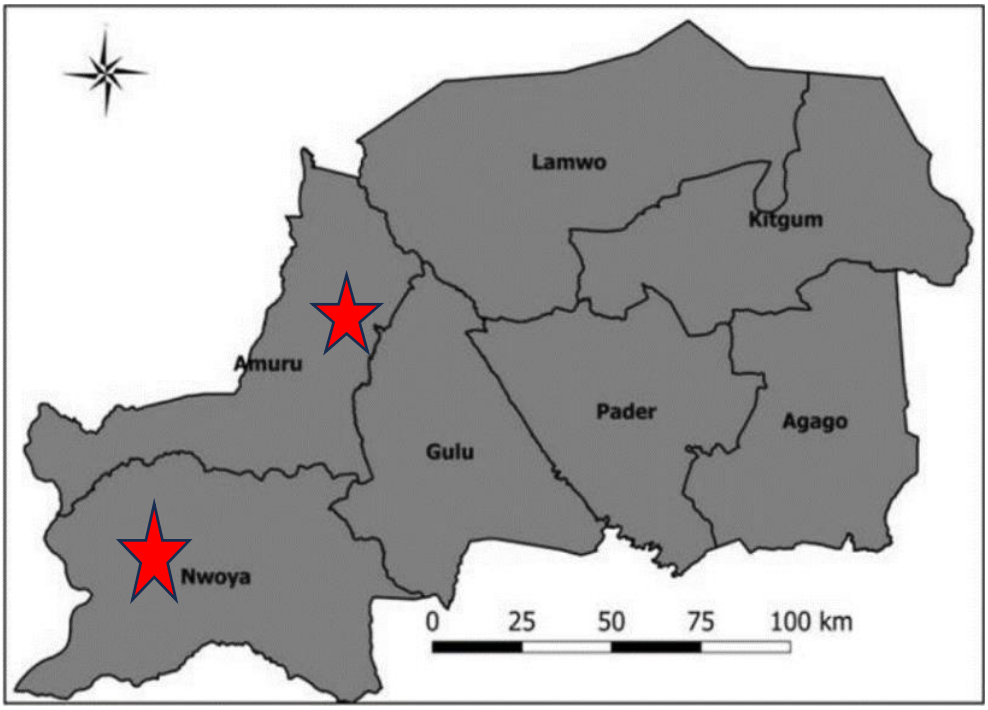
3.1 Study area

The study was conducted in Nwoya and Amuru districts in the Acholi sub-region of Northern Uganda. In terms of location, it lies on the main road of Gulu to Arua which is approximately 44 kilometers (27 mins) by road at the South West of Gulu, the largest city in Acholi sub-region. Its coordinates are 2°38'06.0"N, 32°00'00.0"E. Nwoya district covers an area of approximately 4,736 square kilometers with an estimated population of 4,295 people. While Amuru district is located at 2° 48' 59.99" N, 31° 56' 59.99" E. It covers a total land area of 3,625.9 square kilometers (1,400.0 square miles) and a population of 186,696 people (UBOS, 2014). Nwoya District has an estimated 34,800 households, producing 50,000 to 60,000 metric tons of maize annually, primarily from smallholder farmers while Amuru District, with approximately 33,000 households, produces around 45,000 to 55,000 metric tons of maize each year.

Both the Nwoya and Amuru districts are renowned for their agricultural activity, with majority of the population involved in livestock production and/or crop agriculture. Although the fertile land has considerable potential for large-scale agriculture, small-scale farming now dominates agricultural production. Cotton and tobacco are the most widely planted commercial crops, whereas maize, millet, cassava, and groundnuts are sown mainly for food.

Nwoya and Amuru Districts are currently faced with underdeveloped road network and limited market infrastructure making it difficult for maize farmers to access markets and increase transportation costs. Additionally, inadequate post-harvest handling facilities, including a lack of modern storage options has led to high losses and contamination risks, affecting maize quality and

productivity. The districts of Nwoya and Amuru were selected primarily since they have a high level of involvement in commercialized maize cultivation (Maku et al., 2022)



Source: Adapted from Akongo et al, 2021

Figure 3.1: Map of Acholi Sub-region showing Nwoya and Amuru Districts, Northern Uganda

3.2 Study Design

The study adopted a cross-sectional survey design. The survey design was used to collect data in Nwoya and Amuru districts. It has been adopted because it saves time, is affordable, doesn't need follow-up, and is effective at drawing findings that apply to the entire population. (Martin et al, 2022). It can also compare many different observations at the same time.

3.3 Sample size determination

The formula from Cochran (1977) was used to determine the sample size (n) for the investigation. The choice of this formula is because it is particularly suited for estimating sample sizes when dealing with proportions. The expression for this is given by equation (4).

$$n = \frac{Z^2 Pq}{e^2} \quad (3.1)$$

Where p is the proportion of maize farmers in the Nwoya (45%) and Amuru (32.3%) districts (NPHC, 2017), n is the sample size, Z is the confidence level at 95% (Standard value = 1.96), and e is the margin of error (set at 5%).

The above formula yielded the following:

For both Nwoya and Amuru (45%+32.3= 77.3%)

$$n = \frac{(1.96)^2 \times 0.773\ (0.227)}{(0.05)^2} = 270$$

Therefore, 270 maize farmers were interviewed.

3.4 Sampling procedure

This research adopted the multistage sampling procedure. The first stage involved purposively sampling Nwoya and Amuru districts because of their high level of engagement in commercial maize farming (UBS,2020). In addition, the study area is in close proximity to the South Sudanese borders which is a major gateway for export of agricultural commodities. In the second stage, one sub-county each (Alero and Amuru) was randomly selected from Nwoya and Amuru districts respectively. In the third stage, Alero Kal and Pamuca Parishes were selected randomly each from

the two selected sub-counties. In the fourth stage, two villages (Atocon, Gei) and (Layamo, Amee) were randomly selected from Alero Kal and Pamuca respectively. In the last stage, a total of 90 and 75 respondents each were randomly selected from Atocon and Gei villages respectively, this selection was dependent on the proportion of maize farmers in the villages while a total of 55 and 50 respondents were randomly selected from Layamo and Amee villages respectively making a grand total of 270 respondents across the study areas (Figure 4).

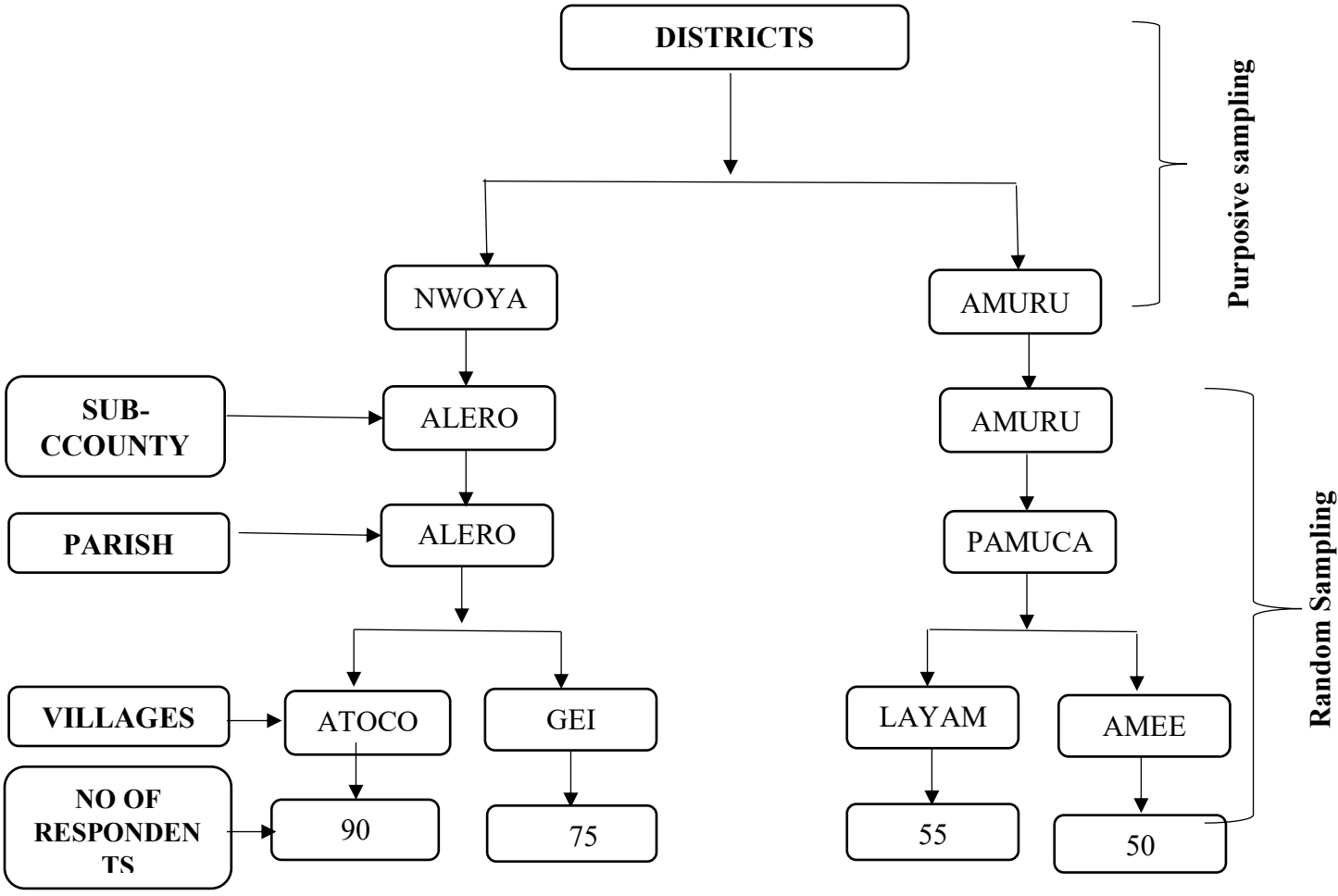


Figure 3.2: Adopted Multistage sampling procedure for this study

3.5 Data collection

To collect the responses of maize farmers on their awareness, level, and extent of utilization of maize grain grades and standards, a well-structured, pre-tested questionnaire (Appendix III) was developed. It included both open-ended and close-ended questions to collect detailed information from maize farmers within the chosen study area, and it was administered by well-trained and carefully selected data collection research assistants. The open-ended questions were suitable for encouraging respondents to formulate their own answers, while close-ended questions allowed them to select a response from a predefined list of choices. The questionnaire was structured in the following way; the first section focused on socio-demographic factors such as respondents' age in complete years, education level based on years of schooling, distance to the market in kilometers (km), other income sources and household composition. The second section gathered information on the awareness of the recommended grades and standards which was captured using a five-point Likert scale. Additionally, farmers' knowledge on the EAC recommended grades based on the different attributes were also captured. The third section addressed farmers' participation in maize grading and standardization.

3.6 Reliability and validity

In order to guarantee the reliability and validity of the data, enumerators were trained on how to use the data collection instruments and how to enter the correct information. In a bid to enhance the validity and reliability of the data instrument, pre-testing was done before data collection. A total of 25 maize farmers were interviewed, 15 farmers from Alero sub-county, Nwoya District and 10 farmers from Amuru sub-county, Amuru District (10 Farmers). The data collected was cleaned, coded, and analyzed. All anomalies that emerged in the form of redundancies and omissions were corrected by restructuring the tool items affected.

3.7 Data Analysis

3.7.1 Objective One: Determine the demographic characteristics of the Maize farmers.

Descriptive statistics including frequencies, percentages, Chi-square, and T-test were used to analyze the socioeconomic, institutional, and market features of the maize farmers in Nwoya and Amuru districts in order to ascertain their demographic characteristics. Additionally, a comparison between the two districts was made using data on the demographics of the maize producers.

3.7.2 Objective two: To determine the factors influencing farmers awareness of recommended maize grades and standards

To determine the factors influencing farmers' awareness of recommended maize grades and standards, the data on farmers' awareness were captured by identifying if a farmer was "aware or not aware" of the recommended maize grades and standards, questions were set based on the various attributes of maize grades and standards by the EAC. A Probit model was used to analyze this objective in that the different attributes were the dependent variable in form of a dummy (0,1) and regressed with the outlined independent variables. The probit model was chosen over the Tobit or logit model to determine the probability of a farmer being aware or unaware, based on independent variables such as education, age, or market access. Since the dependent variable is binary rather than censored, and the underlying latent variable follows a normal distribution rather than a logistic distribution, the probit model is the most suitable option and it is expressed as follows in this model

$$Y_i(0,1) = \beta_0 + \beta_1 Age + \beta_2 Edu + \beta_3 Exp + \beta_4 HHS + \beta_5 A.Credit + \beta_6 Qty.prod + \beta_7 Memb.Corp + \beta_8 Ext.Serv + \beta_9 Incentives + \beta_{10} Market\ Information + \varepsilon_i \quad (3.2)$$

Where;

Y = Awareness (1 =Aware, 0 = not aware)

X_1 = Age (Years)

X_2 = Level of Education (Years)

X_3 = Farming experience (Years)

X_4 = Household Size (HHS)

X_5 = Access to Credit

X_6 = Quantity Produced (kg)

X_7 = Membership to cooperatives (1= Yes, 0 = No)

X_8 = Incentives

X_9 = Market information

ε_i = Error term

3.7.3 Objective three: Ascertaining the determinants of farmer's decision to utilize maize grades and standards

The farmers' decision to use, and the extent to which they used maize grades and standards were assessed using the Heckman two-stage selection model. This model was preferred because it accounts for the two-step decision-making process, corrects for sample selection bias, and handles the censored nature of the data. The model required the estimation of two equations: the first was the extent to which a farmer used maize grade and standards (level of participation), and the second was the question of whether or not they did so. The extent of utilization was subject to the decision to utilize the maize grades and standards. With the widely used inverse mill ratio (IMR), the Heckman technique is a very straightforward method for addressing sample selection bias (Hoffman and Kassouf, 2005).

This technique allowed for the estimation of the selection equation's first step using a probit model and the outcome equation's second step using an OLS regression. Equation illustrates how a Probit model predicted the likelihood that a particular farmer would use the maize grades and standards as shown in equation (3.3)

$$pr\left(Z_i = \frac{1}{w_i}, a\right) = \emptyset\big(h(w_i, a)\big) + \varepsilon_i \quad (3.3)$$

where, Z_i denotes an indicator variable which is equal to one for large scale maize farmers who utilize maize grades and standards, the standard normal cumulative distribution function is represented by $\emptyset$, w_i denotes the variables that influence the decision to use maize grades and standards, a denotes the coefficients to be estimated, and ε_i is the error term which is normally distributed with a mean of zero and a variance of σ^2. The variable z_i takes the value of 1 if the marginal utility that an individual farmer i, gets from utilizing maize grades and standards is higher than zero, and zero otherwise.

The standard normal cumulative distribution function is represented by $\emptyset$, w_i denotes the variables that influence the decision to use maize grades and standards, a denotes the coefficients to be estimated, and _i is the error term, which is normally distributed with a mean of zero and a variance of σ^2. Large-scale maize farmers who use maize grades and standards are indicated by the indicator variable Z_i. The variable z_i has a value of 1 if an individual farmer i gets a marginal utility from using maize grades and standards that is more than zero, and a value of 0 otherwise. This was expressed in Equation (3.4);

$$Z_i = aw_i + u_i \quad (3.4)$$

Where, Z_i is the latent level of utility the large-scale maize farmers obtain from utilizing maize grades and standards, $u_i \sim N(0,1)$ and,

$$Z_i = 1 \; if \; Z_i^* > 0 \quad (3.5)$$

$$Z_i = 0 \; if \; Z_i^* \leq 0 \tag{3.6}$$

In order to account for potential selection bias, a second regressor was introduced to the selection equation. The regressor used was the Inverse Mills Ratio (IMR). The IMR is determined as shown in equation 3.7;

$$\frac{\emptyset(h(w_i,\alpha))}{\emptyset(w_i,a)} \tag{3.7}$$

Where, the normal probability density function is $\emptyset$. The second stage equation is given by:

$$E = (Y_i/Z = 1) = f(x_i,\beta) + \lambda \frac{\emptyset(h(w_i,a))}{\emptyset(w_i,a)} \tag{3.8}$$

Where E is the expectation operator, γ is the (proportion) level of participation, x denotes the vector of explanatory variables influencing the level of utilization, and β is the matrix of the resultant coefficients to be estimated. Therefore, Y_i was expressed as in equation (3.9)

$$Y_i^* = \beta' x_i + \boldsymbol{\lambda}\gamma_i + u_i \tag{3.9}$$

Y_i^* is denotes those maize farmers who utilize maize grading and standardization, where $u_i \sim N(0,\sigma_u), (Z_i = 1)$, in this case $Y_i = Y_i^*$.

The model was estimated as in equation (3.10); the first step was for the decision on whether to utilize maize grades and standards of not;

$$P_{(0,1)} = \beta_0 X_0 + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots\ldots \beta_n X_n + e \tag{3.10}$$

Where Utilization is represented by 1 and non-Utilization is represented by 0, β_0 is a constant, $\beta_i \ldots\ldots\ldots n$ are parameters to be estimated X_{is} are vector of explanatory variables.

The second step which involves a decision to utilize maize grading and standardization was estimated by the use of Ordinary Least Squares (OLS) which is expressed in equation (3.11);

$$Y = \beta_0 X_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \ldots\ldots \beta_n X_n + e \tag{3.11}$$

Where Y denotes the level of participation in utilization of maize grades and standards, β_0 is the regression constant, $\beta_i \ldots \ldots n$ are coefficients estimated $X_{i\ldots\ldots\ldots\ldots n}$ denotes a vector of explanatory variables.

The study adopted a Heckman two-staged model. The model was ideal given that it addresses sample selection bias in an observational data. The model follows Heckman (1979) who suggested a two-step method that involved the estimation of a probit and a linear regression model. The first stage depicts the probability of the farmer utilizing the recommended maize grades and standards, this is presented in equations (3.12). The second stage depicts the extent a farmer utilizes the recommended maize grades and standards, this is presented in Equation (3.14)

$$P_i(0,1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \ldots \ldots \ldots + \beta_n X_n + \varepsilon \quad (3.12)$$

$$P_i(0,1) = \beta_0 + \beta_1 Age + \beta_2 Edu + \beta_3 Exp + \beta_4 HHS + \beta_5 A.Credit + \beta_6 Farm.Size + \beta_7 Qty.prod + \beta_8 Awarness + \beta_9 Memb.Corp + \beta_{10} Ext.Serv + \beta_{11} GradingEquip + \beta_{12} Incentives \quad (3.13)$$

$$Y_i = \beta_0 X_0 + \beta_1 X_1 + \cdots \ldots \ldots \ldots + \beta_n X_n + \varepsilon \quad (3.14)$$

$$Level\ of\ Utilization\ (Y_i) = \beta_0 + \beta_1 Age + \beta_2 Edu + \beta_3 Exp + \beta_4 HHS + \beta_5 A.Credit + \beta_6 Farm.Size + \beta_7 Qty.prod + \beta_8 Awarness + \beta_9 Memb.Corp + \beta_{10} Ext.Serv + \beta_{11} GradingEquip + \beta_{12} Incentives + \beta_{13} Proximity\ WH + \beta_{14} IMR + \varepsilon_i \quad (3.15)$$

Where: Pi (0,1) represents the probability of utilization by farmers (1 = utilization, 0 = non-utilization), Y = level of utilization. The variables used in Heckman two stages are further described in Table 3.1.

Table 3.1: Description of variables and *a priori* expectations

Variables	Description	Apriori expectations			Citation
		Extent of Utilization	Decision to Utilize	Awareness	
Age	Age of Farmers (Years)	+	+	+/-	(Rahman, *et al*., 2021)
Education	Years spent in school (years)	+	+	+	
Farming experience	Farming experience of farmer (years)	+/-	+	+	(Sunny, *et al*., 2022)
Household size	Number of persons in a household of farmers	+/-	+/-	+/-	
Access to Credit	Credit access by farmers (Yes =1, otherwise	+	+	+/-	(Sunny, *et al*., 2012)
Farm Size	(0)	+	+	N/A	
Quantity Produced	Size of farm cultivated by farmers in hectares	+/-	+	+	(Akidi, 2016)
Level of Awareness	Quantity of maize produced in Kg	+/-	+	N/A	(Akidi, 2016)
Membership to Cooperatives	Awareness in maize grading (Yes=1, No=0)	+/-	+/-	+	(Munialo *et al*., 2019)
	Membership to a group (Yes =1, otherwise = 0)	+	+	+	(Buckland *et al*., 2021)
Access to Ext. Services	Access to extension service (Extension agents	+	+	N/A	
	=1, NGOs =2, Universities =3, BDS =4)	+	+	N/A	(Munialo *et al*., 2019)
		+	+	+	
Access to Equipment	Access to maize grading equipment	N/A	N/A	+	(Munialo *et al*., 2019)
Proximity WH	Proximity to the warehouses				
Incentives (Premium Prices)	Incentives in form of high profits				(Sunny *et al*., 2012)
Market Information	Market Information				(Maku *et al*., 2022)

3.8 Ethical Consideration

The study adhered to all legal and ethical research requirements in Uganda. It received approval from the Gulu University Research Ethics Committee (GUREC) prior to commencement (refer to Appendix IV) and consent from the Chief Administrative Officers of the two study districts for the research to be conducted in the designated areas. Informed consent was obtained from all respondents who signed consent forms before participating in the interviews. The study ensured that both participants and research assistants worked in a safe and supportive environment, with strict respect for human rights. To protect privacy and confidentiality, the principle of voluntarism was followed, and respondents' information was kept highly confidential. In order to avoid

plagiarism and fraud, the researcher properly cited all references. Additionally, all study resources were used responsibly, and the results will be published to benefit all stakeholders.

3.9 Limitations of the study

The major limitation encountered in this study was from the Data collection tool. As a non-Ugandan, a structured questionnaire designed in English was to be administered to illiterate /semi-literate respondents. This could have an adverse effect on the quality of responses. However, this was checked by selecting well educated, trained and native speaking research assistants who were in a position to translate the survey tool items into Acholi language.

CHAPTER FOUR: RESULTS

4.1 Socio-economic characteristics of maize farmers by District

According to the findings, maize was produced in the Nwoya and Amuru areas by both men and women (Table 4.1). There was a substantial correlation between district and gender, as shown by the chi-square result for the association between district and gender ($p<0.01$). Compared to their single counterparts, married household heads produced more maize. The chi-square analysis of the relationship between district of residence and marital status revealed a statistically significant relationship ($p<0.05$) between the two variables. More married household heads lived in Nwoya district than Amuru district, specifically.

The vast majority of maize farmers had ready access to markets with Amuru district having higher level of market access (84.1%) compared to Nwoya district (78.7%). Most maize farmers had access to extension services. The chi-square results for the association between district of residence and access to extension services displayed that there was a significant association ($p<0.10$) between district and access to extension service. Specifically, farmers in Nwoya district had access to more extension services (69.1%) compared to their counterparts in Amuru district (57.3%).

In addition, most farmers had access to credit accounting for 77.1% and 79.3% in Nwoya and Amuru districts respectively. Majority of maize farmers in both districts are members of farmers' associations or cooperative societies. Furthermore, most of the farmers acquired their farm inputs from Agro dealers ($p<0.01$) while improved varieties of maize were most grown by maize farmers in the two districts. Moreso, majority of maize farmers in both districts were not aware of maize grading and standardization. There was a significant association between the awareness about maize grading and standardization and maize production in the two districts. In terms of

participating in maize grading and standardization, majority of farmers in Nwoya and Amuru did not participate.

Table 4.1: Comparison of categorical variables for maize farmers' socio-economic characteristics by district

Variables	Overall N=270	Amuru N=82	Nwoya N=188		
	Freq (%)	Freq (%)	Freq (%)	χ^2	Sig
Gender					
Male	121 (44.8)	12 (14.6)	109 (58.0)	43.374***	0.000
Female	149 (55.2)	70 (85.4)	79 (42.0)		
Marital Status					
Married	237 (87.8)	66 (80.5)	171 (91.0)	5.834**	0.025
Unmarried	33 (12.2)	16 (19.5)	17 (9.0)		
Ready Access to Market					
Yes	217 (80.4)	69 (84.1)	148 (78.7)	1.064	0.324
No	53 (19.6)	13 (15.9)	40 (21.3)		
Access to Credit					
Yes	210 (77.8)	65 (79.3)	145 (77.1)	0.151	0.752
No	60 (22.2)	17 (20.7)	43 (22.9)		
Access to Extension Services					
Yes	177 (65.6)	47 (57.3)	130 (69.1)	3.540*	0.070
No	93 (34.4)	35 (42.7)	58 (30.9)		
Membership in Farming Association/Cooperative Society					
Yes	199 (73.7)	60 (73.2)	139 (73.9)	0.017	0.882
No	71 (26.3)	22 (26.8)	49 (26.1)		
Sources of farm inputs					
Governments	29 (10.7)	3 (3.7)	26 (13.8)	7.970**	0.019
NGOs	55 (20.4)	14 (17.1)	41 (21.8)		
Agro dealers	186 (68.9)	65 (79.3)	121 (64.4)		
Maize varieties grown					
Improved varieties	145 (53.7)	47 (57.3)	98 (52.1)	0.828	0.661
Local varieties	104 (38.5)	30 (36.6)	74 (39.4)		
Both varieties	21 (7.5)	5 (6.1)	16 (8.5)		
Awareness about maize grading and standardization					
Aware	109 (40.4)	19 (23.2)	90 (47.9)	14.472***	0.000
Not aware	161 (59.6)	63 (66.8)	98 (52.1)		
Participation in maize grading and standardization					
Yes	66 (24.4)	3 (3.7)	63 (33.5)	27.549***	0.000
No	204 (75.6)	79 (96.3)	125 (66.5)		

Source: Field survey 2023; χ^2 denotes Pearson chi-square coefficient; *** and ** indicates significance at 1% and 5% respectively

4.2 Socio-economic characteristics of maize farmer by Awareness of grades and standards

The findings from Table 4.2, shows that majority of farmers who were aware of maize grades and standards were male (51.4%), compared to their female counterparts (48.6%). There was a notable association between gender and awareness, as indicated by the chi-square result ($p < 0.10$). Married household heads (87.2%) were more likely to be aware of the recommended maize grades and standards compared to unmarried heads (12.8%).

Table 4.2: Comparison of categorical variables for maize farmers' socio-economic characteristics by Awareness of grades and standards

Variables	Overall	Aware	Not Aware		
	N=270	N=109	N=161		
	Freq (%)	Freq (%)	Freq (%)	χ^2	Sig
Gender					
Male	121 (44.8)	56 (51.4)	65 (40.4)	3.182*	0.074
Female	149 (55.2)	53 (48.6)	96 (59.6)		
Marital Status					
Married	237 (87.8)	95 (87.2)	142 (88.2)	0.066	0.797
Unmarried	33 (12.2)	14 (12.8)	19 (11.8)		
Ready Access to Market					
Yes	217 (80.4)	93 (85.3)	124 (77.0)	2.840**	0.092
No	53 (19.6)	16 (14.7)	37 (23.0)		
Access to Credit					
Yes	210 (77.8)	90 (82.6)	120 (74.5)	2.428	0.119
No	60 (22.2)	19 (19.4)	41 (25.5)		
Access to Extension Services					
Yes	177 (65.6)	85 (78.0)	92 (57.1)	12.500***	0.000
No	93 (34.4)	24 (22.0)	69 (42.9)		
Membership in Farming Association/Cooperative Society					
Yes	199 (73.7)	81 (74.3)	118 (73.9)	0.035	0.852
No	71 (26.3)	28 (25.7)	43 (26.7)		
Sources of farm inputs					
Governments	29 (10.7)	17(15.6)	12 (7.5)	4.885**	0.087
NGOs	55 (20.4)	19 (17.4)	36 (22.4)		
Agro dealers	186 (68.9)	73 (67.0)	113 (70.2)		
Maize varieties grown					
Improved varieties	145 (53.7)	64 (58.7)	81 (50.3)	2.340	0.310
Local varieties	104 (38.5)	36 (33.0)	68 (42.2)		
Both varieties	21 (7.5)	9 (8.3)	12 (7.5)		

Source: Field survey 2023; χ^2 denotes Pearson chi-square coefficient; *** and ** indicates significance at 1% and 5% respectively

Most maize farmers with ready access to markets (85.3%) were aware of maize grades and standards, compared to those without access (14.7%). The chi-square analysis revealed a statistically significant relationship between market access and awareness ($p < 0.10$). Additionally, 78.0% of farmers aware of the recommended grades and standards had access to extension services, while 22.0% did not. The chi-square results for this association showed a strong link between awareness and access to extension services ($p < 0.001$).

Furthermore, 82.6% of farmers who were aware had access to credit, compared to 17.4% who were not aware. A majority of aware farmers were also members of farmer associations or cooperatives. Lastly, most farmers who were aware obtained their farm inputs from the government ($p < 0.10$), while improved maize varieties were more commonly grown by those who were not aware of the recommended grades and standards.

Results from Table 4.3 compared the characteristics of maize farmers in the districts of Nwoya and Amuru. In Nwoya and Amuru, maize farmers are on average 38.3 and 36.7 years old, respectively. The average household size and educational level of maize farmers in Nwoya and Amuru were seven people and seven years, respectively. The t-test result for mean equality showed a statistically significant difference between districts in the mean years of schooling ($p<0.05$). On average, farmers in both districts had eight years of experience growing maize.

Table 4.3: Comparison of continuous variables for maize farmers' characteristics by district

Variable	Mean			Mean difference	Sig
	Overall N=270	Nwoya N=188	Amuru N=82		
Age	37.8	38.3	36.7	-1.530	0.575
Years of education	15.6	7.9	7.7	- 0.278**	0.042
Household size	13.6	6.9	6.7	-0.210	0.876
Years of experience	8.2	8.1	8.4	0.247	0.608

Source: Field survey 2023; ** denotes p-value < 0.05

4.2 Factors influencing farmers' awareness of the recommended maize grades and standards

In this study, a probit regression model was used to determine factors that influence farmers' awareness of the recommended maize grades and standards. The likelihood ratio was highly significant ($p<0.01$), implying the model has a high level of explanatory power, as shown by its Chi-square value of 0.2117. The model fit was significant, meaning that it was fit. The mean Variance Inflation Factor (VIF) test VIF was 1.22. The VIF values for the independent variables in the awareness model were less than 2, signifying that multicollinearity was not severe. Five variables were shown to have a significant impact on awareness. These were education, access to extension services, credit, association membership, and gender (male). While the equation's coefficients that had no obvious significance were only employed to make the most of the likelihood function. Additionally, the marginal effects of the probit model findings were generated and used to interpret the outcomes. The findings indicated that factors such as education ($p<0.10$), access to extension services ($p<0.01$), credit accessibility ($p<0.10$), gender (male) ($p<0.05$), and association participation ($p=0.05$) all had a positive and substantial influence on farmers' awareness. However, age, access to market information, and marital status did not influence farmers' awareness of the recommended maize grades and standards.

Table 4.4: Marginal Effects of the probit regression on factors influencing awareness of recommended grades and standards in maize

Variables	Coefficient (SE)	Marginal effect (SE)	p-values
Age	-0.006(0.007)	-0.002(0.002)	0.385
Education	0.045(0.025)	0.016(0.009) *	0.077
Access to extension service	0.682(0.195)	0.244(0.065) ***	0.000
Access to credit	0.369(0.223)	0.132(0.079) *	0.098
Membership of association	0.480(0.219)	0.172(0.077) **	0.029
Access to market information	0.212(0.266)	0.076(0.095)	0.426
Marital status (married)	-0.272(0.252)	- 0.097(0.090)	0.282
Gender (Male)	0.340(0.166)	0.122(0.580) **	0.041
Constant	-1.327(0.500)		0.008
Log-likelihood	-169.337		
p-value	0.001		
Number of observations	270		
Pseudo R^2	0.0701		
GOF Pearson Chi^2 (242) = 259.35; Prob > Chi^2 = 0.2117			
Mean VIF	1.22		

Source: Field survey, (2023); ***, ** and * infers significance at 1%, 5%, and 10% respectively

4.3 Determinants of farmers' decision to utilize and the extent of utilization of maize grades and standards

4.3.1 Determinants of farmers' decision to utilize maize grades and standards

To identify the factors that influence farmers' decisions to apply maize grades and standards, a probit regression model was used. The likelihood ratio was highly significant ($p<0.01$), which suggests that the model's explanatory power was strong, according to the chi-square result (0.1252). The model fit, as indicated by the robust goodness of fit. On the average, Variance Inflation Factor was 1.21 which indicates there was no severe multicollinearity as the VIF values

for each of the explanatory variables in the regression were all less than 4. Four variables had substantial effect on farmers' decisions to utilize maize grading and standardization. These are membership of association, Farmers awareness on grades and standards, distance to input markets, and access to extension services. Since there was no direct interpretation of the coefficients of the model, they were only used to maximize the loglikelihood of the function. To aid in the understanding of the findings, the marginal effects of the probit regression were computed. Awareness on grades and standards ($p<0.01$) and access to extension services ($p<0.01$) were statistically significant predictors of farmers' decisions to use maize grade and standards, whereas association membership ($p=0.05$) and distance to the input market ($p<0.05$) had a significant but negative effect on the farmers' decisions to use maize grades and standards. However, access to credit, education, and household size did not influence farmers' decision to utilize recommended maize grades and standards.

Table 4.5: Marginal Effects of the probit regression model on determinants of utilization of maize grades and standards

Variables	Coefficient (SE)	Marginal effect (SE)	p-values
Education	-0.028(0.295)	-0.006(0.006)	0.345
Household size	0.026(0.332)	0.006(0.007)	0.426
Access to credit	0.108(0.269)	0.023(0.058)	0.687
Membership of association	-0.417(0.250)	-0.089(0.053) *	0.095
Awareness	1.312(0.209)	0.281(0.036) ***	0.000
Distance to the market	-0.038(0.016)	-0.008(0.003) **	0.020
Access to extension service	0.958(0.324)	0.205(0.066) ***	0.003
Constant	-0.805(0.471)		0.087
Log-likelihood	-103.841		
P-value	0.000		
Number of observations	270		
Pseudo R^2	0.3085		
GOF – Pearson Chi^2 (236) = 261.15; Prob> Chi^2 = 0.1252			

Mean VIF	1.21

Source: Field survey, (2023); ***, ** and * implies significance at 1%, 5%, and 10% respectively

4.3.2 Determinants of the extent of utilization of maize grading and standardization among farmers

OLS regression model was used to determine the drivers of the extent of maize grading and standardization among farmers. The Breusch-Pagan test of independence which was used to test for heteroskedasticity confirmed the existence of correlated error terms. The adjusted R^2 (0.726) showed that 72 % of the variation in the extent of maize grading and standardization was explained by the independent variables. The mean VIF for the Variance Inflation Factor (VIF) test was 2.44. The VIF values for all of the independent variables in the model were less than 4, indicating that the quantity of multicollinearity was not severe. Five variables were revealed to posted a significant influence on farmers' maize grading and standardization levels. These are quantity of maize produced, household size, membership of association, education, and awareness. Positive statistically significant predictors of the extent of maize grading and standardization among farmers were quantity of maize produced ($p<0.01$), education ($p<0.10$), and awareness ($p<0.10$) whereas membership of association ($p<0.05$), and household size ($p<0.05$) negatively and significantly influenced the extent of maize grading and standardization among farmers. The negative but significant IMR implies that the error term of both the selection and outcome equation are negatively correlated. The Heckman two step model was therefore appropriate because this demonstrates the existence of a sample selection bias. In other words, when it comes to maize grading and standardization, there is a noticeable disparity between participating and non-participating farmers.

Table 4.6: OLS regression model results of the extent of utilization of maize grading and standardization among farmers

Variable	Coefficients	Std error	P-Values
Quantity of maize produced	0.220 ***	0.900	0.015
Household size	-0.836 **	0.402	0.038
Membership of association	-1.141 **	0.362	0.002
Land size for maize prod.	0.039	0.087	0.656
Education	0.507 *	0.280	0.071
Age	0.514	0.536	0.339
Source of input (NGO)	-0.436	0.372	0.242
Awareness	1.238 *	0.756	0.102
Constant	6.607	2.366	0.006
Lambda (IMR)	-3.719	0.584	0.000
P-value	0.000		
Adjusted R2	0.7256		
Mean VIF	2.44		

Source: Field survey, (2023); *, **, and *** indicates significance at 10%, 5%, and 1% respectively

CHAPTER FIVE: DISCUSSIONS

5.1 Socio-economic characteristics of maize farmers by District

According to the result in Table 4.1, women made up the majority of the maize growers in both areas. Compared to Nwoya, Amuru has more female farmers. In the two districts, there was a correlation between gender and maize production as indicated by the matching chi-square p-value, which is significant at 1%. This finding implies that gender plays a crucial role in maize production, it further suggests that gender may influence factors like access to resources, decision-making, or involvement in maize production activities. The bulk of the maize farmers, according to the study's findings, were married and lived in the Nwoya areas. This would suggest that farmers began growing maize in order to provide for their families. These findings concur with those of Yassoungo et al. (2018), who claimed that 99% of maize farmers in Mali were married. The production of the maize crop and marital status were highly correlated in the two districts.

Most of the maize farmers reported that they had ready access to markets. This could be as a result of the proximity of their farms to the marketplace. Many of the maize farmers also reported that they had access to credit. A similar study carried out by Midamba (2022) on the determinants of maize income in western Uganda indicated that 73.5% of maize farmers had access to credit. In order to boost agricultural productivity, expand farming enterprises and ensure timely access to crucial inputs, access to agricultural credit is indispensable.

In terms of access to extension services, most of the maize farmers had access to both government and NGO-led extension services with its chi-square value indicating a significant association between access to extension services and maize production in the two districts. This indicates that access to extension services plays a crucial role in improving maize farming outcomes. It implies

that Farmers who receive guidance and support from extension officers are likely to implement better farming techniques, improve productivity, and possibly adopt new technologies or best practices. This is consistent with the findings of Midamba (2022) who found out that 85.5% of maize farmers had access to extension services. Extension service is paramount in crop production as it helps to provide farmers with up-to-date information and novel techniques to ensure optimum production although it may come with a cost sometimes. Seasoned extension agents with adequate knowledge of maize grades and standards can definitely help farmers understand the peculiarity of productivity enhancing inputs.

Majority of maize farmers in both districts belonged to either a farmer group or cooperative society. This result counters that of Onuk *et al*. (2010) who discovered that 84.4% of maize farmers did not belong to any cooperative. Farmer group associations and cooperatives could provide the opportunity for bulk sales and bargaining power as well as share information on maize grades and standards.

Most maize farmers in Nwoya and Amuru districts commonly sourced their inputs from Agro dealers. There was a significant association between sources of farm inputs and maize production in the two districts. This implies that the availability and type of farm inputs—such as seeds, fertilizers, and tools—are strongly linked to the levels of maize production. It was further reported that the improved varieties of maize were commonly grown by farmers followed by the local variety of maize. Additionally, majority of maize farmers in both districts were not aware of maize grading and standardization. There was a significant association between the awareness about maize grading and standardization and maize production in the two districts. In terms of participating in maize grading and standardization, majority of farmers in both study districts did

not participate. This could be as a result of their lack of proper awareness of maize grading and standardization and the benefits thereof.

5.2 Socio-economic characteristics of maize farmers by Awareness

According to the result in Table 4.2, The findings indicate that a majority of farmers aware of maize grades and standards were male (51.4%) compared to females (48.6%), with a significant gender association at 10%. Additionally, married household heads (87.2%) were more likely to be aware than unmarried heads (12.8%). These results suggest a need for targeted interventions to increase awareness among female and unmarried farmers, potentially through gender-sensitive programs and inclusive training to ensure all farmers have equal access to vital agricultural information. This consistent with the findings of Ragasa et al. (2013) who demonstrated that gender and married farmers had a positive influence on the access to agricultural services especially the male headed households

From the results, most maize farmers with ready market access (85.3%) were significantly more aware of maize grades and standards than those without access (14.7%), with a statistically significant relationship between market access and awareness at 10%. Additionally, farmers with access to extension services (78.0%) had a much higher awareness compared to those without access (22.0%), with a strong and highly significant association at 1%. These findings imply that improving market access and strengthening extension services are crucial for increasing farmers' awareness of agricultural standards, which can lead to better practices and higher productivity. This study conforms with the findings of Kudi et al (2011) on analysis of adoption of improved maize varieties among farmers in Kwara State, Nigeria which revealed that most farmers who were aware of the improved maize varieties also had access to extension services.

Furthermore, results show that 82.6% of farmers who were aware of maize grades and standards had access to credit, and a majority were members of farmer associations or cooperatives. Most aware farmers obtained their inputs from the government ($p < 0.10$), while those unaware tended to grow improved maize varieties. These findings suggest that access to credit, involvement in associations, and government input programs are linked to greater awareness. However, farmers using improved maize varieties may require targeted education on recommended grades and standards to enhance their understanding and practices. Furthermore, this finding aligns with the results of Mazher et al (2003) which revealed a positive association between farmers membership to cooperatives and their awareness on recommended sugarcane production technologies. Obayelu & Ajayi, (2018) revealed that the majority of maize farmers who were aware of the improved maize production technologies also used improved maize seed varieties and organic fertilizer.

Table 4.3 showed the mean age of maize farmers in both districts, implying that the majority of the farmers were agile, youthful, and strong enough to carry out the maize producing activity, which is often capital intensive and arduous to manage. Oladejo and Adetunji (2012) in a similar study reported that the mean age of maize farmers was 45.8 years. The mean years of education of maize farmers in both districts was 8 years. The number of years they spent in school suggests that farmers had some education that enabled them to evaluate input and market-related information for increased output. This contradicts the findings of Ajambo *et al*. (2017) whose study on farmers preference for maize attributes in eastern Uganda reported a low level of education among maize farmers.

Furthermore, maize farmers in both districts had an average of 7 household members. The implication of this is that household members could serve as a source of farm labour especially in

carrying out the grading process which involves categorizing the maize grains and this would immensely help reduce the cost incurred in hiring farm labour for their maize production enterprise. A comparable study conducted by Adenegan *et al*. (2012) on determinants of market participation of maize farmers in Osun State Nigeria reported an average household member of 10 members.

In terms of years of experience, the mean was approximately 8 years of farming experience for maize farmers in the two districts. The high years of experience could afford them some level of managerial ability to make certain farm management decisions that can enhance output. This is similar to the findings of Girei et al. (2018) who reported 8 years as the mean years of farming experience of maize farmers in Nasarawa State, Nigeria.

5.2 Factors influencing farmers' awareness of the recommended maize grades and standards

Table 4.4 showed that increase in the number of years spent in school increased the likelihood of farmers' awareness by 1.6%. This could be attributed to the fact that, as more educated farmers are actively seeking knowledge related to improved technology in crop production, they tend to gain awareness. These findings are consistent with Muatha *et al*. (2017), who noted that formal education positively improved farmers' awareness of extension devolution. Farmers' capacity to process and apply knowledge improves as their education level rises. According to Ado *et al*. (2019), years of schooling significantly and favorably increased farmers' awareness on the perception of climate change impacts.

Farmers' awareness of the recommended maize grades and standards was positively and significantly associated with access to extension services. Farmers who used extension services were 24.4% more likely to be aware of recommended grades and standards than those who did not use extension services. This implied that extension service helps to keep farmers up to date with the latest trends, novelties and technological advances in agriculture, particularly in crop production. This finding correlates with those of Ullah *et al*. (2022) who conducted similar studies in Pakistan which resolved that there was a significant relationship between farmers' awareness of improved wheat varieties and their access to extension service providers. Extension agents play a very significant role in farmers' awareness and adoption of certain agricultural technologies (Meijer *et al*., 2015).

Furthermore, findings showed that gender had a substantial connection with farmers' awareness of the recommended maize grades and standards. The male gender was 12.2% more likely to be aware of the recommended maize grades and standards than their female counterparts implying that male-headed households were better exposed to information on maize grades and standards. This supports the findings of Ofuoku and Campus (2011) who reported that households headed by males were more likely to perceive climate change than those headed by females. However, Adekoya and Ajayi (2000) reported that gender did not have a significant relationship with awareness on practices of land management techniques among farmers.

Access to credit had a significant influence on farmers' awareness of the recommended maize grades and standards. Farmers who had access to credit were 13.2% more likely to be aware than those who did not have access to credit. This finding could be because of the fact that higher access to credit facilities increases their likelihood of exploring farm activities that could yield more

returns to them. Results concur with Ullah et al. (2022) whose findings indicated that credit access improved farmers' awareness of extension-recommended wheat varieties. Poverty is the primary source of farmers' low levels of knowledge and poor adoption decisions, whereas credit helps farmers overcome financial obstacles and gives them access to agricultural innovations (Ullah et al., 2022).

Further, findings revealed that farmers who are members of an association or cooperative society were more likely to be aware of the recommended maize grades and standards than those who are not members of any association or cooperative society. This emphasizes the role farmer groups play in bringing agricultural information to their members. This is in agreement with the findings of Buckland and Campbell (2021) who indicated that participation in groups and associations had a positive influence on climate service awareness. Alhassan *et al*. (2018) also reported that membership of a farmer-based organization was a significant determinant of farmers' awareness of indigenous adaptation strategies.

5.3 Determinants of farmers' decision to utilize and their extent of utilization of maize grades and standards

5.3.1 Determinants of farmers' decision to utilize maize grades and standards

The result (Table 4.5) showed that farmers who were aware of recommended maize grades and standards were more likely to utilize maize grading and standardization. People who are aware of something and its potential benefits are more likely to utilize/adopt it than those who lack the awareness. This finding correlated with the findings of Sunny *et al*. (2022) who noted that

environmental awareness significantly and positively influenced the adoption of solar irrigation facilities.

It was further discovered that farmers were more likely to choose to adopt maize grades and standards the closer they lived to the market. This could be because the proximity of maize farmers to the market encourages them to utilize maize grading and standardization. Also, they will not have to spend a huge chunk of their profit on transportation which might discourage their adoption of the recommended grades and standards (Mukisa et al., 2022). The findings are related to the findings of Kelebe *et al*. (2017) that reported that a household's decision to adopt biogas technology was negatively influenced by distance to market.

A negative but significant relationship was observed between the probability of farmers' decision to utilize maize grades and standards and membership of association. Although farmers may be aware of the existence of these improved varieties, their collective lifestyle in a farmer group which complies them to collectively make decisions might negatively influence their adoption rate. For instance, farmers who lack interest or the requisite knowledge on the grades and standards can discourage those who are interested. Also, because they collectively sell their products in bulk, if the market they service do not have a high demand for graded maize, this can negatively influence their interest to utilize grades since they are more interested in increasing their profit margin (Simtowe et al. 2016).

It was observed that farmers who had access to extension services had a higher probability of deciding to utilize maize grading and standardization than those who had no access to extension services. The findings could be attributed to the fact that extension agents are key to the participation of farmers in maize grading and standardizations. Orientations and training provided

through extension services afford farmers the opportunity to decide to utilize maize grades and standards. Study findings are consistent with those of Beshir (2014) who conducted a similar study and attributed the probability of adoption of improved forages in Ethiopia to the availability of extension services. Martey et al. (2020) also reported that farmers' adoption of drought-tolerant maize is influenced by their access to extension services.

5.3.2 Determinants of the extent of utilization of maize grades and standards among farmers

The result (Table 4.6) shows that the quantity of maize produced significantly exerted a positive influence on the extent of maize grading and standardization. This implied that the more the quantity of maize produced, the more the possibility of maize grading and standardization. Mahoussi et al. (2021) reported that maize yield significantly and positively influenced the intensification of the use of improved maize seeds among farmers.

Furthermore, it was discovered that the extent of maize grading and standardization increased with decreasing household size. This could be that farmers who had fewer numbers of household members resulted to fewer financial burdens and thus were able to invest more in maize grading and standardization. Results are contrary to the findings of Udumezue et al. (2024) whose findings on the Adoption of improved sweet Potato production technologies reported that household size positively and significantly influenced the extent of adoption of improved potato technologies among farmers in Nigeria.

Membership in farmers' associations significantly exerted negative influenced the extent of maize grading and standardization. The finding suggests that farmers who are members of farmers'

associations tend to engage less in maize grading and standardization compared to non-members. This negative influence could be due to various factors, such as less emphasis on individual quality control within associations or other priorities that overshadow grading practices. Rahman and Majumder (2021) reported a negative association between membership in farmers' associations and the adoption of agricultural technology. It was asserted that adoption depends on the nature of technology and members' characteristics. It also depends on the connectedness of the society or association with agricultural activities. Farmers could be spending time fulfilling their roles in an organization that is not centered on agricultural activities which may prevent them from adopting certain technologies (Rahman and Majumder 2021). These factors could equally be affecting the intensity or extent of maize grading and standardization among farmers.

Education significantly exerted positive influence on the extent of maize grading and standardization. This implied that the more the years spent in school, the higher their ability to involve in maize grading and standardization. Educated farmers recognize the benefits of maize grading and standardization and can commit their resources to it. This aligns with the findings of Kebedom and Ayalew (2012) who reported that years of school had a positive and significant effect the intensity of use of coffee technology packages among farmers in Ethiopia

In addition, it was discovered that the extent of maize grading and standardization increased with the level of awareness of maize grades and standards. Farmers who were aware of the various maize grades and standards, as well as its benefits, were more likely to participate in grading and standardization. Zondo (2020) reported that farmers' use intensity of organic fertilizers was positively influenced by their knowledge of organic fertilizers.

Finally, according to the model output, the Inverse Mills Ratio (IMR) which accounted for selectivity bias was found to be negative and statistically significant. This suggests that there was an inverse relationship between the unobserved factors and the independent variables influencing the extent of use of maize grades and standards. The marginal significance at ($p = 0.000$) suggests the presence of selection bias which therefore justifies the use of the Heckman two stage model to correct for this selection bias.

CHAPTER SIX: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 Summary

The goal of the study was to determine whether maize farmers in northern Uganda's Nwoya and Amuru districts were aware of and using grades and standards. The study specifically sought to identify the characteristics of maize farmers, pinpoint what influences their knowledge of suggested grades and standards, and pinpoint what influences their choice to use such grades and standards. In the districts of Nwoya and Amuru, a cross-sectional study was conducted with 270 maize farmers using pretested structured questionnaires. The data were analyzed using descriptive statistics, the probit model, and Heckman's two-stage model.

A substantial correlation was found between the districts and both gender and marital status using the descriptive analysis's chi-square test. The data also revealed that the majority of maize farmers had easy access to markets, with Amuru district having greater market access than Nwoya district. Extension services were available to the majority of maize producers. Particularly, farmers in the Nwoya district had better access to extension services than their counterparts in the Amuru district. The majority of farmers in the two districts also had access to credit, and both districts' maize growers are primarily members of cooperative societies or farmers' associations. However, a majority of farmers in both districts were unaware of maize grading and standardization, and participation in these practices was low. There was a significant association between awareness of grading and standardization and maize production.

In addition, the findings indicate that male farmers (51.4%) were slightly more aware of maize grades and standards compared to females (48.6%), with a significant gender association ($p <$

0.10). Married household heads (87.2%) showed higher awareness compared to unmarried ones (12.8%). Access to markets significantly influenced awareness, with 85.3% of those with market access being aware ($p < 0.10$). Additionally, 78.0% of farmers who had access to extension services were aware of maize standards ($p < 0.001$), and 82.6% of those aware also had access to credit. Membership in farmer associations, government-provided inputs, and the use of improved maize varieties were further linked to awareness of maize grades.

Education, access to extension service, access to credit, membership of association, and gender (male) were the factors influencing farmers' awareness of the recommended grades and standards. However, these factors influenced household awareness of maize grades and standards. differently (negative or positive). Membership of association, awareness, distance to input market, and access to extension service significantly influenced farmers' decision to utilize maize grades and standards while the extent of maize grading and standardization was influenced by the quantity of maize produced, household size, membership of association, education, and awareness.

6.2 Conclusions

The study determined the demographic characteristics of the maize farmers, established the factors influencing farmers' awareness of the recommended grades and standards and ascertained the determinants of farmers' decision to utilize and the extent of utilization of maize grades and standards in Nwoya and Amuru districts, northern Uganda.

Farmers in both districts were unaware of maize grading and standardization, and their participation in maize grades and standards were low. In terms of farmers' awareness of the

recommended maize grades and standards, the probability of awareness increased with increasing education, credit access, access to extension service, male gender, and membership of association.

With regards to farmers' decision to utilize maize grades and standards, the probability of farmers' decision to utilize increased with awareness and access to extension service and decreased with increasing distance to input market and membership of association.

The extent of maize grading and standardization increased with an increasing quantity of maize produced, increasing education and awareness. Nonetheless, it decreased with increasing household size and membership of association.

6.3 Recommendation

6.3.1 Policy recommendations

Policymakers, NGOs, and other stakeholders might consider the following for implementation in order to improve the utilization of grades and standards among maize producers in Uganda.

Because the findings indicates that farmers in both districts had low level of awareness and participation in maize grades and standards, we recommend that sensitization programs should be organized by the Ugandan government and relevant stakeholders to create more awareness about maize grades and standards and the benefits farmers can derive from its utilization.

Findings of the study indicated that access to extension service increases farmers awareness as well as drives their decision to utilize maize grades and standards, there we recommend that extension services tailored to maize grading and standardization should be made available to maize farmers to enable participation and enhance output and to bridge the information gap between research institutes and the farmers (end users of research findings).

The results shows that access to credit can increase farmers awareness, thus Policies that would ensure sufficient access to credit by maize farmers should be enacted. Maize farmers should also be encouraged to use credit obtained judiciously for the expansion of their maize produce and not for other purposes

From the result, distance to the market tends to negatively influences farmers decision to utilize maize grading, therefore programs that would ensure the proximity of grading and standardization stations to maize farmers should be implemented so as to enable them to participate.

As results indicated a negative influence of the membership groups on farmer awareness and participation in grading, we therefore recommend that resource pooling activities related to maize grading and standardization should be encouraged in farmers' cooperative groups and associations so as to enhance productivity.

6.3.2 Recommendations for further studies

First, this investigation adopted a cross-sectional methodology to assess the knowledge and application of grades and standards among maize farmers in the northern Ugandan districts of Nwoya and Amuru. Therefore, it is crucial to verify the accuracy of the findings by comparison studies of the knowledge and application of grades and standards by maize farmers in various regions of Uganda because the findings may be unique to some places based on a variety of factors.

Other studies are recommended to ascertain the awareness and utilization of grades and standards by farmers of other crops including cereals, pulses and legumes in all regions of Uganda.

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APPENDICES

Appendix I: Informed consent document

Title of the study: AWARENESS, UTILIZATION OF GRADES AND STANDARDS AMONGMAIZE FRMERS IN NWOYA AND AMURU DISTRICTS.

University: GULU UNIVERSITY

Introduction

I'm Onyinyechi Kalu, a graduate student at Gulu University in Uganda's Faculty of Agriculture and Environment in the Department of Rural Development and Agribusiness. The topic I am researching is "**Awareness, Utilisation of Grades and Standards Among Maize Farmers in Nwoya and Amuru Districts, Northern Uganda**." The goal of this academic study is to better understand how well-informed maize farmers in the Nwoya and Amuru districts are about grades and standards and how they use them. To participate in this survey, you were picked at random. Please be aware that the data you provide will be kept private and that it won't be possible to identify which data was given by you. We would appreciate it if you could answer our questions in about 30 minutes. Many thanks.

Sponsors of the Project

The funding for this project comes from Mastercard RUFORUM in partnership with Tagdev Gulu University.

Purpose

The aim of the study is to assess the level of awareness in addition to the level of utilization of Grades and Standards by Maize farmers in Nwoya and Amuru districts. The study will be a useful tool for agricultural researchers and will help farmers get the knowledge they need to increase their involvement and conformity to the East African Council's defined grades and standards. This will in turn enhance the quality of the maize produced to increase farmer income and general food security. Researchers will make use of the study's findings to raise awareness among researchers, politicians, consumers, and producers.

Procedures

Your engagement in this project will involve answering the questions while filling in the questionnaires as requested.

Participants in the Study

You have been chosen to participate in this study because you are a maize farmer in the selected study area. The interview will involve 305 individuals, including you, and it won't go longer than 30 minutes.

Risks/Discomforts

The only risk that comes from doing this study is the potential spread of COVID-19 and the Ebola virus. By adhering to Covid SOP recommendations, such as utilizing hand sanitizers, and nasal masks, and maintaining social distancing, this risk will be minimized. The proper use of gloves, nasal markings, and hand sanitizers, as well as maintaining social distance to minimize physical contact, are crucial Ebola prevention measures.

Time Compensation

Research Participants will be paid for their time with gift goods such as bar soaps, sweets and bathing soap. Additionally, they will be compensated with lunch and travel expenses, as well as proper medical attention in the event of an injury. However, prior to data collection, an agreed-upon amount will be used to pay the research assistants in cash.

Benefits

This study could boost the production and commercialization of high-quality maize grains that adhere to the specifications set by the East African Council for maize grains. The agreed-upon cash and gift compensation will be given to research participants. They will also be updated on the study's progress and findings, and they will have access to any new information that could have an influence on the study participants (including unintended outcomes).

Confidentiality

We will only use codes to identify participants, so nobody will know your identity. Only the research team will have access to the data collected. Hard copy files will be maintained behind closed doors, and password protection will be used to protect soft copies of the data. Only the lead investigator will have access to confidential data.

Alternatives

If you are not interested, you are not required to take part in this study. If you choose not to participate, you will not lose any benefits.

Costs

There won't be any additional costs associated with taking part in this study.

Concerns

You can reach the lead researcher, Kalu Onyinyechi, by phone at 07741600529 or by email at kaluonyinyechi30@gmail.com if you have any concerns about the study or your rights as a research participant.

Declaration of Voluntaries

You may choose whether or not to participate in the research study at your own free will. You are free to leave the study at any time without incurring any fees.

Contact the Chairperson of the Gulu University Research Ethics Committee, Dr. Gerald Obai, at (0772305621), via email at lekobai@yahoo.com or (lekobai@gmail.com), or the Uganda National Council for Science and Technology at Plot 6 Kimera Road, Ntinda, Kampala, on (0414705500), if you have any questions about your rights or participation in the study.

Name ……. Signature/thumbprint of Participant …… Date ……

Name ……... Signature of Witness ……... Date.…….

Name …… Signature of Interviewer ……... Date ……...

Appendix II: Informed consent document (Translated version)

NGEC ME MOK

Wii Kwed: "NGEC KI TIC KI DIRO ME PIM IKIN LUPUR ANYOGI I NWOYA KI AMURU DISTRIK"

La kwed: Onyinyechi Kalu

Gang Kwan: Gulu University

Wiye Wiye

Apwoyo, nyinga Onyinyechi Kalu, latin kwan masters I faculty me agriculture ki kabedo ma orumu me gulu university. Atye ka timo kwed ikom '**Ngec, Tic Ki Diro Me Pimo Tee Ikin Lupur Anyogi I Nwoya Ki Amuru Distrik**'. Kwed man tye me kwan ki miti pa lakwed man tye me nyang ngec ki tic ki diro me pimo tee ikin lupur anyogi me nwoya ki amuru distrik. Ki yero in wek I gam lapeny me kwed ikin lupur madwong. Bed ki ngec ni lagam ma ibi miyo ki bi gwoko I mung dak pe ki bi ngeyo ni man aye lagam ma megi. A bi bedo ki yomcwiny ka imiyo dakika pyera dek me gamo lapeny magi.

Apwoyo

Lok ikom dul ma gu culu pi kwed man

Kwed man dul me Mastercard RUFORUM kacel ki Tagdev Gulu Univerity aye ma gu culu pire.

Tyen lok me kwed man

Kwed man tye me ngyang ngec ki tic ki diro me pimo tee pa lupur anyogi I nwoya ki amuru distrik. Kwed man bi tic maber pi lukwed me agriculture dak bi konyo medo kero pa lupur me tic ki diro me pimo tee malube ki cik pa dul me East African Council. Man bi ilo rwom me anyongi pa lupur wek omed lim icing lupur. Adwogi me kwed man bi medo ngec pa lukwed mukene, miyo ngec bot ludiro, lumok cik, luwil ki lupur mukene.

Kit ma kwed man obi woto kwede

Tic ma megi bi bedo pongo lagam magi I karatac me peny man

Anga ma twero gamo lapeny ikwed man

In ki yero in pyen I lapur anyogi I kabedo man. Peny man bi tero daki ka pyera dek, dano miya dek ki abic in weng ikin ma gi bigamo lapeny magi.

Angola ngola/bedo ma ipe agonya

Anogola ngola ma twero bedo tye ikare me kwed man tye nongo two Covid, ki bi gengo man ki lubu cik me gengo two covid macalo tic ki sanitizer, labo dog ki bedo boo, ngat acel acel bi bedo boo ki lawote, pe ki bi gude kun ki tiyo ki roc cing ki yoo mukene me gengo two Ebola. Jo ma gi obu gamo lapeny ki bi miyo it gi mic macalo cabun lwoko bongo, cukari ki cabun lwok.Bene ki bi miyo ite cing cent me gi wok, cam ki bene cente maromo nongo kony me yat ka awanuobedo tye. Lu cok lagam ki bi nongo cul marwate ki wel ma ki moko ma pud pe ki cako tic me coko lagam magi.

Ber pa kwed man

Ber pa kwed man aye bi ilo rwom me puru ki cato anyogi ma rwome lamal malube ki moko pa East African Council. Jo ma gu bi gamo lapeny magi gi bi nongo adwogi ki ngec malube ki kwed man.

Gwoko Mung

Ngec ikom in ki bi gwoko I mung kun ki tiyo code me moko in. Lagam ma ibi miyo be bedo bot lakwed man keken. Ki bi keto I computer ma ki gwoko ki password ki karatac magi ki bi gwoko gi kama ki loro ki kopulu.

Yoo mukene

Itwero kwero gamo lapeny magi ka miti ni peke me gamo gi. Acara mo peke ma ibingo ka pe igamo lapeny magi.

Cul

Pe ibi culu cente mo me gamo lapeny magi

Lapeny

Ka itye ki lapeny mo keken malube ki kwed man onyo twero ma megi macalo lagam lapeny magi, itwero penyo lakwed Kalu Onyinyechi I numba cim 0774600529 onyo email kaluonyinyechi30@gmail.com

Lok ikom dyere me gamo lapeny

Gamo lapeny me kwed man tye I yoo me dyere dak itye agonya me gamo lapeny magi. Itye bene ki twero me weko gamo lapeny cawa mo keken labongo kit dic mo keken.

Ka itye ki koko malube ki twero ma megi ki gamo lapeny me kwed man, cwal koko bot won kom me Gulu University Research Ethics Committee, Dr Gerald Obai I numba cim 0772305621 onyo email: lekobai@yahoo.com/lekobai@gmail.com onyo bot dul me Uganda National Council for Science and Technology ma ngonge I plot 6 Kimera Road, Ntinda Kampala I numba cim 0414705500

Nying ……. Cing lagam lapeny …… Nino dwe ……

Nying ……... Cing cadedn ……... Nino dwe.……

Nying ……... Cing lapeny …….. Nino dwe.……

Appendix III: Data Collection Tool (Questionnaire) for maize Farmers

Dear Respondent,

You have been chosen as one of the respondents to provide the necessary information in order to answer the particular objectives of the study. I am Kalu, Onyinyechi Nnenna, a master's student in the department and university previously mentioned. I kindly ask that you answer the questionnaire's questions and items in as objective a manner as possible. All information you provide will be carefully kept confidential and used only for the research, as it is solely for academic purposes. Thanks a lot.

Date: …….. District …… Sub-County …….. Parish ……

Village …….

SECTION A: SOCIO-ECONOMIC, SOCIO-DEMOGRAPHIC AND MAIZE PRODUCTIONDATA (PLEASE INDICATE AND/OR TICK WHERE APPLICABLE).

Qn.	Question	Responses
1	Gender of the respondent	1 = Male 2 = Female
2	Age ***(in completed years)***	
3	Educational Status (in years)	
4	Marital Status	1 = Married 2 = Single 3 = Widowed/Widower 4 = Divorced
5	Household Size (Number of people who live and eat together)	
6	Years of Maize Farming Enterprise (years)	
7	Do you have any other enterprise other than maize farming?	1 = Yes 2 = No
8	If yes, what is your other enterprise (s)?	
9	What is the estimate of the amount of money realized from the other farming enterprise(s) monthly? (In UGX)	

10	Do you readily have access to market?	1 = Yes 2 = No
11	Distance to adjacent market (in km)	
12	Do you have access to credit?	1 = Yes 2 = No
	If yes, what are the uses of credit obtained	
	Indicate amount of credit used for maize production (In Ugx)	
13	Are you a member of a farming association/ producer group/cooperative society?	1 = Yes 2 = No
	If yes how does the group support maize production?	
	If the group bulks maize, what is the nature of the bulking store?	1. Permanent with recommended pallets 2. No permanent store
14	What is the source credit?	1 = Personal Savings 2 = Borrowed Loan 3 = Others (Specify) ……
15	Land size owned (acres)	
	Land size used for crop production (acres)	
	Land size used for maize production per year (acres)	
	What type of maize varieties do you grow	1. Improved varieties 2. Local varieties 3. Both varieties
16	Land acreage devoted to improved varieties	
	List purchased inputs used in maize production	
	Distance to nearest input purchase point (Km)	
	What is average production cost per acre of maize (UGX)	
	What storage facilities do you have for your maize	
	What equipment do you have to control maize grain quality	1. Improved storage bags 2. Storage containers 3. Moisture meters 4. Tumpline 5. Grain sorter/sieves

SECTION B: AWARENESS OF THE RECOMMENDED GRADES AND STANDARDS

The statements in this section relate to your attitudes on quality of maize grain. Answer the following questions by ticking a box that reflects your evaluation of each statement given below using a five-point Likert scale, 1= Not aware, 2= Less aware, 3= Neutral, 4= Moderately aware, 5= Highly aware

	Variable	Response				
		1 Not Aware	2 Less Aware	3 Neutral	4 Moderate Aware	5 Highly Aware

1	Have you heard of maize grading and standardization before					
2	Are you aware of the different grades of maize					
3	Are you aware of the characteristics that makes up each grade					
4	Are you aware of the EAC recommended grades and standards					
5	Are you aware of the benefits of maize grading and Standardization					
6	Are you aware of the certification bodies that controls grading and standardization					
7	Are you aware that grading can help add value to your maize Product					
8	Are you aware that standardization helps to make the quality specifications of maize grades uniform among buyers and sellers					

Different maize grades and standards for Uganda and EAC grain council

Maize Grain Characteristics	**Maximum Limits**		
	Grade 1	Grade 2	Grade 3
Foreign Matter, %	0.5	1.0	1.5
Inorganic Matter %	0.25	0.5	0.75
Broken Kernels %	2.0	4.0	6.0
Pest damaged grains	1.0	3.0	5.0
Rotten and Diseased grains	2.0	4.0	5.0
Discolored grains	0.5	1.0	1.5
Moisture %	13.5		
Immature/Shriveled grains, %	1.0	2.0	3.0
Filth, %	0.1		

Which of the following grades do you practice on your farm"?

Maize Grades	YES	NO
Grade 1		
Grade 2		
Grade 3		

SECTION C: FARMERS PARTICPATION IN MAIZE GRADING AND STANDARDIZATION

1	Do you participate in maize grading and standardization?	1 = Yes 2 = No
2	If you are not a participant, then explain why you are not?	1 = lack of equipment 2 = Inadequate capital 3 = Lack of awareness 4 = Others (specify) ……..
3	If you are participant in maize grading and standardization, forhow many years have you been involved?	
4	What is the distance from your farm to the grading and standardization location?	
5	Explain why you are a maize grading and standardizationparticipant	
6	Do you have access to market price information?	1 = Yes 2 = No
	If yes, …..	
7	Do you have access to extension services on maize grading andstandardization?	1 = Yes 2 = No
8	If yes, who offers the extension services on maize production?	1 = VSLA 2 = NGOs 3= Government 4= Other(specify) ……
9	How do you sell market harvested maize grains?	1 = farm gate 2 = group marketing 3 = contract marketing
10	What is the quantity of maize produced in the last planting season?	……KG
11	What quantity of maize produced was graded and standardized in last planting season?	……KG
12	What are your means of maize transportation to the market?	1 = Motor cycle2 = vehicle 3 = Others
13	What is the distance to the market where you sell your	

	maize?	
14	What maize marketing channels do you have for selling yourmaize?	1 =WFP 2 = FAO 3 = Export Organizations4 =Others
15	What maize storage facility do you use?	1 = Personal store 2 = Community silo3 = Maize cribs 4 = Other
16	Do you wish to continue to participate in maize grading and standardization?	1 = Yes 2 = No
17	If no, why?	

Thank you

Appendix IV: Work Plan (Data Collection and Reporting)

Project Activities	Responsible Party	February 2022 – April, 2023								
		Feb–August	Aug--Dec	Aug – Dec	Aug – Dec	January 2023	January	Jan - Feb	Feb-March	February – June 2023
Preparation Phase										
Proposal Development, Presentation and Finalization	Kalu and S									
Design and Review of survey Instruments	Kalu and S									
Selection and Training of Enumerators	Kalu and S									
Pilot of survey Instruments (Test-retest)	Kalu and E									
Sampling of Study Area	Kalu and E									
Data Collection Phase										
Field data collection + Back checking	Kalu and E									
Re-visitation (Attrition)	Kalu and E									
Data Entry										
Data Entry and Sorting	Kalu									
Data Analysis										
Statistical analysis (Round 1 and 2)	Kalu									
Results and Discussions	Kalu									
Report Writing										
Draft Findings Presentation	Kalu									
Comments on draft Reports	Supervisors									
Incorporation of Comments	Kalu									
Final Report	Kalu and S									

NB: S- Academic Supervisors, E - Enumerators

Appendix V: Research Budget Breakdown

TITLE: AWARENESS, UTILIZATION OF GRADES AND STANDARDS AMONG MAIZE FARMERS IN NWOYA AND AMURU DISTRICT.

	PROJECT BUDGET LINE DESCRIPTION	Cost per unit (UGX)	Quantity.	No. of days	Total Cost (UGX)
A.0	PREPARATION: TESTING AND PILOTING				
A.1	Transportation (Hired car)	250,000	1	1	250,000
A.2	Fuel	300,000	1	1	300,000
A.3	Stationery (Pens, notebooks and clear bags)	20,000	5	1	100,000
A.4	Training Enumerator	150,000	1	1	150,000
A.5	Communication (Airtime)	20,000	1	1	20,000
A.6	Mobilization/community appreciation	100,000	1	1	100,000
A.7	Printing Cost (plus photocopying)	1,200	30	1	30,000
A.8	Enumerator's allowance during Piloting	50,000	6	1	300,000
A.9	Translation of Questionnaire and Informed Consent	100,000	1	1	100,000
A.11	Masks	50,000	1	1	50,000
A.12	Hand sanitizers	60,000	1	1	60,000
	SUBTOTAL				**1,460,000**
B.0	**FIELDWORK: DATA COLLECTION FOR BOTH NWOYA AND AMURU DISTRICT**				
B.1	Enumerator's allowance	50,000	6	10	3,000,000
B.2	Accommodation (Researcher)	50,000	1	10	550,000
B.3	Travel cost (Hired car)	250,000	1	12	3,000,000
B.4	Fuel (five full tanks for entire period)	200,000	NA	12	2,400,000
B.5	Printing Questionnaires and consent forms	1,200	310	1	372,000
B.6	Communication (Airtime)	Lump-sum	1	15	150,000
B.7	Bar soap token of appreciation	4000	305	1	1,220,000
B.8	Mobilization (Local guides)	15,000	1	15	225,000
B.9	Stationary	50,000	1	NA	50,000

B.10	Masks	80,000	1	15	80,000
B.11	Hand sanitizers	100,000	1	15	100,000
	Sub-Total				**11,147,000**
	Total				**12,607,000**

Appendix VI: Ethical Approval

GULU UNIVERSITY

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RESEARCH ETHICS COMMITTEE

06/01/2023

To: Onyinyechi Kalu

Gulu University
08136013068

Type: Initial Review

Re: GUREC-2022-403: Awareness and Utilization of Grades and Standards among Maize Farmers in Nwoya and Amuru District , 2.0, 2022-11-28

I am pleased to inform you that at the **93rd** convened meeting on **20/10/2022**, the Gulu University REC, committee meeting, etc voted to approve the above referenced application.
Approval of the research is for the period of **06/01/2023** to **06/01/2024.**

As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re-review and approval **prior** to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **eight weeks** prior to the expiration date of **06/01/2024** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by Gulu University REC:

GULU UNIVERSITY
RESEARCH ETHICS COMMITTEE
APPROVED UNTIL
★ 06 JAN 2024 ★
FACULTY OF MEDICINE
P. O. Box 166, Gulu

Appendix VII: Stata Output. (Correlation Metrix)

	LnMaiz~d	lnQtyP~d	lnHous~e	Member~y	__21_L~t	lnEduc~n	lnAge	NGO_In~y	Awaren~y
LnMaizeQty~d	1.0000								
lnQtyProd	0.2172	1.0000							
lnHouseho1~e	0.0059	0.1048	1.0000						
Membership~y	-0.2378	0.0908	0.1524	1.0000					
__21_Lands~t	0.1680	0.3820	0.2197	0.0309	1.0000				
lnEducation	0.0183	0.0994	-0.1988	0.0017	0.0230	1.0000			
lnAge	0.0394	-0.0019	0.4841	0.1548	0.1698	-0.3386	1.0000		
NGO_InputS~y	-0.0816	-0.0102	0.0666	0.0723	-0.0853	-0.0066	0.1052	1.0000	
Awarenessd~y	0.5150	0.1563	0.0788	0.0114	0.1530	0.0503	0.0458	-0.0600	1.0000

	__2_iA~t	__5_Ed~t	A~ndummy	A~tdummy	Member~y	M~Info~y	Marrie~y	Gender~y
__2_iAgeof~t	1.0000							
__5_Educat~t	-0.3429	1.0000						
AccessExte~y	0.2009	-0.0523	1.0000					
AccesstoCr~y	0.0754	-0.0248	0.2687	1.0000				
Membership~y	0.1275	0.0296	0.3814	0.4902	1.0000			
MarketInfo~y	-0.0125	-0.0281	0.1790	0.0869	0.1543	1.0000		
Marrieddummy	-0.1914	0.2905	0.0151	-0.0363	-0.0174	-0.0280	1.0000	
Genderdummy	-0.0336	0.1342	-0.0207	-0.1453	-0.0200	0.0676	0.1771	1.0000