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The Role of Farming Methods on Income of Smallholder Maize Farmers in Nakifuma Sub-county, Mukono District, Uganda

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ABSTRACT

Maize farming among rural and urban smallholder farming has historically been the source of livelihood and incomes. Many rural people and governments are increasingly focusing on designing robust strategies to promote smallholder maize production and marketing involving a shift in technologies and reducing bottlenecks along the production chain. However, despite the great effort and frameworks, persistent bottlenecks exist in achieving this target. This conundrum formed the gist of this study that focused on assessing the farming methods used by smallholder maize farmers, effects of such methods on production and marketing, challenges facing smallholder maize farmers during production and marketing and strategies being designed by farmers and government to reduce production and marketing challenges by farmers in Nakifuma sub-County, Mukono district.

The study used a mixed research approach involving both qualitative and quantitative methods, where 384 local participants mainly women in smallholder maize farming and 10 key informants in Nakifuma sub-county including the Local Chairperson, and NGOs leaders among others were targeted for interview. Study findings indicate that women form a higher proportion of the smallholder maize farmers and the traditional methods of farming are the ones mainly used to grow maize. The maize yields are very low (less than 1 ton/hectare per season) as reported by respondents; especially in Kasawo and Nagojje. The study also revealed that maize prices are still very ranging from Shs. 200/= to Shs. 500/= which amounts to a maximum of Shs. 500,000/= that can be obtained from a hectare. However, despite the informal nature of farming, some farmers are transitioning to fairly modern methods which has been dotted with several benefits such as increased employment, better livelihoods, and increased yields (more than 1 ton/hectare/season). The current COVID-19 pandemic, expensive inputs and local taxes are some of the main challenges hampering smallholder maize farmers' production and marketing of maize. To this end, stakeholders have developed strategies such as training on financial literacy,formation of SACCOs, setting up of rural farmers' groups, and increasing rural roads networks to ease production and marketing. The study recommends that farmers should practice mixed methods of farming, growing of better varieties of maize that are favored by the prevailing local conditions and local government providing some easy access to some funds for farmers to enable them easily obtain agricultural inputs. Policies should be developed aimed at boosting on the marketing of the farmers' produce by lessening on farmers dealing with middlemen who tend to benefit more

Keywords: Smallholder farmer; Maize growing; Modern farming methods.

1.0 Introduction

Maize is among the cereals produced by small holder farmers worldwide due to its demand as well as wider adaptability, hence the name the "queen of Cereals".[(1)]Global production of maize in 2017 rose to 1.04 billion tones, with approximately 15% being sold on worldwide markets making maize second most traded agricultural commodity after wheat [(2)]. Furthermore, maize represents one third of international cereals traded [(3)]. As such, increasing the income of small holder maize farmers over the last few years resulted into the global stock-to-use ratio of about 25% leading to stabilizing consequence on maize prices internationally [(2,3)]. Meanwhile in the recent years, change has been observed in the pattern of output for maize and there is a divergence to some extent in individual regions of the world resulting from modern farming practices being exhibited by farmers [(4)].
Africa produces about one third of the global maize crop [(5)], and in 2018, maize production in Africa was approximately 75 million tons accounting for 7.5% of world production[(2)]. About 24% of farmland in Africa is occupied by Maize and the average yield is stagnated at approximately 2 tons/hectare/year[(6)]. The largest African producer is Nigeria with over 33 million tons, followed by South Africa, Egypt, and Ethiopia[(7)]. An estimated 208 million people in Sub Saharan Africa (SSA) depend on maize as a source of food security and economic wellbeing [(8)]. Maize occupies more than

33 million ha of SSA's estimated 200 million hectares of cultivated land [2,3]. Considering the low average maize grain yields that are still pervasive in farmers' fields, meeting the projected increase demand for maize grain in Africa presents a challenge [8]. In order to boost maize production new modern farming practices including; use of quality seeds, soil testing, fertilizer application, water conservation and farming machinery have been recommended[4,9].

In East Africa, maize is the most essential cereal crop grown and consumed in the four largest countries found in eastern Africa[10]. In 2016, East Africa attained a combined production of 17.2 million tons even when drought was ongoing [3]. This production was nearly 50% more than the production that was being attained a decade ago. Within East Africa, Tanzania and Uganda have had approximately 70% increase in production since 2006 when they had only 27%[10].

The total maize production in Uganda has increased gradually over the years, from approximately 800,000 tons produced in 2000 to 2,575,000 tons in 2019[1]. The increase in production is partly due to expansion of maize acreage, and not improved productivity [1]. The maize sub-sector in Uganda provides a livelihood for an estimated 5.7 million Ugandan farm households, approximately 3,000 traders and more than 70 exporters [11]. As such, maize is an emergent source of household income as well as foreign exchange through exports [12]. Low productivity is one of the biggest challenges facing Uganda's maize industry. The modern farming practices in Uganda such as use of quality seeds, soil testing, use of fertilizers, water drainage systems and mechanization have positively improved maize production among maize farmers [9] but unfortunately majority of Ugandan maize farmers live in absolute poverty including those from Mukono district [13]. Maize productions are low in Mukono as compared to other similar agro-climatic districts in Uganda [14]. Hence, this study will ascertain how modern maize farming practices have been taken up by farmers and how it has affected their income in Mukono district, using Nakifuma sub-county as a case study. The study will assess the different farming practices used to increase maize production the challenges faced, as well as the farmer possible solutions in use.

1.1 Problem Statement

The Agriculture Sector Strategic Plan (ASSP) 2015/16-2019/20 revealed that maize production in 2014 was 2.9 million metric tons with low yield levels that ranged between 2.2-2.5 tons per hectare and Mukono district was among the most affected districts in Uganda. This rate of production was very low when compared to the potential yield of 5 tons per hectare[15]. The above problem is magnified by the ever increasing population which competes for the land which is fixed [16]. Additionally, over 90% of Uganda's maize is produced by smallholders who consume about 60% of their total maize production [8]. Thus, increasing maize production requires farmers to adopt new technology and farming practices [2,8] as lack of appropriate and feasible technologies coupled with poor operational skills of farmers constrain maize production in Uganda[1].

However, this can only be achieved by first establishing the production technologies and adoption of better farming methods used by farmers and addressing the production inefficiencies if any.

This study therefore, assessed how farming practices have influenced maize production in Nakifuma sub-county in Mukono, what constraints farmers face during maize production and the likely strategies the central government is putting forth to enable the farmers overcome the faced bottlenecks.

1.2.0 Study Objectives

- The main objective of this study was to understand the role of the different maize farming methods on smallholder farmers' production and how they have improved income among smallholder farmers in Mukono District.

1.2.1 Specific Objectives of the study

- To find out the farming methods used by smallholder maize farmers forthe production of maize and income generation in Mukono District.
- To determine the effect ofthedifferent farming methods on the yields of maize in Mukono District.
- To examine the challenges the maize farmers face during the production and marketing of maize in Mukono district.

1.3 Research questions

The following research questions were addressed to achieve the study objectives

- Has the use of different farming methods by smallholder farmers in Mukono improved their yields?
- Is there a relationship between a given farming method used and the level of maize production?
- Which of the said challenges has/ have highly affected maize productivity and farmer incomes?
- Are there strategies by smallholder farmers and government to address the challenges facing smallholder farmers?

1.4 Scope of the study

The study was conducted in Mukono District found in the Buganda Sub-Region of Central Uganda. Mukono District is bordered by Kayunga District to the north, Buikwe District to the east, Kalangala District to the south-west, Kira Town and Wakiso District to the west, and Luweero District to the north-west. The study was conducted from May-July 2021 in Nakifuma Sub-County because the researcher believed the allocated time was ample to collect sufficient data which was useful in answering the research questions and achieving the specific objectives of the study.

1.5 Justification of the study

The inappropriate and feasible technologies coupled with the poor operational skills of users remain the main constraints to the production of maize in

Uganda [1].Small holder maize farmers in Mukono continue to count losses due to the low yields from maize production and this could be attributed to underutilization of modern farming practices by the small holder famers [17]. Moreover very little is known about the challenges faced by maize small holder farmers in Mukono district while implementing the recommended maize farming practices. As such, the proposed study is timely to establish better technology use among maize farmers in Mukono and what can be done to address the challenges that lead to ineffective adoption.

2.0 Literature Review

2.1 Contextual perspectives on the importance of maize

In terms of acreage and production, maize is among the most important cereal crops grown worldwide. In the year 2016/2017, global production of Maize was about 1040 million metric tons with 38% and 23% being contributed by USA and China respectively [2,3]. In India: after rice and wheat, maize is the 3rd most important cereal with nearly 15 million farmers being involved in maize cultivation [18]. Andhra Pradesh is ranked first in maize production in India followed by Karnataka with per cent share of 20.9 and 16.5, respectively [18].

Maize can be grown successfully in loamy sand to heavy clay, well aerated, neutral pH soils. As such, farmers should avoid cultivating maize in low-lying or poor drainage fields [19]. Furthermore, ,maize crop is affected by prolonged low temperature which is less than 5℃ though 25 - 35℃ is the most favorable range of temperature for better crop growth that leads to yield realization [4,8]. Since it is a day neutral crop, maize has the potential of being planted two times in a year thereby leading to high yield levels within short periods of time [20]. This implies that when appropriate technology is used, then the farmers are capable of attaining wide margins of profits from maize production.

Considering the 23 countries globally which have the highest per capita consumption of maize as food, 16 are in SSA. Maize is estimated to provide 50% of the calories in diets in southern Africa, 30% in eastern Africa, and about 15% in west and central Africa. More than 300 million Africans consume maize as their staple food. The maize grains are known to be rich in vitamins A, C and E as well as carbohydrates, essential minerals and contain 9% protein. Important to note is that maize grain is also rich in dietary fiber [21].

2.2 Maize production in Uganda

Although maize is among the crops which have been grown for a long time in Uganda, nevertheless, unlike in neighboring countries like Kenya, Tanzania and others it does not constitute a main part of the population's traditional diet, on the other hand it is grown primarily for generation income, instead of food security [7,8,10]. However, the cost of cultivating traditional staple foods like Matooke has impacted on increasing maize consumption, particularly in urban areas as Kampala alone is responsible for approximately 50% of formal trade in maize[22].

Traditionally, Uganda's small-scale farmers produced maize both for food and for income generation[23]. The main production agro-ecological zones of maize crop are in the west, east, north and southeast Uganda with the Eastern region accounting for over 50% of annual production [24]. Maize occupies around 1.5 million hectares of land being the third most planted crop after banana and beans. Evidence has it that in some regions of the country, the crop has eventually become a staple food, substituting crops such as sorghum, millet, cassava and banana. Maize is considered a major source of income in the districts of Kapchorwa, Mbale, Iganga, Masindi and Kasese, with about 75–95 % of the household harvest being sold for the purpose of earning money [2,25].

Maize export market for Uganda is predominantly regional, encompassing markets in Eastern and Southern Africa, Southern Sudan and the Democratic Republic of Congo [2]. Maize being exported to Kenya alone almost more than doubled from 2010 to 2014[15]. The export potential for maize in Uganda is estimated between 200,000 and 250,000 MT per annum (USAID, 2010). On the other hand, the country has only been able to formally export half of this amount, which reflects a low level of penetration into the regional markets resulting from poor rural road network, and inadequate business exposure [26] much as maize is sold across borders through Mutukula for Tanzania, Gatuna for Rwanda, and Busia for Kenya which is an opportunity for small holder maize farmers to benefit [3].

2.3 Recent developments in Maize and Maize production strategies for Uganda

Uganda has registered an increment in adoption of agricultural technology but given the high levels of poverty faced by numerous smallholder farmers within the country, farmers may only need to be trained on how to use resources which are locally available to boost production [27]. For example, many smallholder farmers may not be in position to afford pesticides or artificial fertilizers. However, they mix shrubs with hot pepper together with animal urine to use as pesticides, and this practice works for them whereas others make use of organic and composted manure on their gardens [28].

A number of productivity-enhancing technologies including high-yielding crop varieties and land management techniques have been developed and released by the Ugandan National Agricultural Research System (NARS) during the past 100 years of agricultural research in Uganda [29]. However, because of the low uptake of these technologies, farmers' yields of most major crops are low (typically less than one-third of potential yields found on research stations) and have remained stagnant or deteriorated during much of the 1990s[29].

Despite the efforts which have been geared towards maize production in Uganda, there still exists low production due to the fact that the technology implemented is not appropriate in maize production [17]. For new technologies to be available to farmers, dynamic agricultural research programmes that take into account the needs of client farmers, as well as extension services that work actively with farmers as they learn about new practices of maize cultivation, are necessary [30, 10].

Maize production in Uganda is being held back by numerous problems. Abiotic stress is one set of challenges since most maize cultivation in the developing world relies on rainfall making the crop predominantly vulnerable to drought and heat [5,29]. According to current estimates, approximately 25% of maize production is susceptible to frequent drought[31]. It is accepted widely that these stresses are going to become more serious due to climate change, leading to a probable loss of up to 10% in maize production both in Africa and Latin America by 2055 [31]. Poor/degraded soil quality is another abiotic stress which is also seen as a noteworthy contributor to poor yields [5].

2.4 The Traditional and Modern Farming Practices Used By Small Holder Maize Farmers

There has been a recommendation of an array of production technologies for maize crop, ranging from land preparation to harvesting [32]. Small holder farmers are responsible for production of over 90% of Uganda's, with about 60% of the yearly maize output being consumed on the farm [2]. The production intensity looks to be a function of the position which the crop holds in the food system and the marketability of the crop [3].

Given the linkage which exists between agricultural productivity and poverty, and since agricultural growth can be augmented significantly through utilization of modern farming methods, the possibility for sustainable reduction of poverty is linked to the capability to transform agriculture so as to escalate productivity [20]. Therefore, the agricultural sector offers an enormous opportunity for reduction of poverty in Uganda.

The fluctuating and deteriorating growth of the agricultural sector in Uganda shows the sector's low level of sustainability[27]. People produce only what can sustain them for a short time, but thereafter go hungry again. This pattern can- not aid the achievement of sustainable development. Efforts need to be made to enable the growth of the agricultural sector beyond mere sustainability towards sustainable development[8, 29]. Per capita food production in Uganda is much more variable than the average for sub-Saharan Africa, largely as a result of lack of irrigation.

2.5 The Challenges Faced By Small Holder Maize Farmers in Implementing Recommended Farming Practices In Maize Production

Global production has not been able to meet the increasing demand for food because food insecurity is principally a problem associated with access to the resources as well as services required by families to produce, buy or to obtain adequate nutritious food [25]. The inadequate production largely owes to the low utilization of modern farming practices in most parts of the world[16, 33].

In Africa, the productivity of agricultural sector much lags behind other regions [12]. There 33 million farms of less than 2 hectares in Africa accounting for 80% of all farms [34]. Based on premises that the farming system relies predominantly on family's capital and labor force for production, the overall productivity is low [12, 34]. These make is hard for subsistence farmers to significantly implement the recommended farming practices in maize production because they have access to pieces of land which are too small[35].

In developing countries, maize together with rice and wheat offers at least 30% of the required food calories to over 4.5 billion people living in 94 developing countries [36]. These comprise of 900 million people who are poor consumers regarding maize as the preferred staple food [8,36].

In the developing world, low and lower middle income countries are responsible for about 67% of the total maize; therefore, millions of poor farmers earn livelihoods from maize[5, 2]. It was projected that by 2020, the world would have around 7.7 billion people and by 2050 the figure will be approximately 9.3 billion between which the demand for maize will double in the developing world[37].

Notwithstanding the farm sizes, the maize yield levels in Uganda's are low and are usually between 1.0 and 1.8 metric tons/ hectare with up to 80% of losses arising from crop failure due to drought[24]. The problem has a high magnitude in districts like Kasese where losses can go to catastrophic levels with other drought-prone regions comprising of eastern, northeastern and northern Uganda [3, 24].

Poverty is a big problem barring small holder farmers from implementing recommended farming practices in maize production and it stems from the fact that a vast majority of Uganda's labor force is employed in agriculture, a sector which receives less than half of the total income (GDP) in the economy [38]. As such, this has been mainly ascribed to low productivity of agricultural sector[38].

Finally maize cultivation is faced with a challenge of lack of resources as well as training for smallholders[2, 8, 38]. These constraints stretch to include limited access to better-quality varieties and improved quality seeds, inadequate access to regularly expensive fertilizers and pesticides, meager dissemination of good agricultural practice, small-scale mechanization aimed at replacing manual labor, and remarkable post-harvest losses resulting from poor storage, attack from pests and spoilage [17].

There is change being experienced in the nature of the demand for maize as it has been a significant food crop nevertheless its demand as livestock feed over the past decade grown enormously[39]. The driving force behind this has largely been the swift economic growth regions which are densely populated in Latin America, Asia and the Middle East thereby resulting to amplified demand for poultry and livestock products from more wealthy consumers[40].

Maize grain is a fundamental constituent in animal feed which puts an added demand for maize thereby driving up prices of maize grain on the market [(3)]. As such, poor consumers in various regions of the world are finding maize less affordable for them [(41)]. There is a tremendous growth in the maize feed market in countries like China and India, having many who are able to afford meat, milk, and eggs due to economic progress[(42)]. Swift development taking place in these countries has also driven up the demand for maize which will be used as in industries as raw material and this is evident in USA where maize is a fundamental ingredient in the bioethanol program [(43)].

2.6 The Possible Measures by Farmers and Government to Address Challenges Faced By Farmers to Implement Recommended Maize Farming Practices

A widely accepted notion is that small holder farmers can achieve increment in production by improving yields as opposed to clearing more land for cultivation [(44)]. There is growing competition for land, water, labor and other resources even in those areas where all suitable land is not already under cultivation in addition to increasing concern about the effect of deforestation as well as land clearance on the quality and fertility of land (for example due to problems like erosion, acidification and salinity), climate change and biodiversity [(45)]. Consequently, there is need to increase yields by striving to make agriculture more effective, profitable and sustainable, predominantly for smallholders staying in regions such as sub-Saharan Africa which have a mixture of a high dependence on maize for food with low levels of productivity and agricultural systems which are more vulnerable[(5, 37)].

The government of Uganda launched a plan known as the modernization of agriculture (PMA), on a mission to eliminate poverty through changing subsistence agriculture to commercial farming by re-orienting the production of poor subsistence farmers towards the market[(27)]. A recognition from the government is that the success of PMA depends on the acceptance of improved agricultural technologies by a substantial section of farmers in order to increase total factor productivity as well as farm income [(27)]. In this regard, the government has among other things made a resolution to back the process of generation, dissemination and adoption of technologies which are productivity-enhancing[(8).]

A measure which can be undertaken by the government is introduction of weather index insurance which partially protects farmers from climate variability as well as partially compensates for the negative impacts of drought. Precisely, the index insurance would cover the costs of irrigations in years when farmers are hit by drought thereby enabling farmers to implement the recommended farming practices leading to high yields [(46)].

The small holder farmers can be connected to large business farmers by means of mutually beneficial contract farming otherwise known as out-grower schemes which enable farmers to access to inputs, end-markets, financing, and their involvement in agriculture value chains [(47)]. This is in congruence with a study in 2016 which ascertained that investments in technology and innovation is required for a comprehensive transformation of the agricultural sector in Africa towards agro-industrialization requires so as to improve the productivity of both land and labor[(33).]

The use of Internet could be an important measure which would improve integration into value chains the traceability of food and animals. This measure involves displaying the lot number and the name of the production facility on the case of each product and having this information recorded on invoices and bills of lading[(33, 8)].

Commercialization can be facilitated by innovation which would in turn enhance the access of farmers to broader markets and financial systems thereby promoting the utilization of recommended maize farming practices [(49)]. According to Moyo, Bah, & Verdier-Chouchane (2015), this innovation will ultimately give room for the formation of modern incorporated agribusiness economies of value chain which is grounded on specialization[(33).] Remarkable changes have already been caused in agribusiness in Africa by domestic and international private investment in the agricultural sector with positive effects being observed on revenues of smallholder farmers and productivity [(50)].

Uganda has had low adoption and use of modern agricultural technology, which has contributed to low productivity growth. The government of Uganda is, however, trying to tackle this through the implementation of the National Agricultural Advisory Services (NAADS), established in 2001 as a public-private approach to extension service delivery. One of NAADS's key objectives is promoting food security, nutrition and household incomes through increased production and market-oriented farming [(51).]

1.7 Conceptual framework

A conceptual framework is a diagrammatic representation of variables in a study, their operational definition and how they interact in a study[(52)]. The framework below is an illustration of modern farming practices coupled with other possible underlying factors that influence increased maize production and incomes for small holder maize farmers. The independent variables are grouped together at the top but not in any order of importance. The dependent variable is placed at the bottom, connected with arrows as a sign of direct relationship.

Independent variable

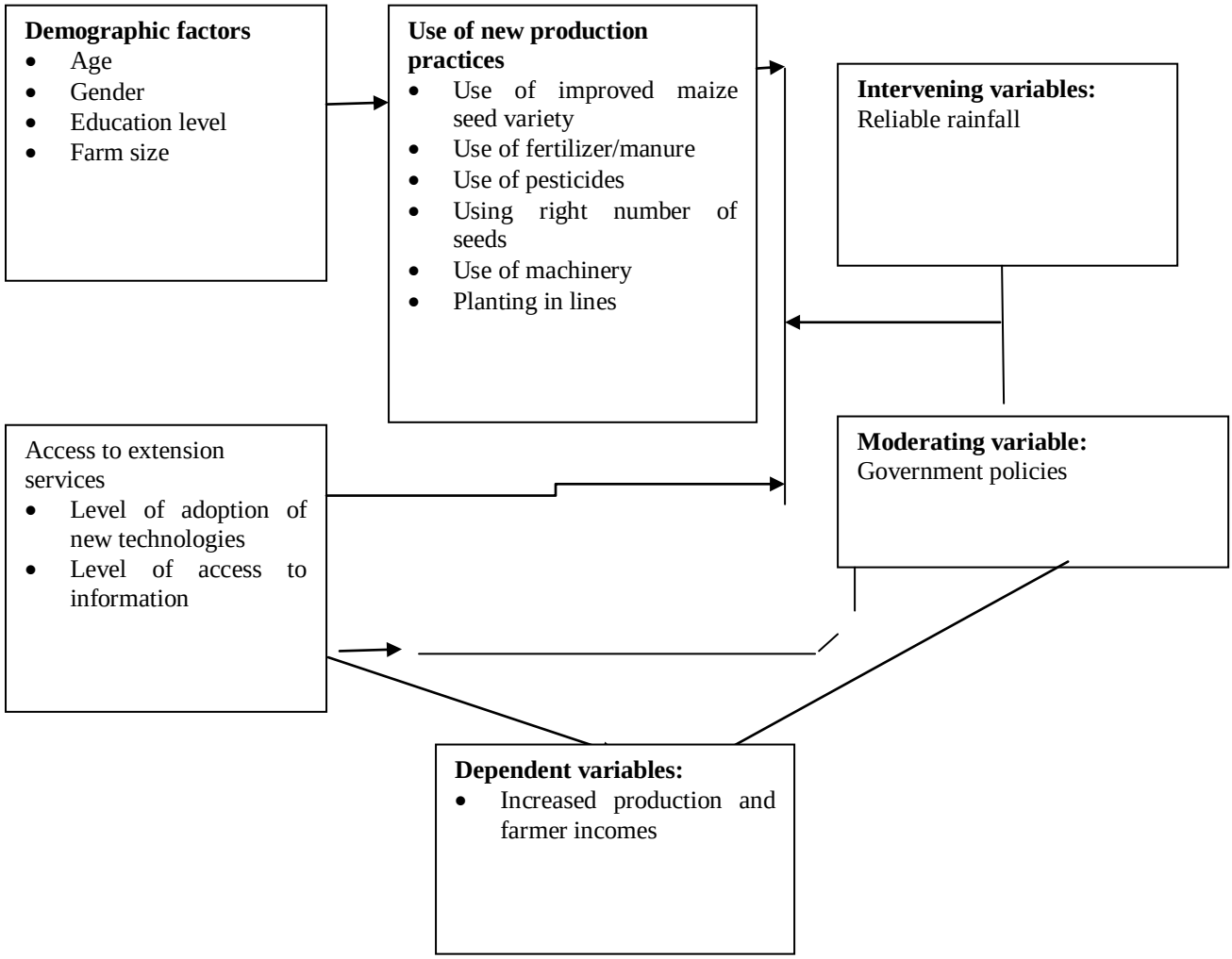

Figure 2:1 Conceptual framework showing the relationship between the independent and dependent variables: Source: Adopted and modified from Simiyu, 2014 framework on factors influencing maize production among small scale farmers[53].

2.7.1 Discussion of the conceptual framework

Use of modern farming methods such as application of fertilizer, planting improved maize varieties, use of machines, using the right number of seeds and good spacing among others have a great bearing on yields realized and so farmer incomes.

The influence of farmer characteristics and farm attributes also influence productivity and income. For example, studies in Eastern Africa report a positive and significant relationship between farm yield and access to extension services(8). This attribute helps farmers to access new information and also adopt new technologies as well as acquire farm inputs for better yields. Age, farm size, gender and level of education of the farmer involved also plays a positive role in increasing household output. Young farmers are more likely to adopt a new technology because they are more open to attitude change than older farmers (53). Similarly, education enhances the allocative ability of decision makers by enabling them to think critically and use information sources efficiently. Farmers with more education should be more aware of more sources of information and more efficient in evaluating and interpreting information about innovations than those with less education.

Other factors though not directly related to the study for example government policies, community attitude and weather conditions will also affect farmer productivity and incomes. For example, a study in Kenya found out that a unit increase in the mean precipitation had a considerably favorable impact on yield while a decrease in precipitation had a negative impact on the yield of maize farmers and so their income(8).

3.0 Methodology

3.1 Research Design

A study design is an overall plan and strategy for conducting research; it is a master plan specifying the nature and pattern the research intends to follow while carrying out the research study to ensure that sound conclusions are reached[54]. This was a descriptive cross sectional study which

utilized both quantitative and qualitative methods of data collection. Several authors such as Creswell express that such design seeks to interact with the respondents in their natural situation without altering any of the living conditions[55]. To achieve the research objectives, descriptive cross sectional design was used to explain the use of modern technologies in maize cultivation, what has worked well for farmers, establish what has failed and why as well as what farmers have done to change the status-quo[52]. This study design also allowed the researcher to examine the challenges faced by small holder maize farmers in implementing recommended farming practices in maize production and the possible solutions.
Additionally, the design was chosen because it allows collecting data from a relatively large number of respondents at a particular time [56].
Quantitative methods of data collection were used to gather the data required for this study and Questionnaires were the chief tool for data collection.

3.2Description of the Study Area

This study was carried out in Mukono district because agricultural statistics and Uganda demographic statistical reports highlight that it is one of the main maize growing areas with a large proportion of people growing maize on small holder farms [57]. Mukono district lies in the central region of Uganda, sharing boarders with the Buikwe district in east; Kayunga along River Sezibwa in the North, Luweero in the North West; Kampala and Wakiso in the south west; Tanzania-lake Victoria in the south with the Island of Buvuma District [58]. The district has a population of 596,804 persons with 289,757 males [59]. Mukono district has a total area of 2,986.47 Sq. Km, most of Mukono District lies on a high plateau (1000-1300 Meters above Sea Level). The rainfall in the district is bi-modal with peaks in March-May and September- November [60]. Both relief and the climate provide a good potential for investment in cash and food crop, horticulture and floriculture on a commercial basis.
The main economic activity is subsistence agriculture and the major crops grown include; maize, cassava, sweet potatoes, millet, ground nuts, peas, soya beans, bananas, sim- sim; yams; fruits and vegetables. Partial commercial agriculture exists with farmers like SCOUL sugarcane plantations, cotton and coffee growers as well as tea estates in Numa and Nagojje sub-counties.

3.3 Study Population

The study population can be defined as the total collection of elements which one would like to study or make inferences[52]. The target population comprised small holder maize farmers in Nakifuma Sub County found in Mukono district. Nakifuma Sub County constitutes the largest proportion of households engaged in maize growing at 30,024 households accounting for 67.2 percent of the agricultural households in the sub-county [61,62]. Additional information will also be collected from; the Community Development Officers (CDO), Agricultural Extension Officers (AEOs) the parish chiefs and members from Non-Government Organizations (NGOs) that run agricultural and environmental programs in Mukono district. Such organizations included; SSAMBA foundation, CARITAS and Mercy Corps.

3.4 Sample Size

According to authorsCohen, Manion, & Morrison (2013), a sample size is in a way determined by the style of the research[63]. In a survey study, it would be required to obtain a representative sample of the population to help in the generalization of the study findings. For this study the sample size was obtained using Charan & Biswas (2013) sample size method[52]. This method was used in this study because it is accurate in determining single proportion sample sizes most especially when a similar study has not been done before in the same geographic region. The formula was therefore presented as follows.
The following formula was used for determining study sample.

$$n = \frac{Z^2\, p(1-p)}{d^2}$$

Where: n is the sample size

Z is the standard normal deviate or variant (at 5% p<0.05, Z is 1.96)
P is the expected proportion of characteristic being measured in the target population based on previous studies (For this study, it is estimated at 50% or 0.5) since no similar study was done in a local context
d is the absolute error or level of statistical significance (For this study set at 0.05).

A sample size was determined from statistics that showed that smallholder farmers in Mukono are estimated to be 16,641. This estimate has a confidence level of 99% and margin of error +/-1% (.01), using the standard deviation suggestion of .05.

$(2.58)^2$*0.5(1-0.5)/$(0.01)^2$ = 6.656*0.5(0.5)/0.0001= 16,641

However, this sample was large and thus, the confidence level was reduced to 95% and a 5% margin of error. After reducing the confidence level, the obtained sample was 384.16; which is approximately 384 respondents. These were the ones considered in the study.

3.5 Sample selection

3.5.1 Inclusion Criteria

Small holder maize farmers who were 18 years and above were included in the study provided they consent to take part. The term "smallholders" included small farmers who own/control the land they farm and those who do not. Also to be included in the study were be key informants directly dealing with agriculture like CDOs, AEOs, Parish chiefs and NGO workers.

3.6.0 Sampling techniques

3.6.1 Simple Random Sampling

Simple random sampling was applied while selecting the small holder maize farmers. According to Creswell (2014)simple random sampling technique is a sampling technique that gives every member of the target population equal chance of being included in the study[(55).] Using this technique, the researcher generated a list of respondents who had been selected with the support of the sub county chief to participate in the study. The sub county chief was considered because he is the lead technical person of the sub county. The researcher then assigned codes or numbers that identified each participant. These were written on small equal sized pieces of paper put in a tin; tossed and three hundred and eighty four pieces (384) of paper bearing participants' codes were randomly picked.

3.6.2 Purposive Sampling

Purposive sampling on the other hand was used to select key informants such as the Community Development Officer, Agricultural Extension Officers, the parish chief and representatives of NGOs that deal in agriculture. (SSAMBA foundation, CARITAS and Mercy Corp). According authorsSekaran & Bougie (2016) purposive sampling enables the researcher to obtain in-depth knowledge of the subject under study[(64)]. Ten (10); key informants that were involved in the production of maize were involved in the study. These comprised of; Community Development officer (01); Local Chairpersons (02) Agricultural extension officer (01); the district Agricultural officer; parish chief (01); Agriculture NGO (01); farmer SSACO (01); Women farmer group (01) and the sub county chairperson. Information generated from the key informants helped complement the findings from farmers and also enabled the researcher to seek more explanations of the information collected from farmers.

3.7.0 Data collection instruments

Questionnaires, document review and interview guides were the data collection instruments that were used in this study.

3.7.1 Document review

This involved the review of reports, articles, books and scholarly information on the smallholders farming, maize growing, and agro-related income generation. The main reports and statistical information considered was from the Ministry of Agriculture, Animal Industries and Fisheries, UBOS, and FAO. This information was sourced from online databases on Google scholar.

3.7.2 Questionnaire

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from respondents. This study employed a researcher administered questionnaire because it was less costly and allowed the researcher to gather information from a large audience in a relatively short period of time [(52)]. Questionnaires were administered by three trained research assistants to participants that were sampled. The questionnaires captured information regarding the farming methods used by the small holder farmers in growing maize. Such information included; Major maize varieties grown in the area; those grown by the respondents and reasons why they prefer growing such varieties. Captured information also included; the yields of maize attained as a result of practicing the different farming methods; challenges faced during the production and marketing of maize as well as the different measures used by farmers and government to address the said challenges.

3.7.3 Interview Guide

To complement the quantitative data generated by questionnaires, qualitative data was collected from key informants using an interview guide. An interview guide is a data collection tool that contains a list of structured questions that the researcher uses to guide the discussion with key informants[(52).] This method of data collection enabled the researcher to gain more insights into the traditional and modern farming methods used by the small holder maize growing farmers in the area, commonly grown maize varieties, challenges faced in the production and marketing of maize as well as measures employed to address the experienced challenges. Information collected from key informants served to validate and complement the information given by the maize growing farmers.

3.8.0 Data analysis

3.8.1 Quantitative data

Quantitative data generated through questionnaires was analyzed using the Statistical Package for Social sciences (SPSS). The software package is very good for analyzing survey data and can perform highly complex data with simple instructions [(52).] Descriptive statistics such as percentages were computed to determine yields of maize realized in relation to practicing the different farming methods; challenges faced by farmers in the production and marketing of maize, strategies used to address them as well as the maize farming practices used. Chi square tests were run to see whether there exists a relationship between methods used and yield potential as well as methods used and income realized. T- Test were run to establish the strength of the relationship.

3.8.2 Qualitative Data

Content analysis was used to analyze qualitative data. Qualitative research scholars highlight that the method follows a systematic procedure that can easily be replicated by other researchers and also yield results with high reliability[(65, 52).] Content analysis was used to describe the different farming methods used by maize growing small holder farmers in Mukono's Nakifuma sub county; the challenges that farmers do face while producing and marketing their maize as well as the measures employed to address the said challenges. The researcher came up with merging themes that were used to describe farming methods, challenges faced by the small holder farmers while growing maize and the measures used to address the challenges. These were entered into SPSS and analyzed using frequencies and percentages. Frequencies of these themes were used to understand which themes appeared more than the other throughout the study[(66).]

3.9 Data Management, Processing and presentation

Data management describes the process of organization, storage, preservation and sharing of collected data which is used in a research project. Data management encompasses the everyday handling of research data throughout the period of a research project[(52).] In the present study, field data was edited and entered using SPSS. All data collected was reviewed at two levels prior to data entry into the research database and upon entry prior to analysis. The data collection and entry process was planned in such a way that all data collection sheets completed in a day were reviewed and entered on the same day.

Qualitative data was presented in form of themes and data extracted from questionnaires was coded presented in form of tables, charts, and graphs.

3.10 Validity of instruments

Validity is the measure of how appropriate and the extent how a research instrument quantifies what it is intended to measure [(54)]. In order to attain this, the researcher availed the instrument to the supervisor and any other scholars with the understanding of the subject matter to evaluate the appropriateness of the research tool. In this assessment, Content Validity Index (CVI) was obtained. Content validity index was computed as average percentage score of relevant questions using the formula below.

$$CVI = \frac{R}{R + N + IR} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

Where CVI=Content Validity Index

R=Relevant Questions

N=Neutral Questions

IR=Irrelevant questions

Interpretation: The CVI value from 0.7 to 1 is interpreted as high, implying that the data collection tool contains highly valid objective questions while <0.7 is low validity.

3.10.1 Reliability

Reliability is the consistency of an instrument to produce the same results each time it is measured under the same conditions with the same subjects. Meaning, the questionnaire administered to the respondents should provide similar information and not differing from the objectivity of the study[(52, 54).] Consistency was ensured through the test-retest approach. The questionnaire was administered to a sample of 20 people with characteristics similar to those of the specific study area. That is to say, another sub county in Mukono with maize growing farmers. The sample size was chosen because it is the smallest number that can give meaningful results on data analysis in a survey study[(52).]Test–retest reliability was carried out in a lapse of two weeks before carrying out the study. After realizing that instruments produces similar results, the researcher therefore inferred that the instruments are reliable for use and later used them to carry out the study

3.10.2 Quality Control Methods

Data collection tools were pretested in similar setting but in a different district and the results were used to review the questionnaire and corrections were made before actual data collection. Strict supervision of the data collection process was carried out at the field level by the researcher; meanwhile any inconsistencies and errors were checked and solved immediately. The researcher ensured that all completed forms from the field are reviewed daily and on-the-spot feedback was provided with follow-up undertaken, where needed. Data collection instruments that are completed were signed by the

researcher and were transferred for data entry on that very day. Data collection instruments was coded with unique ID numbers to make them traceable. The researcher verified how data has been coded and entered into the computer.

4.0 Research Findings, data analysis and interpretation

4.1.0 Demographic characteristics of Respondents

4.1.1 Location of participants in the study

The largest number of respondents were from Nagojje parish accounting for 33 percent with a frequency of 127 respondents, with the least number of participants from Kasawo accounting for 6.3 percent of the sampleas shown in Table 4.1. This finding corresponds with demographic statistics given by a key informant of Nakifuma Sub-County during interview; who reported that '*Nagojje has the largest proportion of smallholder farmers engaged in seasonal maize farming activities.*'

Table 4.1: Location of participants (Primary data)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nagojje	127	33.1	33.1	33.1
	Nabbaale	44	11.5	11.5	44.5
	Kimenyedde	94	24.5	24.5	69.0
	Kasawo	24	6.3	6.3	75.3
	Seeta	95	24.7	24.7	100.0
	Total	384	100.0	100.0	

4.1.2 Gender of participants

Study findings indicate that the largest proportion of participants were women representing 54 percent of the sample population with a frequency score of 207 respondents; a mean of 1.54 and a standard deviation of 499 and the number of male participants is 177 representing a percentile of 46. This primary data finding resonates with secondary data on the sex rations of Mukono and interview data obtained from a local leader of Nagojje who reported that '*most farm activities are done by women*.

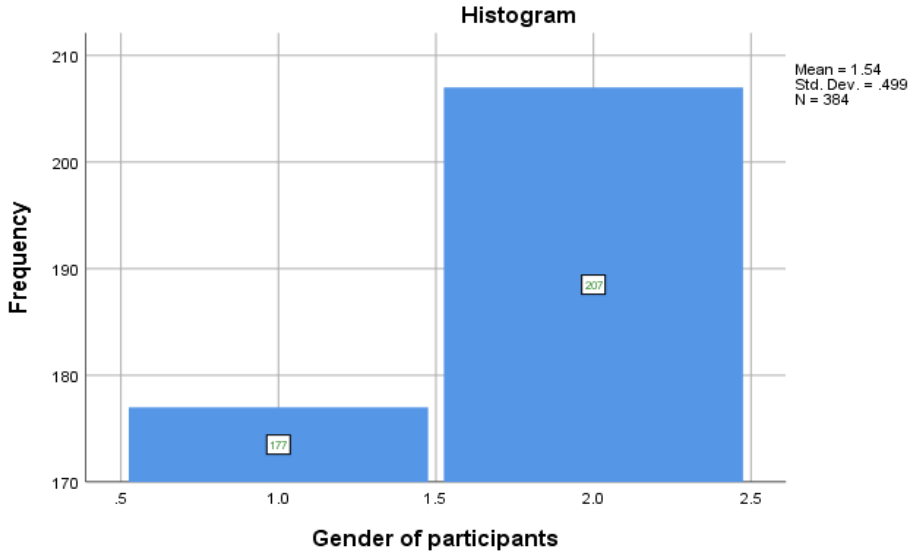

Figure 4.1: Gender of participants

4.1. 3 Relationship between gender and level of education

Primary data findings highlight a positive relation between gender, and level of education. The largest proportion of respondents are semi-literate with formal education up to secondary level with a frequency of 310 of the sampled respondents. Few respondents have attained university education with the largest mean of participants with university education being females in parishes of Kasawo, Seeta, and Kimenyedde.

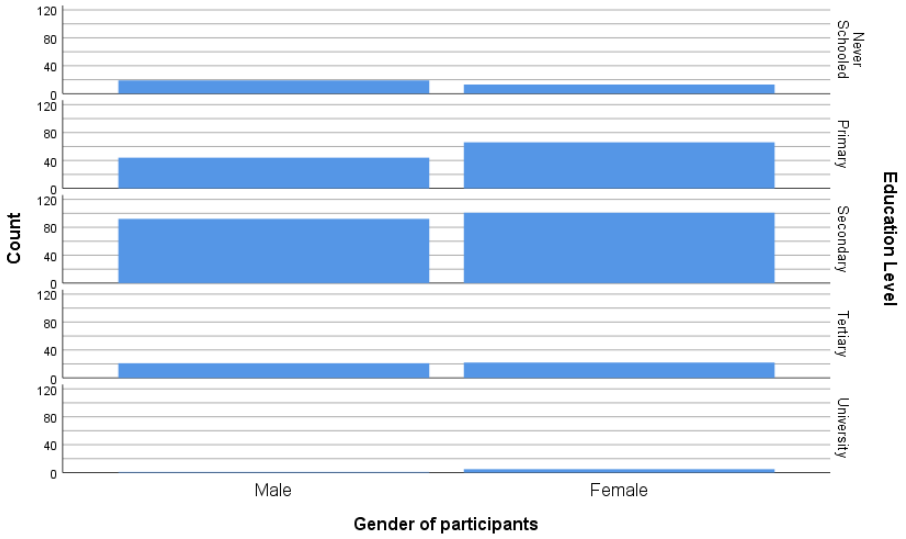

Figure 4.2: Relationship between gender, and level of education

4.1.4 Age of respondents

Primary data findings on the age of respondents indicate that the largest proportion of the respondents were adult youth from 28-37 years accounting for 36 percent of the sample population. The least proportion of respondents were young adults 18-27 years who accounted for 11 percent of the sample with a frequency count of 43 respondentsas shown in Figure 4.3. This finding correlates with the qualitative response from a local leader of Seeta who reported that '*most of the young people in Mukono detest smallholder farming in preference for less menial jobs in towns.*'

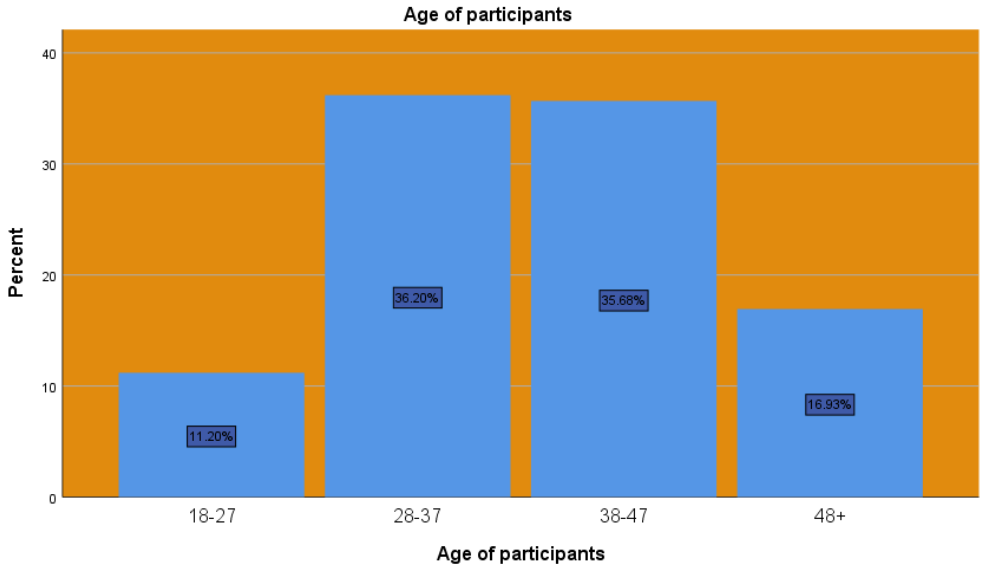

Figure 4.3: Age of participants

4.1.5 Tenancy status of smallholder farmers

Primary field data shows that 59 percent of the sampled participants have ownership/permanent tenancy on land and 41 percent of maize growers practice farming on rented land as shown in Figure 4.4. However, participants owning land; especially women have low/limited permanent tenancy rights as they are considered '*Bibanja*' owners.

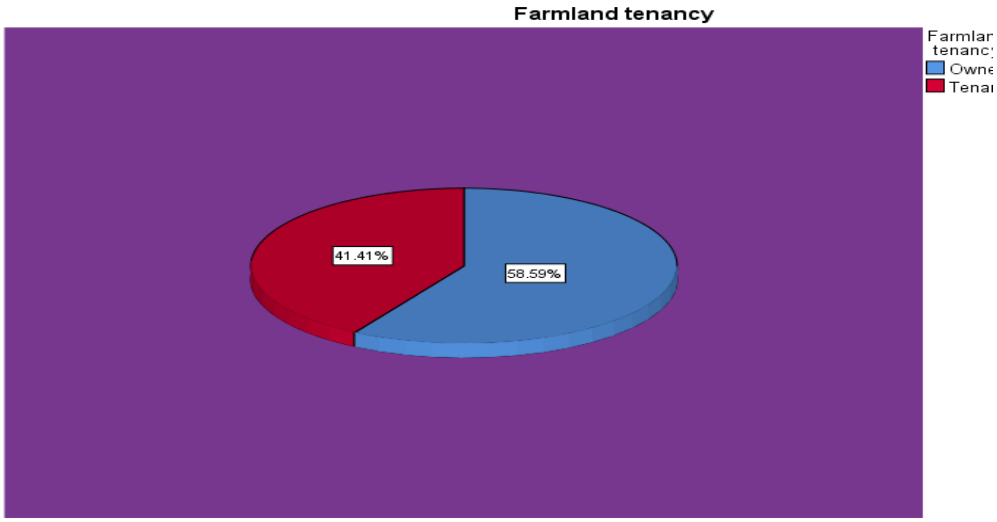

Figure 4.4: Farmland Tenancy of smallholder maize farmers

4.1.6 Main maize varieties grown by farmers

Study findings indicated that smallholder maize farmers mainly use three main maize varieties-Bazooka, Longe 9H, and Longe 10H. However, the dominant variety is Bazooka with a percentile of 54 participants reporting use of Bazooka. The least grown variety is Longe 10H; as a paltry 8 percent of sampled smallholder maize farmers plant it. The largest proportion of farmers growing Bazooka, Longe 9H and Longe 10H is in Nagojje with a frequency of 127 respondents.

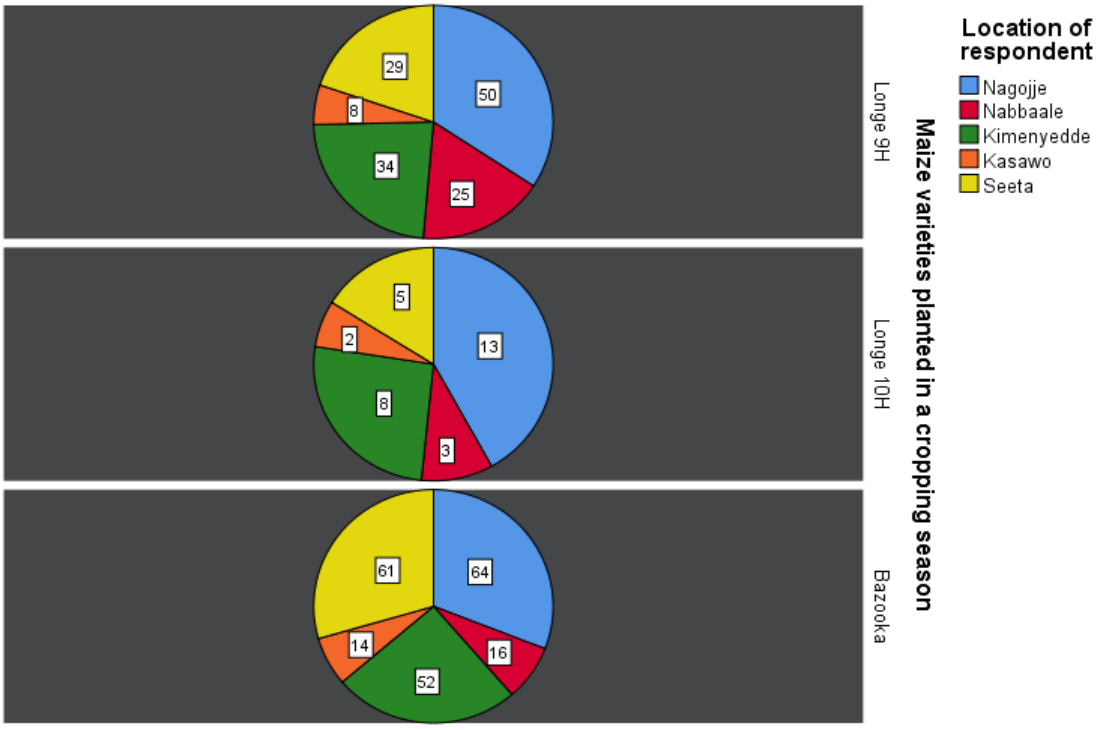

Figure 4.5: Main maize varieties planted by farmers

4.2 Main farming methods used by smallholder maize farmers in relation to their location and maize variety

Participants in the study reported that they use three methods of farming; Traditional, Modern (mainly use of capital intensive technologies), and improved/mixed method (involving use of improved techniques such as watering cans, and generators for pumping). 51% of farmers use traditional methods, 15% use modern methods 34% use mixed methods of farming. In relating a farming method to the maize variety, 57% of farmers planting

bazooka use traditional farming methods involving menial operations. 31% of farmers using Mixed farming methods mainly grow Longe 9H as shown in Figure 4.6. 18% of farmers are using modern farming methods. In Kasawo for instance, there is no Longe 10H farmer using modern farming methods such as tractors.

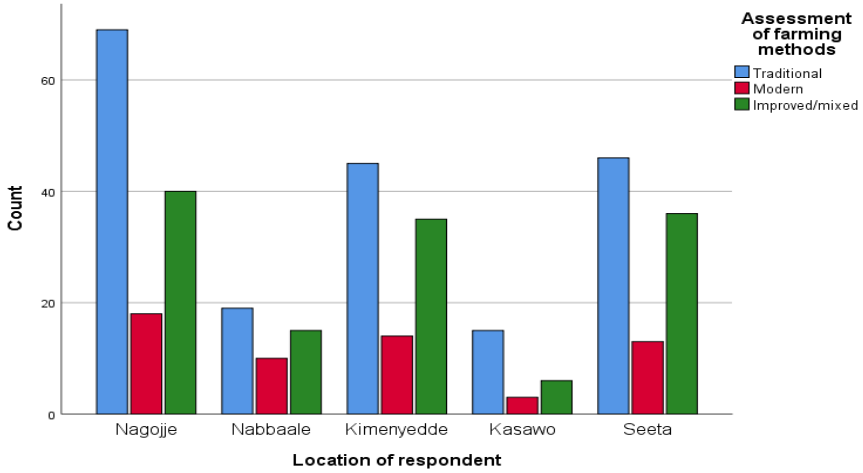

Figure 4.6: Assessment of the main farming methods used by maize farmers

Most farmers reported that the predominance of traditional farming methods mainly involving the use of subsistence tools such as hand hoes for farming is accounted for by the shortage of finances to secure modern tools, small land acreage that hinders mechanization and unscrupulous landlords who seasonally rent land limiting long-term investment.

4.3 Effect of a farming methods on yields in Mukono

The domination of traditional farming methods implies that most farmers still harvest low yields. Farmers yielding maize of less than 1000Kgs/1 ton per harvest, predominantly use traditional farming methods. Generally, adoption of modern methods is low and for the few farmers using it, yields are still low. For instance, in Seeta, out of 42 farmers who harvested yields in excess of 1000KGS/1 ton, only 3 use modern methods. Modern methods of farming have not increased bumper harvests yet. For instance, 10 percent of farmersyielding maize of less than 1000 Kilo grams per hectare per harvest, predominantly use traditional farming methods. 18 percent of farmers using mixed farming practices have experienced a relative increase in farm harvests especially in Kimenyedde where a frequency of 21 participants reported harvesting in excess of 1000KGS due to use of mixed farming methods. Generally, adoption of modern methods is low and for the few farmers using it, yields are still low. For instance, in Seeta, out of 42 farmers who harvested yields in excess of 1000KGS, only 3 use modern methods.

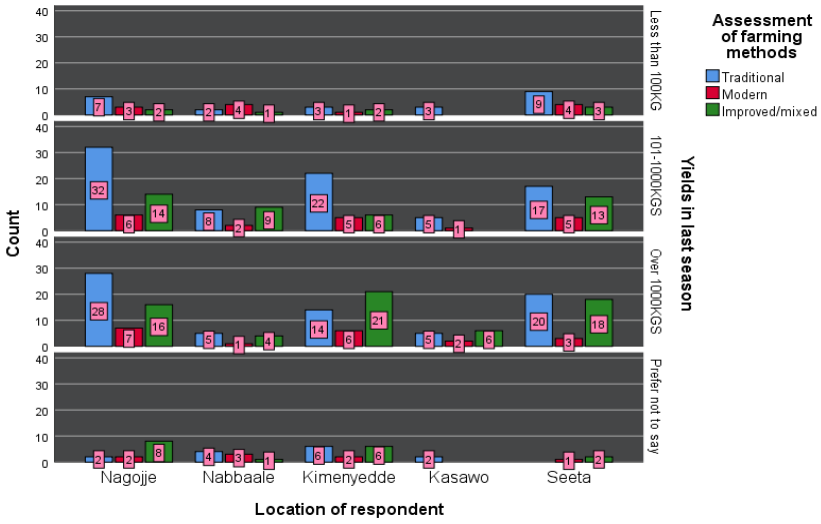

Figure 4.7: Examining the effect of a farming method on yields

4.4 Income returns of smallholder farmers

Farmers reported that most of the maize yields are sold at prices ranging from below 200 Uganda shillings with seasonal high prices of 500-100 Uganda Shillings. However, most farmers sell their produce at relatively low price indicating relatively low benefits from maize farming. 57% of

respondents reported that they sell a kilogram of maize at prices ranging from 201-500 Uganda Shillings, 33 percent sell at prices of 501-1000 UGX and 10% sell at less than 200 Uganda shillings as shown in Figure 4.9. This means that for an average yield of 1000 Kilograms at a price of 500, farmers gain a revenue of 500,000 Uganda shillings. An interview with a key District Officer related to this finding that, '*mainly middlemen gain more profit from the produce than primary farmers. '*

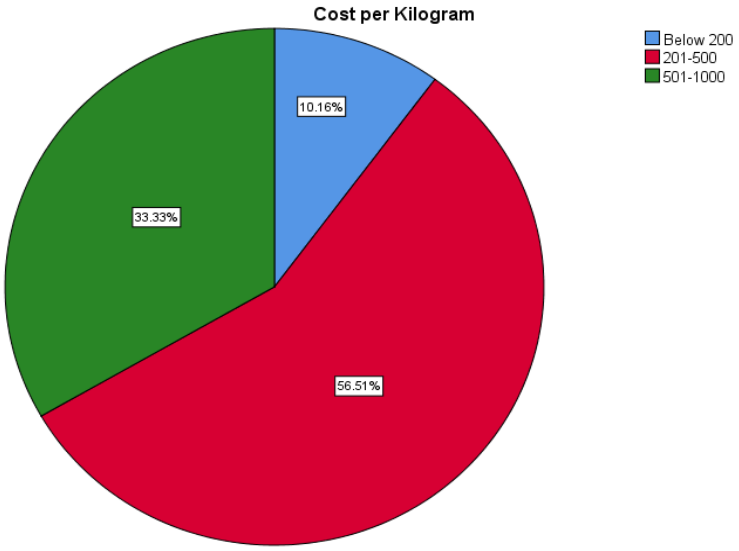

Figure 4.8 Cost/Price of harvested maize/Kilogram

4.5 Marketing and production challenges facing smallholder farmers

Study findings indicated that 99 percent of participants reporting that they find many challenges during marketing and production of maize. Participants reported that there are four main challenges including: price changes, climate change, expensive inputs and manipulation by middlemen.

33 percent of participants ranked price changes as the main challenge facing smallholder farmers as shown in Table 4.3. This correlates with an interview finding from Nakifuma as a Key informant reported that '*COVID-19 led to a fall in maize prices affecting profitability.'*

30 percent of participants reported an increasing threat of climate change that is affecting yields and farming seasons. In fact, a key informant in Nakifuma said that '*increasing dry spells are leading to stunted maize growth and low yields.'*

Table 4.2: Main challenges in the last season (Primary data)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Price changes	128	33.3	33.6	33.6
	Climate change	113	29.4	29.7	63.3
	Expensive inputs	53	13.8	13.9	77.2
	Manipulation by middlemen	87	22.7	22.8	100.0
	Total	381	99.2	100.0	
Missing	System	3	.8		
Total		384	100.0		

4.6 Perceptions farmers and government have advanced for betterment of their productive and marketing of maize.

Study findings report that 97 percent of participants acknowledge that there are drastic measures by many stakeholders including; government, NGOs, local farmer groups to redress the challenges facing smallholder maize growers. In fact, during an interview with a field team member of Nakifuma, it was reported that *'the organization conducts village trainings on the best maize farming practices in Mukono.'*

On the other hand however, 3 percent of participants especially in Kasawo reported that they are unaware of any stakeholder involved in promoting or helping smallholder maize farmers address the main production and marketing gaps they encounter.

Figure 4.9: Knowledge of strategies to boost farmers' productivity and incomes

4.6.1 Perceptions on strategies by government to boost farmers' productivity and incomes

Participants in the study reported that government has designed some measures to boost incomes and productivity ranging from: promoting agricultural finance, rural road extension, encouraging of 'emyooga' programme, and rural extension work.

An interview with a key informant in Nakifuma reaffirmed this by stating that '*government is trying to extend agricultural support services to all rural farmers.'*

The most commonest and reported government strategy is promotion of agricultural finance as 35 percent of participants reported about it and the least strategy in villages is the encouragement of the emyooga with a percentile of 17 percent.

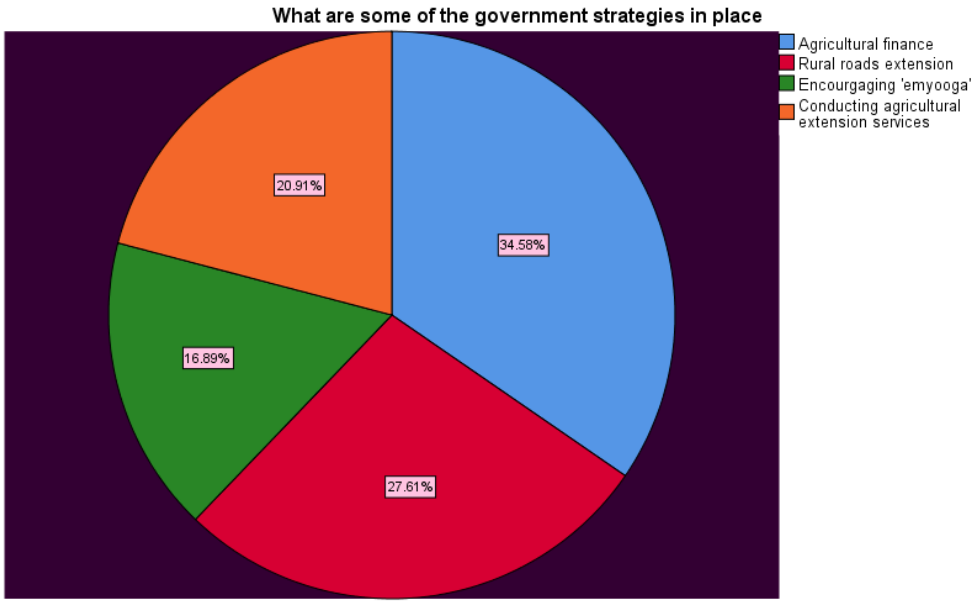

Figure 4.10: Government strategies to promote smallholder maize production and marketing

4.6.2 Perceptions of other strategies by other stakeholders to boost maize productivity and income

Participants reported that other stakeholders including local farmers' groups have developed complementary strategies including: training of farmers, formation of rural agricultural/farmers' groups, seasonal savings, seasonal use of manure, and promotion of integrated farming.

An interview with a member of the *Twezimbe* Women's SACCO in Nagojje contends that '*women in farming are encouraged to save through weekly bibiina, and trained on better farming practices.*'

The most dominant rural stakeholder strategy is training of rural farmers via local groups sustainable farming practices; and this accounts for 35 percent of the participants' sample population as seen in Figure 4.11 below.

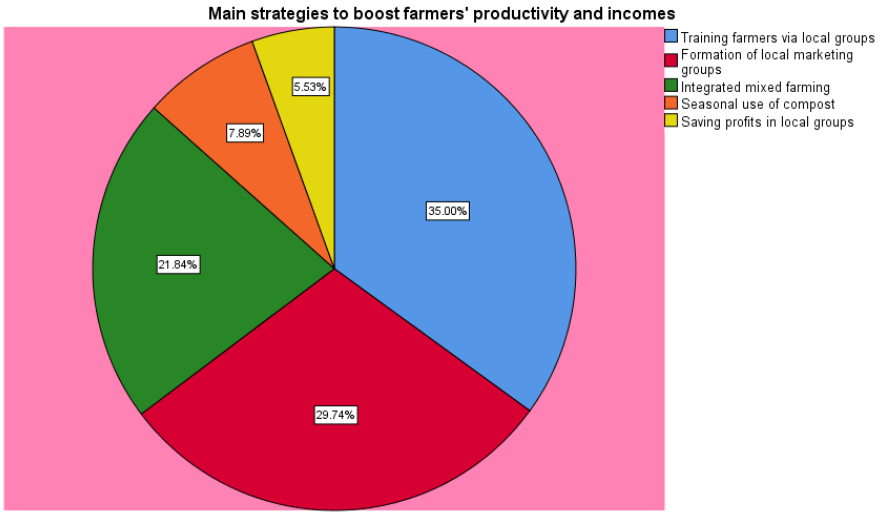

Figure 4.11: Other main strategies to boost farmers' productivity and income

5.0 Discussion, conclusions and recommendations

5.1 Assessment of the farming methods used by smallholder maize farmers for increased production and income

Study findings reported that most maize farmers are using traditional farming methods and the few who have adopted modern methods are yet to reap benefits. This finding highly correlates with a study on subsistence farming in sub-Saharan Africa that documented that about 70 percent of rural farmers use traditional farming practices that has led to chronic harvesting of low quality and quantity yields [67, 68, 8].

Furthermore, a report by MAAIF on the state of the rural agro-sector reports that though rural farmers are transitioning to better and modern farming practices[69, 29], the low levels of technological use and low capital base has led to the underutilization of modern technologies[69]. This relates to a study finding in Seeta parish that indicates that only 3 maize farmers transitioning to modern farming methods have harvested yields in excess of 1000KGS.

5.2 Effects of maize farming methods on the harvests and incomes of smallholder maize farmers

Field data shows that the domination of traditional farming methods implies that most farmers still harvest low yields. Modern methods of faring have not increased bumper harvests yet. For instance, farmers yielding maize of less than 1000 Kgs per harvest, predominantly use traditional farming methods. A few farmers using mixed/improved farming practices have experienced a relative increase in farm harvests especially in Kimenyedde where a frequency of 21 participants reported harvesting in excess of 1000KGS due to use of improved methods. However, 98 percent of respondents reported that harvested produce is used for household consumption.

This report matches the 2020 EPRC report on food production systems in rural areas that ideates that about 70 percent of the produce is meant for agricultural production [70, 69, 15]. A comparative study by the FAO on food chain system in Uganda documents that though most rural farmers aim for selling of produce to meet their household needs [71, 2], the huge household demands necessitate the diversion of farm produce for household consumption [72].

However, a regional report on maize markets in East Africa comparatively refutes this observation. In fact, during the recent COVID-19 pandemic, a UBOS survey indicated that most smallholder farmers are focusing on marketing produce to neighboring countries[62] such as Kenya due to a surge in Markets [73]. This correlates with the field finding that most smallholder farmers owning land in excess of 2 acres and producing harvest in excess of 1000KGS are focusing on marketing produce to reap from the relatively higher prices in regional countries compared to Mukono.

5.3 Challenges faced by smallholder maize farmers during production and marketing

Study findings show that 99 percent of participants experience production and marketing challenges. A breakdown on occurrence of challenges exposed that 51 percent of the challenges are experienced during production including climate change, and unfavorable land tenure. This positively

relates to a study by MAAIF on bottlenecks to Agricultural financing that revealed that over 60 percent rural smallholder farmers in Central Uganda have insecure tenure [15, 69, 70] and are increasingly becoming vulnerable to climate and environmental shocks[74].

Furthermore, a report by the Bank of Uganda on structural bottlenecks in rural farming revealed that gendered disempowerment affects women financing and also access to agricultural support services[72, 70]. A financial stability report in Uganda's agribusiness marketing chains documents that increasing domination of maize monopolies and middlemen has led to artificial price changes and falls leading to low profits among smallholder maize farmers [70].

5.4 Perceptions being undertaken by farmers and government to address production and marketing challenges facing smallholder maize farmers.

Participants in the study reported that government has designed some measures to boost incomes and productivity ranging from: promoting agricultural finance, rural road extension, encouraging of 'emyooga' programme, and rural extension work. Furthermore, participants reported that other stakeholders including local farmers' groups have developed complementary strategies including: training of farmers, formation of rural agricultural/farmers' groups, seasonal savings, seasonal use of manure, and promotion of integrated farming.
An interview with a member of the *Twezimbe* Women's SACCO in Nagojje contends that '*women in farming are encouraged to save through weekly bibiina, and trained on better farming practices.*'
These observations are in tandem with the National Development Plan III and government targets on promotion of smallholder farming[74]. Through the parish model, the government is using the 'emyooga' programme to incentivize rural farming and promote value addition so as to boost markets[75, 78].
The 2020 Agricultural Credit Facility (ACF) report further confirms that government is embarking on women and smallholder rural farmers' financing though waiving and developing alternative collateral to promote rural farming and agribusiness[70,75]. Through the Bank of Uganda, the ACF has been refinanced with over 120 billion to support smallholder farmers [70].
The observation that rural stakeholders are designing strategies to support farmers rhymes with a study recommendation on reviving agri-business in Africa that observed that the merging of government efforts with local initiatives by stakeholders[15, 68] and civil society leads to increased knowledge[2, 3, 72, 71, 76] and skilling of smallholder farmers better farming practices (Lusembo, 2004) that boost yields, quality and marketability[72, 67]. A quantitative finding by Northern Uganda revealed that rural agricultural support services have a 60 percent probability of reviving farmers' yields and incomes [77, 78].

5.5 Conclusion

There is increasing evidence that smallholder maize farmers in Mukono are increasingly engaging in both small and medium production and marketing for agro-income generation. However, practical insights in Mukono and Nakifuma on the nature of maize marketing and production chain evidences that most farmers are involved in informal production and marketing using rudimentary methods that are prone to socioeconomic shocks such as the current COVID-19 pandemic, minimum chances of business expansion and economic disincentives that increasingly reduce the profitability of businesses and insecure production mechanisms dotted with insecure tenure and ignorance on lucrative marketing channels. This has led to reduced economic benefits for socioeconomic development and livelihood improvement. On average, smallholder maize farmers in Mukono produce about 500-1000 kilograms of maize per season which is comparatively low compared to the amount of inputs. This low return is mainly attributed to climate change, increased soil infertility partly due to continuous farming using pesticides, presence of middlemen who manipulate farmers and use of traditional farming methods. Thus, a new collaborative, inclusive and feasible empowerment and inclusive strategy needs to be systematically developed and incorporated into local governance systems in Mukono to boost the maize production and marketing value chain to boost smallholder farmers' incomes.

5.6 Recommendations

- Mixed methods of farming should be promoted to improve on the yields of maize in Mukono district.
- Government should setup local maize or agricultural stores to store the produce during bumper harvests. This can also help in eliminating middlemen who exploit farmers during bumper harvesting seasons.
- Subsidies on agricultural inputs like the seeds, machines should be provided by the government to encourage farmers buy the inputs that can lead to increased yields and incomes.
- Further areas of research could include: Examining the perceptions of smallholder maize farmers towards transitioning from traditional to modern maize farming technologies and methods in rural Uganda, A comparative analysis of the costs and benefits of using modern farming methods and technologies among smallholder maize farmers in Uganda.

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Declaration
The author declares that this work has never been published anywhere.

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