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# Factors Affecting Maize Production in Kiteto District, Manyara Region, Tanzania: Cross Sectional Design

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**ABSTRACT**

*Maize is one of the most important food crops globally; however, its production in most of the developing countries has been facing several challenges that also affect the livelihood of the large number of smallholder farmers who highly depend on the crop for food and income. Therefore, to deepen understanding of the same, the current study explores factors affecting maize production in Kiteto district, Manyara, Tanzania. This study employed a cross-sectional research design to gather primary data from a randomly selected sample of 100 individuals. The data was analysed using the multiple linear regression technique. The findings revealed that farm size (0.0083, p<0.01), access to irrigation (0.0878, p<0.01), and access to improved seeds (0.0582, p<0.01) had a significant statistical influence on the level of maize production. Furthermore, regarding the challenges, the results were analysed through the utilisation of measures such as the mean, frequencies, and percentages. Furthermore, the study found that shortage of rainfall, maize price fluctuation, diseases, and pests were the main challenges facing maize farmers in the study area. The study findings recommend that in order to improve maize production, there is a need to increase accessibility to irrigation facilities, improved seeds, fertiliser, and modern farming techniques among smallholder maize farmers, and this may be done by the government in collaboration with the private sector.*

**Keywords:** Agribusiness, Agriculture, Climate Change, Livelihood, Poverty

## I. INTRODUCTION

The maize crop is one of the most important staple food crops in the world, where globally it is estimated to be grown on about 197 million hectares of land and on about 40 million hectares of land in Sub Saharan Africa (Abdulai et al., 2017; Huma, 2019). In Africa, maize made up about 20.9% of global land under maize production (Abdulai et al., 2017). This made maize the most widely cultivated crop in Africa (second) compared to other cereals (Epule et al., 2022). Recently, Africa experienced a rapid increase in the demand for maize, which led more land to be devoted to maize production (FAOSTAT, 2019; Romy, 2020; Kitole et al., 2023). However, recently, most developing countries, particularly African countries, have experienced a decline in maize production despite the large area devoted to maize production. In Africa, maize production stands at 2.1 tonnes/ha, which is lower compared to other countries, for instance, Asian countries, whose production stands at 5.4 tonnes/ha (FAOSTAT, 2021). According to Kitole et al. (2024), the East Africa region experienced a maize production deficit of 97,000 million tonnes in 2022/23, which is 112 percent higher mainly due to poor rainfall performance, and Tanzania, since it is a main producer in the region, is expected to have an export surplus of 20% below in 2022/23.

Smallholders are the main maize producers in developing countries, specifically in Africa (Epule et al., 2022). In Tanzania, this group contributes to about 85% of maize production (Suleiman & Rosentrater, 2015), but is exposed to a number of challenges that limit their production capacity. low maize production due to several challenges, mainly drought, political insecurity, poverty, rapid population growth, land shortages, pests and diseases, and shortages of rain, and this situation created some production deficit compared to its level of consumption that led to about 240 million people, which is almost 20% of sub-Saharan Africa, with food shortages (Lee et al., 2022; Kitole et al., 2023). Moreover, in Tanzania, smallholder farmers are facing challenges in their production, including unreliable rainfall, pest and disease fall of army worms, inefficient extension services, and post-harvest loss (Baijukya, 2020).

Tanzania has implemented several initiatives and strategies to address the challenges affecting maize production, aiming to enhance maize production among smallholder farmers, who are the primary maize producers in the country (Utonga, 2022). The new seventeen Sustainable Development Goals (SDG), which include ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture, serve as the foundation for some of these initiatives. The Tanzanian government has taken several measures to boost maize production and agriculture at large in order to ensure economic development and the availability of food. The country introduced some institutional initiatives, including the National Strategy for Growth and Reduction of Poverty one and two (NSRGP I & II), the introduction of District Agriculture Development Plans (DADPs), and the establishment of the Agriculture Sector Development Programme (ASDP), whereby all these strategies aimed at the transformation of agriculture, promoting yields, including increased maize yields in the country, and promoting livelihood and economic growth (Utonga, 2022; Kitole & Utouh, 2023; Utouh, 2024).

Tanzania's smallholder farmers, who are the primary producers of maize in the country, continue to struggle with low production levels despite the significant contribution of maize to the country's economy (Xiong & Tarnavsky, 2020). Currently, Tanzanian maize production stands at 1.2 to 1.5 tonnes per hectare, which is considerably less than the recommended global average yield of 4.3 tonnes per hectare (Utonga, 2022; Fumbwe et al., 2021). The limited production leads to various shortcomings, including a decrease in personal and national income, amplified food insecurity among Tanzania's growing population, and an escalation in levels of poverty within the country (Lobulu, 2019; Kitole, 23). Gaining a thorough comprehension of the variables that influence maize production among smallholder farmers is crucial for enhancing the effectiveness of response mechanisms pertaining to maize crop growth, both in government and private organisations within the nation. This study aims to fill the existing knowledge gap by conducting a detailed spatial analysis of the factors that influence maize production in Kiteto town and rural areas. The study focuses on three main factors: production factors, institutional factors, and socio-economic factors that impact maize production in Kiteto District.

## II. LITERATURE REVIEW

### 2.1 Theory of Production

This study is guided by the theory of production. The theory of production was developed from the work of in Smith 1776 in his article on the wealth of the nation (Foss, 1997; Lewis, 1988; Smith, 2005; Smith, 2010; Boucoyannis, 2013; Collins, 2017) . The classical views of the theory of production only consider the physical factors that are directly involved in production. Basically, the theory of production is simply the application of constrained optimisation, which either minimises the cost of producing a given amount of output or maximises output level with an affordable level of cost.

The production function is a model used to analyse the existing relationship between dependent and independent variables (Ntabakirabose, 2021; Kitole & Sesabo, 2024). The theory of production is a step forward to explain the principles by which a firm decides how much of each commodity that it sells (its “outputs” or “products”) it will produce and how much of each kind of labour, raw material, or fixed capital good that it employs (which are inputs or factors of production) it will use. The theory involves some of the most fundamental principles of economics. According to Dhakal et al. (2022), the theory of production is displayed with the aid of the production function. The production function is a mathematical equation that describes the technical relationship that transforms input (resources) into output (commodities). And production function takes a number of forms, but in general, production function can be written as:

$$Y= f (K, L)$$

Where Y represents firm output, K represents the level of capital, and L represents the level of labour force used in production. Thus, the production function represents the maximum quantity of output (Y) that can be produced by the combination of two input factors, labour and capital. The above relation described by the production function is that the given output Y can be produced by using more capital K and less labour or by using more labour L and less capital. In this study, the theory of production provides a basic understanding of how high maize yield or production is obtained at the expense of many factors, such as production factors, institution factors, and socio-economic factors.

### 2.2 Empirical Literature Review

Njogu (2019) observed that tilling by using tractors has a significant and positive effect on maize production, and the positive impact is due to the fact that preparation of farms by using modern means (tractors) increases maize production since farmers are able to cultivate large areas in a reasonable time, compared to those who apply traditional farm practices, whereby 69.02 of the respondents were using tractors and the remaining 30.98% were using manpower in tilling their farms. On the other hand, Mohammed (2021) found a significant positive relationship between land size under maize cultivation and the quantity of farmers’ maize production in the study area, and the study observed that an increase in the land size under maize cultivation resulted in a significant increase in the level of maize production.

According to Ogujiuba et al. (2021), the number of labourers working on the farm was found to have a positive and statistically significant influence on small-scale maize production in the study area, where it imposed a greater influence than any other actor. Additionally, according to Mohammed (2021), access to fertiliser among small-scale farmers is an important factor in their maize production since it increases their production level by enhancing maize yield and quality. The study found that access to fertiliser has a positive and significant effect on the level of maize production. That is, farmers who access and apply fertiliser, both manure and chemical fertiliser, have high production compared to others; hence, the amount of fertiliser used by the farmer leads to a significant increase in the quantity of maize. Also, Eticha (2020) found that improved maize seeds have a positive and significant effect on maize production results; 56.2% (59) of respondents used improved seeds while 43.8% (46) did not use modified seeds, and the results of the study indicated that farmers were aware of the nature and importance of improved seeds. In addition, FAO (2015) argues that the higher the age of the household head, the better the family maize production, due to the fact that elder people have a lot of farm experience. The results are incongruous with the study by Ombuki (2018), which found the age of the farmers had an insignificant influence on maize production in selected areas, and it was proposed from such a result that the result could be linked to the fact that the older the farmer, the less efficient he becomes due to his old age.

Ombuki (2018) suggested that education is social capital that impacts households with the ability to improve maize productivity, since education attainment by the farmers could lead to awareness of the available advantages of modern agricultural technologies, the ability to understand the instructions provided on the input packages, and the ability to easily adopt new and modern farming practices, hence increasing farm production. The study findings indicated that the educational attainment of household heads had a statistically significant effect on maize production. In a study conducted by Yassoungo (2018), it was discovered that 63.5% of the participants did not have any formal education, 24% had never received any type of education, and the remaining 12.5% had acquired a formal education According to the findings of Yassoungo (2018), a proportion of the participants (63.5%) lacked formal education, while 24% had not attended any educational institution. The remaining 12.5% possessed formal education. The findings of the study indicate that maize production is negatively affected by a low level of education, which can be attributed to a diminished receptivity to modern technologies and innovations. Additionally, family size has a negative and considerable impact on maize production, according to a study by Tuki (2020). This suggests that maize production decreases as the number of households increases, as land fragmentation among the household heads reduces the area designated for maize cultivation, consequently leading to a reduction in the yield attained.

In addition, Ashenafi et al. (2022) discovered that among the respondents interviewed, the proportion of males engaged in maize production was higher than that of females among small-scale crop producers in the three districts. This suggests that female participation in the area is extremely limited. The result demonstrates that the region is predominantly characterised by households led by males. In addition, Utonga (2022) discovered that the number of years experienced in farming had a positive and significant effect on the amount of maize produced. These findings suggest that experienced farmers who have spent a significant amount of time cultivating maizedevelop a deep understanding of the local climate patterns and are skilled at managing maize diseases. This enhances their maize output.

Moreover, several studies have been conducted in developing countries on assessing the influence of access to credit facilities among farmers on maize production, including one in Zimbabwe by Gracian (2019). The study found that 64.9% of farmers never received loans from financial institutions, while only 35.1% received loans. The results show that the majority of farmers in the study area did not have access to financial services. Also, Urassa (2015) found extension services with statically insignificant effect on maize production, even if extension services is among of key factors affecting the level of maize production , but in the study area the access to extension services was seemed as problem in a study area, and the study found that the access or non- access to extension services among surveyed study respondents was different among various age groups, many elders and middle age respondents found to have low access to extension services, since this group of respondents believe that they had required and appropriate skills based on the number of years they spend on farming experience, while young groups mentioned ignorance as a major factor which hinder them the access to extension service. Furthermore, Eticha (2020) found the majority used irrigation services in their plantations; for instance, 66.7% of the farmers had access to irrigation facilities and only 33.3% did not, and such results reveal that irrigation services have a positive relationship with the quantity of maize harvested. In addition, Tuki (2020) suggested that farmers nearest to the market centres play a significant role in maize production, and it was found to have a positive and significant influence on maize production, and this was because farmers near marketplaces did not incur high marketing costs to reach market centres.

## III. METHODOLOGY

The study was carried out in Kiteto District, Manyara Region, Tanzania. The district shares borders with Simanjiro District to the north, Tanga Region to the east, and Dodoma Region to the south and west. Kiteto District has a total area of 16,865 km2 which is equal to 34.1% of the total land area in Manyara Region. The district is found between 36 15' and 37 25' east longitude, and between 40º 31´ and 6 º 03´ south latitude. Kiteto District is located at an altitude between 1000 metres and 1000 metres above sea level, and there are two weather seasons per year, which are spring and summer. Spring is from December to May, and summer is from June to November. A district also receives an average of 500 mm to 650 mm of rain per year.

### 3.1 Research Design

This study employed a quantitative research approach to collect data from the respondents in order to respond to the research questions. A cross-sectional research design was employed as a quantitative research methodology, wherein data were gathered from study respondents at a single instance without any repetition from the sample population. The cross-sectional research design is useful and convenient for comprehensive data collection, cost-effective, and efficient in terms of time, as it requires less time to execute. The study employed both probability and non-probability sampling techniques to select a representative sample for information collection. The sampling method known as non-probability sampling selects samples according to the study's purpose. For the study, we applied a purposive sampling procedure based on non-probability sampling to select district maize producer wards, namely Matui, Engusero, Namelock, and Partimbo, based on their maize production intensity and district contribution.

Thereafter, a simple random sampling method was used to determine the size of the sample from a significant population or to determine the sample size of farmers from the purposively selected ward. This simple random sampling is also known as probability sampling because each unit in the population has an equal chance of being selected as a sample for the study. Simple random sampling was applied by the study because it removed bias from the information collected.

### 3.2 Sample Size

The study employed Yamane's (1967) formula to obtain the sample size to be used in the study. The formula states that $n = \frac{N}{(1+N(e)^2)}$, whereas $N$ is a total population available in four selected wards, which is equal to 97,919, $e$ is the error of 10% (0.1), and $n$ is the calculated sample size. Therefore, based on the formula, the estimated sample size is 100 smallholder farmers;

$$n = \frac{97{,}919}{(1 + 97{,}919(0.1)^2)} = 99.9 \approx 100$$

### 3.3 Data

Based on the nature of this study, which is to examine determinants of maize production among smallholder maize farmers, the primary type of data was used and was collected directly from the selected sample of smallholder maize farmers found in Kiteto District. Also, for this study, primary data were collected by using administered questionnaires, which contained a set of questions predetermined in chronological order to collect quantitative primary data from selected sample respondents.

### 3.5 Analytical modeling

The production function based on this study is used to show the maximum quantity of maize produced from the combination of various inputs (factors affecting maize production). Therefore, this study uses the Ordinary Least Squares model (Multiple Linear Regression (MLR)) to analyse factors affecting smallholder production in Kiteto District, as shown below:

$$Z = T(Q_1, Q_2, \dots, Q_n) + v$$

Given that the MLR model is just an extended model for simple linear regression normally it has to adhere to the Gaus-Markov assumption of zero mean and constant variance such that $\varepsilon \sim N(0, \sigma^2)$. of which now the general equation of the model that has been employed is given as:

$$Z = \alpha_0 + \alpha_1 Q_1 + \alpha_2 Q_2 + \dots + \alpha_n Q_n + v$$

Whereas $Z$ represents the amount of maize produced, while $\alpha_0$ is the constant term indicating the value or the amount of maize produced given other factors are constant, and $\alpha_1$ to $\alpha_n$ and variables or factors that affect maize production, which includes the demographic, socioeconomic and institutional factors, and $v$ is the error term. Moreover, to add value to these variables that have been included in the general MRL equation, Table 1 provides a list of variables and their measurements as used in the study.

**Table 1**
*Variables Measurements their Expected Signs*

| Variable | Type of variable | Unit of measurement |
|---|---|---|
| Maize production (DV) | Continuous | Number of bags produced (90kg/bag). |
| Farm size | Continuous | Number of hectors under maize production |
| Farming system | Categorical | 1= use of tractors; 2= use of oxen; 3= use of hand hoe |
| Access of fertilizer | Categorical | 1= access to fertilizer; 2= not access to fertilizer |
| Access to improved seed | Categorical | 1= access to improved seed; 2= not access to improved seeds |
| Amount of labor | Continuous | Total number of family and hired labor employed per hector |
| Age of the farmer | Continuous | Age of the households |
| Level of education | Categorical | 1= primary education; 2= secondary education; 3= university education; 4= never attend to school |
| Income level | Continuous | Farmers monthly income in TSH |
| Farming experience | Continuous | Years spending on maize production |
| Gender | Categorical | 1= male; 2= female |
| Marital status | Categorical | 1= married; 2= single |
| Access to extension service | Categorical | 1= access to extension services; 2= not access to extension services |
| Access to credit | Categorical | 1= not access to credit; 2= access to credit |
| Family size | Continues | Number of family members |
| Use of irrigation | Categorical | 1= use irrigation; 2= not use irrigation |
| Distance to the farm | Continues | Distance in Km from home place to farm plot |
| Distance to the market | Continues | Distance in Km from home place to the nearest market |
| Farming cost | Continues | Cost in TSH |

## IV. FINDINGS & DISCUSSIONS

### 4.1 Determinants of Smallholder Maize Production in Kiteto District

Results in Table 2 show that farm size has a positive and statistically significant influence on smallholder maize production at the 1% significant level (p = 0.002). The results indicate that an increase in area under maize production results in an increase in maize production by smallholders; thus, in order to increase maize yield, it will greatly depend on an increment in the size of the land. The finding is in line with the study by Tuki (2020) on factors affecting smallholder maize farmers production and market participation in Ethiopia. The study determined that land is the primary determinant of production in rural areas. Land size has a statistically significant positive effect on maize output. Farmers who own larger land areas dedicated to maize production tend to yield a greater quantity of maize compared to others.

The study findings suggest that the availability of improved seeds had a positive and noteworthy impact on the maize productivity of smallholder farmers. The finding suggests that when smallholder maize farmers employ better quality seeds, it leads to a higher level of output of maize. This is because improved seeds enhance the quality and quantity of maize yields in comparison to traditional seeds. The finding aligns with the research conducted by Eticha (2020), which concluded that improved maize seeds had a positive and significant effect on maize yield. The study revealed that the accessibility of fertiliser had a positive and statistically significant impact on maize output in the study region, with a significance level of 1% (0.003). The data suggest that having access of fertiliser to a greater number of farmers leads to a corresponding rise in the level of maize production by smallholder farmers. The rise in the quantity of maize harvested by farmers is attributed to the improved soil fertility of the land, which is a direct result of the application of both organic and inorganic fertilisers. This results aligns with the research conducted by Utonga (2022), which demonstrated that the accessibility of fertiliser among maize farmers had a positive and significant effect on maize output. Furthermore, it was seen that an increase in fertiliser usage resulted in higher levels of maize yields. The study's findings suggest that having access to irrigation has a positive and statistically significant influence on the production of maize by smallholder farmers. This influence was observed at a significant level of 1% (p = 0.000). This finding suggests that providing maize farmers with access to irrigation can lead to higher maize yields because irrigation helps farmers mitigate the impact of climate change, particularly in areas with insufficient rainfall. By utilising irrigation, farmers can ensure higher maize yields compared to those who do not have access to it. The finding mirrored the research conducted by Eticha (2020), which revealed that the accessibility of irrigation had a favourable and substantial impact on the yield of maize. The study also revealed that a significant majority of farmers (66.7%) had access to extension services, in contrast to those who lacked access to irrigation (33.3%).

The study's findings suggest that the quantity of labour had a statistically significant positive effect on the level of maize output within the area of the study, with a significance level of 1% (p = 0.000). The finding suggests that employing more labourers in maize production will lead to higher maize production among smallholder farmers in the study area. This is because a significant number of labourers are involved in all stages of maize production, which helps to save time for each activity. The research by Dimoso and Andrew (2021) and Ogujiuba et al. (2021) supports the finding that the number of farm workers positively and statistically significantly influences small-scale maize production in the examined region, outweighing the influence of any other factor.

The results indicate that the type of farming system has a statistically significant effect on smallholder maize production. At a 5% significance level, the use of animal oxen and hand hoes both have a negative and statistically significant influence on maize production. The impact of animal oxen is significant, with a p-value of 0.014, whereas the impact of hand hoes is significant, with a p-value of 0.012.

The findings implied that the use of local farming systems led to a decrease in smallholder maize output since these methods are time-consuming and less efficient compared to tractors. The results are inconsistent with the study by which it was observed that tilling by using tractors had a positive and significant effect on maize production, and the positive impact was due to the fact that the preparation of farms by using modern means (tractors) increased maize production since farmers were able to cultivate large areas in a reasonable time compared to those who applied traditional farm practices.

**Table 2**

*Multiple regression model on determinants of smallholder maize production in Kiteto District*

| maize_productn | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| farm_size | 0.0076086 | 0.0024186 | 3.15 | 0.002 | 0.0027935 | 0.0124237 |
| ln_farming_cost | 0.0083203 | 0.011117 | 0.75 | 0.456 | -0.0138118 | 0.0304525 |
| ln_income | -0.0124274 | 0.0162104 | -0.77 | 0.446 | -0.0446998 | 0.0198451 |
| Distance_market_place | -0.00373 | 0.0028884 | -1.29 | 0.200 | -0.0094805 | 0.0020204 |
| Farm_distance | -0.0037069 | 0.0039863 | -0.93 | 0.355 | -0.011643 | 0.0042292 |
| d_access_irrigation | 0.0878051 | 0.0213716 | 4.11 | 0.000 | 0.0452575 | 0.1303526 |
| d_access_credit | -0.019011 | 0.0211742 | -0.90 | 0.372 | -0.0611656 | 0.0231436 |
| d_access_extension | -0.0153325 | 0.0189737 | -0.81 | 0.421 | -0.0531063 | 0.0224414 |
| d_gender | 0.0004357 | 0.0178005 | 0.02 | 0.981 | -0.0350025 | 0.0358739 |
| Farming_experienc | 0.0010752 | 0.0048251 | 0.22 | 0.824 | -0.0085308 | 0.0106811 |
| **level_education** | | | | | | |
| secondary education | 0.0064483 | 0.035873 | 0.18 | 0.858 | -0.0649694 | 0.077866 |
| university education | 0.0093689 | 0.024233 | 0.39 | 0.700 | -0.0388752 | 0.0576131 |
| never attend to school | -0.0071263 | 0.0215513 | -0.33 | 0.742 | -0.0500317 | 0.0357792 |
| d_maritial_status | 0.0211261 | 0.020121 | 1.05 | 0.297 | -0.0189317 | 0.061184 |
| Age | 0.0003197 | 0.0008464 | 0.38 | 0.707 | -0.0013654 | 0.0020047 |
| Labor_amount | 0.0163219 | 0.0038594 | 4.23 | 0.000 | 0.0086384 | 0.0240054 |
| d_access_improved seeds | 0.0582859 | 0.022079 | 2.64 | 0.010 | 0.0143301 | 0.1022418 |
| d_access_fartlizer | 0.0662097 | 0.0214599 | 3.09 | 0.003 | 0.0234864 | 0.1089331 |
| **farming_system** | | | | | | |
| use of animal oxen | -0.0643691 | 0.0254906 | -2.53 | 0.014 | - 0.1151169 | -0.0136213 |
| use of hand hoe | -0.0813132 | 0.0315018 | -2.58 | 0.012 | -0.1440285 | -0.0185979 |
| family_size | -0.0021192 | 0.0043298 | -0.49 | 0.626 | -0.0107391 | 0.0065007 |
| _cons | 0.1225913 | 0.2240552 | 0.55 | 0.586 | -0.3234683 | 0.568651 |
| **Model strength** | Number of obs = 100<br>F (21, 78) = 16.46<br>Prob > F = 0.0000<br>R-squared = 0.8159<br>Adj R-squared = 0.7663 | | | | | |

### 4.2 Challenges Facing Maize Production among Smallholder Farmers in Kiteto District

Results in Table 3 present challenges facing maize production among smallholder farmers in Kiteto district, which were determined by the use of a Likert scale of five points. Specifically, results show that a shortage of rainfall is the leading challenge affecting maize production among smallholder farmers in Kiteto District, and this is due to the fact that agriculture production, specifically maize production, heavily depends on rain-fed cultivation, but in current years, Kiteto District and Tanzania at large as a country is experiencing climatic change that results in very low rain, which impedes farmers from high yields, hence being discovered as a leading challenge. This finding is consistent with the study by Ngonkeu et al. (2017), and Theodory and Kitole (2024) found changes in weather conditions, mainly shortages of rainfall, as a major challenge that impeded maize production among study farmers.

The study's findings reveal that a significant number of respondents identified maize price fluctuation as the second challenge affecting maize production in the study area. Price fluctuation is taken as a critical challenge affecting maize production since the price of maize is not constant over a period of time and sometimes tends to fall to the point where the farmer will not generate profit from selling his output. The findings were in line with the study by Wainaina (2016), who found price fluctuation to be a challenge that impeded maize production in the study area.

**Table 3**

*Challenges for Maize Production among Smallholder Maize Farmers in Kiteto District*

| Challenges | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Total |
|---|---|---|---|---|---|---|
| Shortage of rainfall | 62% | 28% | 2% | 3% | 5% | 100% |
| Shortage of storage facilities | 43% | 28% | 5% | 17% | 7% | 100% |
| Maize price fluctuation | 46% | 32% | 14% | 8% | 0 | 100% |
| Shortage of market | 41% | 22% | 12% | 9% | 16% | 100% |
| Diseases and pest | 46% | 35% | 4% | 10% | 5% | 100% |
| Shortage of physical infrastructure | 26% | 47% | 2% | 19% | 6% | 100% |
| Inadequacy of modern seeds and fertilizer | 38% | 20% | 14% | 21% | 7% | 100% |

The survey findings revealed that diseases and pests were the third most significant challenge affecting maize yield for smallholder farmers. This is because in the majority of smallholder maize farming, there is a lack of effective strategies to address crop diseases due to the exorbitant expense of pesticides. The advent of armyworms, very damaging pests of maize, has exacerbated this issue, making it a major problem. The findings are in line with the research conducted by Wainaina (2016), which identified pests and illnesses as significant obstacles that hinder maize production in the specific region under study.

Additionally, the survey revealed that a deficiency in infrastructure is the fifth most significant challenge that impacts the production of maize. The inadequate infrastructure poses an important challenge to smallholder maize producers, as they face difficulties such as poor road conditions and a lack of efficient transportation options. These challenges impede the easy movement of agricultural services and market access, which is critical for maize farmers. Furthermore, the findings indicate that the shortage or absence of markets is the sixth most important challenge affecting maize production. In terms of maize production, the market presents a significant challenge for smallholder maize growers. Due to the challenges in market accessibility, producers are forced to bear the expenses of long-distance transportation, resulting in a decrease in their income. Furthermore, the market's insufficiency constrains the farmers, compelling them to vend their products to intermediaries at reduced costs (Kitole, 2023). Furthermore, the survey revealed that the insufficient availability of high-quality seeds and fertilisers, listed as the seventh most significant obstacle, had a detrimental impact on maize production. This is a result of the insufficiency of high-quality seeds and fertilisers, which therefore drives up the prices of these inputs for farmers. This may also result in the utilisation of inferior and local seeds in the agricultural process, hence diminishing the overall maize yield. The results align with the research conducted by Abebe and Halala (2020), which revealed that farmers encountered the obstacle of insufficient supply of seeds and improved fertilisers, leading to the elevated costs of these crucial inputs.

### 4.3 Test of the Model Assumptions

#### 4.3.1 Test for the Multicollinearity

Multicollinearity was tested by using variance-inflated factor (VIF), and the results show that there was no serious problem of multicollinearity between the independent variables, as shown in the table, with an average of 1.45, which is tolerable, and the maximum VIF of the variable was 1.89.

**Table 4**
*Multicollinearity Test Results for Independent Variable*

| Variables | VIF | 1/VIF |
|---|---|---|
| farm_size | 1.51 | 0.661853 |
| ln_farming_cost | 1.67 | 0.597971 |
| ln_income | 1.39 | 0.719067 |
| Distance_market_place | 1.26 | 0.794615 |
| Farm_distance | 1.21 | 0.823695 |
| d_access_irrigation | 1.67 | 0.598775 |
| d_access_credit | 1.36 | 0.737070 |
| d_access_extension | 1.27 | 0.785474 |
| d_gender | 1.11 | 0.901996 |
| Farming_experienc | 1.16 | 0.861435 |
| level_education | | |
| secondary education | 1.42 | 0.703396 |
| university education | 1.41 | 0.709054 |
| never attend to school | 1.44 | 0.696640 |
| d_maritial_status | 1.52 | 0.658225 |
| Age | 1.17 | 0.853109 |
| Labor_amount | 1.89 | 0.529314 |
| d_access_improvenseeds | 1.83 | 0.547534 |
| d_access_fartlizer | 1.72 | 0.580744 |
| farming_system | | |
| use of animal oxen | 1.50 | 0.666218 |
| use of hand hoe | 1.57 | 0.635738 |
| family_size | 1.30 | 0.769469 |
| **Mean VIF** | **1.45** | |

### 4.3.2 Test for the Heteroscedasticity

The test for heteroskedasticity in the model was done by using the Breusch-Pagan test, where the null hypothesis is that there is hemoskedasticity. The test yields a high chi2 (1) = 0.23 statistic, which is insignificance (Prob > chi2 =0.6332), as shown below. In which the null hypothesis failed to be rejected and concluded that there was no problem of heteroskedasticity in the model.

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of maize production
chi2 (1) = 0.13
Prob > chi2 = 0.7160

### 4.3.3 Test for normality

The normality assumption of linear regression was checked by using the histogram of residuals. Figure 2 shows that the residuals of multiple regressions were normally distributed.

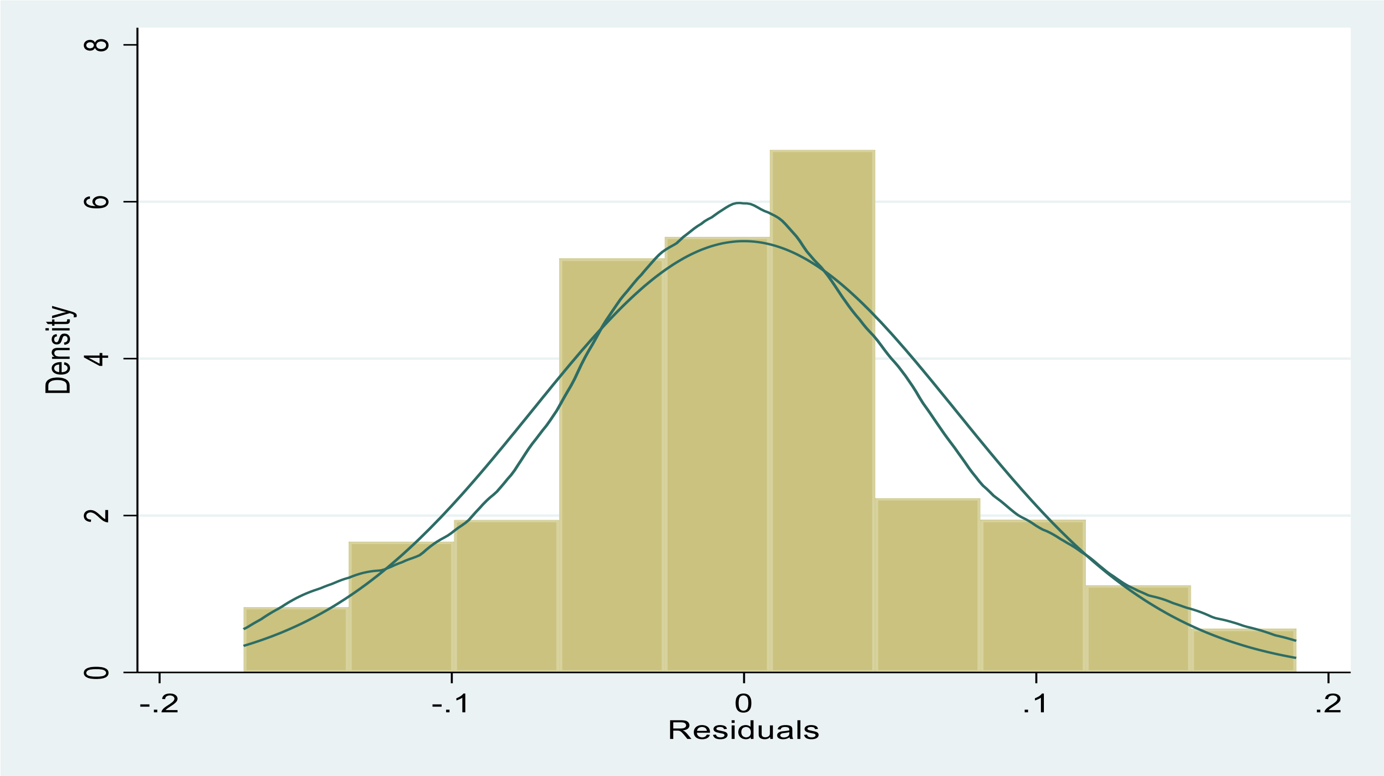


**Figure 1**
*Histogram for Normality Test*

## V. CONCLUSIONS & RECOMMENDATIONS

This study has shown that maize production is highly influenced by farm size, access to irrigation, the size of the labour force, the use of improved seeds, and fertiliser usage in crop production. On the other hand, the study has shown that major challenges affecting maize production are weather variability, especially shortages of rainfall, excessive dry seasons, price fluctuations of the maize crops, as well as diseases and pests. In addition, this result informs several policy recommendations that need to be considered for the proper production of maize and to enhance the livelihoods of smallholder farmers who depend on maize for their livelihood.

These recommendations include the provision of assistance to maize growers, especially by helping them access fertiliser at lower prices. This should go hand in hand with the development of proper subsidy schemes that help farmers get fertiliser on time. Therefore, the government can increase subsidies and its supply among smallholder farmers in order to ease the accessibility of modern seeds and fertiliser at a reasonable price that is affordable to a large number of smallholder farmers. By doing so, the quality and quantity of maize will be improved.

In addition, the government, in collaboration with the agriculture research centres, should conduct research and produce a variety of maize seeds that will be primarily resistant to diseases, have a short growth period, and have low water requirements. By doing so, this approach will effectively address the problems of pests, diseases, and the shortage of rain. Furthermore, it is imperative for the government and private institutions to expand the construction of cost-effective storage facilities, such as public warehouses, to cater to the needs of smallholder maize farmers. This measure will effectively mitigate post-harvest losses.

Finally, the government must provide farmers with reliable climate variability data to enhance their understanding of optimal maize planting seasons and strategies for mitigating the impact of pests and diseases, often influenced by changing weather conditions. Furthermore, it is imperative for the government to provide farmers with accurate information regarding crop-specific farming techniques. This would enable them to achieve higher levels of output, resulting in an increased food supply for both personal and commercial purposes.

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