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# Impact of Maize Production on the Welfare of Small-Scale Famers in Uasin Gishu County; a Case Study of Moiben Constituency

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**Abstract:** When a community engages in economic activity, they always expect to use it as a resource to elevate their economic status. Residents of Uasin Gishu county have over the years engaged tremendously in maize farming expecting it to aid in elevating their economic status. However, despite the heavy investment in the farming of maize, the majority of small-scale farmers in the region still languish in poverty despite farming maize every season. As a result, the study aimed at determining the impact of maize farming on the economic welfare of small-scale farmers in the region. The study looked at how maize farming influenced the income, food security, and employment status of the farmers. The study was carried out in the Moiben constituency which had a population of 300 maize farmers and it was able to sample a total of 75 farmers from the constituency who were sampled through a simple random sampling technique. The study used a structured questionnaire to interview the farmers. The study used simple linear, Poisson, and binary logistic regression models to determine the effect of maize production on income, food security, and employment of small-scale farmers in the region. The results of the linear regression model showed that maize production had a positive significant effect on the income of the farmers in the region ( $p < 0.05$ ). An increase in the size of land for maize production by 1 ha was determined to increase the income of the farmer by approximately Kshs 55,945/=. Based on the results of the Poisson regression model, maize production was determined to have a positive significant effect on the food security of the farmer ( $p < 0.05$ ). An increase in land size under maize production by 1 ha was determined to increase the number of bags of maize stored for family consumption by 1 bag. Lastly, the logistic regression model showed that maize production had a significant effect on the employment of small-scale farmers ( $p < 0.05$ ). The results showed that a farmer with 1 ha of land more was 3.942 times more likely to only carry out farming as a source of employment compared to a farmer with 1 ha of land under maize farming. In conclusion, the study was able to determine that maize farming was able to increase the income of the farmers, increase food security and provide employment opportunities for small-scale farmers. Therefore, this showed that maize production was able to improve the welfare of maize farmers in the region.

**Keywords:** Welfare, Maize Production, Food Security, Income, Job Opportunity

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## 1. Introduction

Among all cereals produced in the world, maize is considered one of the most important cereals grown. This is due to the benefits of maize such as human consumption, animal feed, and even industrial use and raw material. In terms of production, maize is considered one of the world's

leading cultivated crops with the crop being grown on approximately 142 million hectares of land around the world with an annual production of 637 million tons each year [8, 18]. In terms of future production and demand around the world, it has been approximated that the future maize demand around the world will increase by between 4% to 8% annually as a result of an increase in food demand around the

world [8, 23, 24, 25, 26].

In Kenya, maize is considered the most important food crop with over 60% of the citizens in the country relying on maize flour product ("*Ugali*") as their main staple food. Despite the high level of maize demand by Kenyan citizens, the production of maize in the country has not been constantly stable over the years. In the year 2020 for example, the production volume of maize in the country declined to 4.2 million bags down from 4.4 million bags in the previous year. The drop of 4.3 percent was mainly attributed to unfavorable weather conditions. Although Kenya's maize production fluctuated substantially in recent years, the general trend of maize production in the country has been observed to possess a constant upward trend from the years 1970 to the year 2021. This might be attributed to the constant population growth [3, 28]. In terms of economic contribution, Maize in Kenya contributes about 24% of the GDP, 75% of the industrial raw materials, and 60% of export earnings and employs an estimated 3.8 million Kenyans directly (First Medium-Term Plan) [9, 10, 27, 29].

Within the country, one of the main areas that are recognized as the main producers of maize in the country is Uasin Ngishu [10]. Apart from being the main producer of maize in the country, the area is also considered the mainstay of agricultural production in the country owing to its fertile soils and reliable rainfall [10]. The majority of the residents of the County rely on maize production for their well-being because it acts as a source of food, income, employment, and even school fee for their children's educations [15, 20, 21, 22, 27].

However, due to climate change, the trend in maize production in Uasin Ngishu county has constantly fluctuated which has resulted in sometimes farmers experiencing huge losses which are attributed to the low returns they receive from the production of maize, it has also led to food insecurity at times among farmers in the region and even children dropping out of school because their parent could not raise school fees from maize production which is their only source of income. All these have led to several small-scale farmers languishing in poverty despite the heavy investment in maize production over the years [15, 16]. Therefore, the study sought to assess the impact of maize production on the welfare of small-scale farmers in Uasin Gishu County to know if the continuous production of the crop by the residents helps in elevating their lives or it's contributing toward their anguish in poverty.

## 2. Methods

### 2.1. Research Design

To attain the aim of the study, a cross-sectional research design was adopted in the study. The design was deemed appropriate because it allowed the collection of data from sample farmers at a specified point in time. In the design, the sampled data was collected from the farmers through the use of structured questionnaires which were used to interview the farmers on factors of interest in the study [1, 2, 11, 14].

### 2.2. Sampling Technique

The study adopted the simple random sample technique, in which all the farmers in the constituency were assigned random numbers then the lottery technique was used to select random numbers from a set of all numbers assigned to the farmers in the constituency. Random sampling was done without replacement. The selected farmers were then interviewed with the aid of a written questionnaire [2, 5, 11].

### 2.3. Sample Frame

The sample frame for the study was all 300 Maize farmers in the Moiben sub-county. This was based on the records that were obtained from the Uasin Gishu County Agricultural office which showed that the sub-county had a total of 300 registered maize farmers [5, 16].

### 2.4. Sample Size

Based on the sample frame obtained from the Uasin Gishu County Agricultural office and the limited resources to carry out a complete enumeration of all farmers in the region, the study adopted the Yamane 1967 formula to calculate a smaller sample size ( $n$ ) that could be used to undertake the study. The study assumed a true population size to be 300, with a margin of error of 0.1 and a 90% confidence level during the calculation of the sample size. The results of the computation were as illustrated below [2, 4, 5, 11, 14];

$$n = N/(1+Ne^2)$$

Where;

$n$  = collected sample size

$N$  = population size

$e$  = margin error (0.1)

Registered small-scale maize farmers ( $N$ ) = 300

$n = 300 / (1 + 300 * 0.1^2)$

$n = 75$

(Additional of 10 or more questionnaires in case of nonresponse)

$n = 85$

### 2.5. Data Analysis

#### 2.5.1. Model Specification

The study used three sets of regression models to aid in answering the research objective thus; linear regression, Poisson regression, and logistic regression.

In the model specification, the study believed that maize production ( $x$ ) affected the welfare of small-scale farmers through its influence on income ( $y_1$ ) food security ( $y_2$ ), and employment ( $y_3$ ) [2].

$$y_i = f(x)$$

#### 2.5.2. Income and Maize Production

The study adopted the use of a linear regression model to check on the effect of maize production ( $x$ ) on the income of small-scale farmers in the region ( $y_1$ ). The fitted regression model was illustrated in Equation (1).

$$y_1 = \beta_0 + \beta_1x + \varepsilon \tag{1}$$

Where  $y_1$  was the average amount of income that the farmer got from maize production in a production season and  $x$  is maize production which was measured by the land size in Ha used for maize production by the farmer.

**2.5.3. Food security and Maize Production**

The study measured food security among the farmers using the number of bags of maize that the farmers stored for household consumption in a given production season. To determine the effect of maize production on food security, the study adopted the use of a Poisson regression model. The fitted model was illustrated in Equation (2);

$$y_2 = e^{\theta_0 + \theta_1x + \varepsilon} \tag{2}$$

Where  $y_2$  is food security which was measured by the average number of bags of maize that the farmer kept for consumption during a production year after harvesting.  $x$  is maize production which was measured by the land size in Ha used for maize production by the farmer.

**2.5.4. Employment and Maize Production**

Lastly, the study looked into the effect of maize production on the employment status of the small-scale farmers in the area. The study measured the employment status of the farmers using a dummy variable in which 1 showed that farming was the main source of employment and income for the farmer while 0 indicated that farming was a secondary source of employment or income for the farmer. A binary logistic regression model was used to study the effect of farming on the employment status of the farmer. The fitted regression model was illustrated in Equation (3).

$$\Pr(y_3 = 1) = \frac{e^{\alpha_0 + \alpha_1x + \varepsilon}}{1 + e^{\alpha_0 + \alpha_1x + \varepsilon}} \tag{3}$$

Where  $y_3$  is the employment status of the farmers where  $y_3 = 1$  if the farmer has no other source of employment and  $y_3 = 0$  if the farmer has another source of employment other than farming.  $x$  is maize production which was measured by the land size in Ha used for maize production by the farmer.

**2.5.5. Hypothesis Testing**

*Effect of Maize Production on the Income of small scale farmers*

The study tested for the significance of the coefficient of maize production in the first model to assess if maize production had a significant effect on the income of the small-scale farmers in the region. The test was based on the null and alternative hypotheses;

$$H_0: \beta_1 = 0$$

$$H_a: \beta_1 \neq 0$$

To test for the significance of the coefficient based on the above null and alternative hypothesis, the study used the individual parameter t-test where the test statistic was given by the formula;

$$t = \frac{\beta_1}{SE(\beta_1)} \tag{4}$$

*Effect of Maize Production on food security of small scale farmers*

The study tested for the significance of the coefficient of maize production in the second model to assess if maize production had a significant effect on the food security of the small-scale farmers in the region. The test was based on the null and alternative hypotheses;

$$H_0: \theta_1 = 0$$

$$H_a: \theta_1 \neq 0$$

To test for the significance of the coefficient based on the above null and alternative hypothesis, the study used the individual parameter Wald-test where the test statistic was given by the formula;

$$w = \left( \frac{\theta_1}{SE(\theta_1)} \right)^2 \tag{5}$$

*Effect of Maize Production on the Employment of small scale farmers*

The study tested the significance of the coefficient of maize production in the third model to assess if maize production had a significant effect on the employment status of small-scale farmers in the region. The test was based on the null and alternative hypotheses;

$$H_0: \alpha_1 = 0$$

$$H_a: \alpha_1 \neq 0,$$

To test for the significance of the coefficient based on the above null and alternative hypothesis, the study used the individual parameter Wald-test where the test statistic was given by the formula;

$$w = \left( \frac{\alpha_1}{SE(\alpha_1)} \right)^2 \tag{6}$$

**3. Data Analysis, Presentation, and Interpretation**

**3.1. Model Presentation of Income and Maize Production**

The results of the fitted linear regression model which was used to study the effect of maize production income on small-scale farmers as illustrated in table 1.

*Table 1. Model summary.*

R	R <sup>2</sup>	Adjusted R	Std. Error Estimate	Change Statistics				
				R Square Change	F Change	df1	df2	p-value
0.907	0.823	0.821	49236.878	0.823	340.260	1	73	0.000

Based on the results in table 1, there was a strong direct linear relationship between the size of land used for maize production and the amount of income that the farmer obtained from maize production ( $r=0.907, p<0.05$ ). The fitted regression model showed that in the region, 82.3% of the variation in income obtained by the farmer from maize production was attributed to the size of land that they used

for maize production. The test for general adequacy of the model at a 95% level of confidence showed that the model was adequate or in other words fitted well ( $F(1,73) = 340.260, p<0.001$ ).

The results for the coefficient of the fitted regression model together with the test for the significance of the coefficient was as shown in table 2;

*Table 2. Linear Regression Coefficient.*

Variable	Regression Parameters		t	p-value	95.0% Confidence Interval for B	
	Coefficient	Std. Error			Lower Bound	Upper Bound
(Constant)	-14367.044	14208.428	-1.011	.315	-42684.401	13950.312
Land Size	55945.740	3032.926	18.446	.000	49901.128	61990.352

Based on the results contained in table 2, a unit increase in land size for maize production by 1 Ha in the region increased the income that the farmer got from maize production by Kshs. 55, 945/= on average. The true estimated increase in income of the farmer as a result of an increase in the size of land used for maize production showed that there was a 95% chance that the farmer's income would increase by a margin of between Kshs 49,901/= and Kshs 61,990/=. The test for the significance of the regression coefficient showed that at a 95% level of confidence, the coefficient of the size of the land was significantly different from zero ( $t(73)=18.446, p<0.05$ ). This shows that there was sufficient evidence that an increase in the size of land for maize production did increase the income of the farmer therefore, maize production had a significant effect on the income of small-scale farmers in the region.

**3.2. Model Presentation of Food Security and Maize Production**

To assess the effect of maize production on the food

security of the farmer, the study fitted a Poisson regression model with several bags of maize kept by the farmer for consumption as the dependent variable and the size of land used for maize production in Ha as the independent variable. The test for goodness of fit of the fitted regression model was tested using the likelihood ratio test and the results of the test were as illustrated in table 3.

*Table 3. Likelihood Ratio Tests.*

Likelihood Ratio Chi-Square	Df	p-value
72.222	1	0.000

Based on the results in table 3, at a 95% level of confidence, the full model was significantly different from the intercept-only model ( $\text{chi-square}=72.222, \text{df}=1, p<0.05$ ). This shows that the fitted Poisson regression model did fit well.

The coefficient of the fitted regression model was as illustrated in table 4;

*Table 4. Regression coefficient.*

Variable	Coefficient	Std. Error	95% Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	Df	p-value
(Intercept)	2.016	.0820	1.855	2.176	603.649	1	0.000
Land Size	.136	.0158	.105	.167	73.698	1	0.000

The results in table 4, show that a unit increase in land size for maize cultivation by 1 Ha, increases the number of bags kept for consumption by the farmer by 1 bag. The results also showed that all other factors held constant the farmers always keep on average 7.5 bags of maize for consumption during each season of production. The 95% confidence interval showed that on average the farmers keep between 6 bags and 8.8 bags each season of production for consumption purposes. The test for the significance of the intercept at a 95% level of confidence showed that the intercept was significantly different from zero ( $\text{chi-square} = 603.649, \text{df}=1, p<0.05$ ). This shows that during each period of production, the farmers in the region keep a substantial amount of maize for family consumption. The test for the significance of the coefficient of land size showed that at a 95% confidence level, the coefficient was significant ( $\text{chi-square} = 73.698, \text{df}=1,$

$p<0.05$ ). This shows that the increase in land size under maize production did increase the number of bags stored for consumption hence maize production did positively affect food security.

**3.3. Model Presentation of Employment Status and Maize Production**

The study used a Binary logistic regression model to analyze the effect of maize production on the employment status of small-scale farmers using where the employment status of the farmer was used as the dependent variable with 1 showing that the farmer had no other source of employment apart from farming and 0 showing that the farmer had another source of employment other than farming. The size of land used by the farmer for maize production was used as

the independent variable. The goodness of fit of the model was tested using the likelihood ratio test at a 95% confidence level and the results were as illustrated in table 5;

*Table 5. Likelihood Ratio Test.*

Likelihood Ratio Chi-Square	Df	p-value
44.316	1	0.000

Based on the results in table 5, at a 95% level of confidence, there was a significant difference between the full model and the intercept-only model (chi-square = 44.316, df=1, p<0.05). This shows that the regression model did fit properly.

The estimated results of the regression coefficient for the model was as illustrated in table 6;

*Table 6. Parameter Estimates.*

Variable	Coefficient	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-4.981	1.1726	-7.280	-2.683	18.048	1	.000	.007	.001	.068
Land Size	1.372	.3178	.749	1.995	18.626	1	.000	3.942	2.114	7.349

The results in table 6, show that a farmer who uses 1 Ha more in maize production was 3.942 times more likely not to have another source of employment other than farming compared to a farmer who had 1 Ha less. The 95% confidence interval for the odd ratio of land size was also determined not to contain 1 meaning that the ratio was significant at a 95% level of confidence. The test for adequacy of the coefficient of land size at a 95% level of confidence showed that the coefficient was significantly different from zero (chi-square=18.626, df=1, p<0.05). This shows that an increase in land size under maize production did increase the chances of a farmer being a full-time farmer hence it shows that maize production does improve employment opportunities among farmers in the region.

## 4. Conclusion

### 4.1. Income and Welfare

The study was able to establish that the increase in the size of land under maize production was increasing the income of the farmer, this may be to the fact that most of the additional maize that the farmers produce in the excess land is meant for commercial purposes. Therefore, the more maize that the farmers get to produce the more income they get to receive from the sale of the maize. This shows that maize production improves the welfare of farmers in the region by increasing household income through commercial maize production. This result is also supported by the intercept of the first model which was not significantly different from zero ( $t(73) = -1.011$ ,  $p=0.315$ ), meaning that the household income for the farmers could only improve if they added additional land under maize production because the maize produced in the existing land resulted into no additional income. After all, it was meant for family consumption other than for commercialization [12, 22].

### 4.2. Food Security Per Household and Welfare

The study findings showed that maize production contributed to an average of between 6 and 8 bags of maize for family consumption with an additional Ha of land under

maize production increases the amount of maize stored for family consumption by 1 bag. This shows that the more maize a farmer produces in the area the more bags that he/she will be able to keep for family consumption hence this improves food security. This is because a majority of the small-scale farmers in the region, do maize production for consumption purposes, and even when they invest in additional land for farming maize they would still prioritize consumption over-commercialization of the produce. This shows that small-scale farmers in the constituency regard maize production as a source of food and not income and only opt to sell their maize when they have adequate storage for consumption [6, 7, 19].

### 4.3. Employment Status and Welfare

The study established that the increase in the size of land for maize production increases the chances of a small-scale farmer being a full-time farmer in the region. This is because farming is a labor-intensive job and the more size of land that a farmer would invest in maize production the more labor input would be required from the farmer and given that among small-scale farmers family labor is the primary source of labor [6, 7]. Farmers who invest in large tracks of land for maize production would not have time to undertake other jobs that could give additional income to the household hence maize production became the primary source of employment for the small-scale farmers in the region.

In conclusion, given maize production was established by the study to increase household income, and food security and also act as a primary source of income for a small-scale farmer in the region. Maize production is capable of improving the welfare of small-scale farmers in the region and the country at large if it is properly carried out.

## 5. Recommendations

To improve the welfare of small-scale farmers in the regions through maize production, the government and the relevant stakeholder should undertake the following [12, 13, 15, 17, 20, 21];

- 1) Provide farming subsidies and incentives to small-scale maize farmers to encourage them to participate in maize

production since it is an activity that will improve their welfare.

- 2) Provide extension services on maize farming for the farmers in the regions to improve their knowledge of new and improved methods of maize production that could improve maize productivity.
- 3) Provide a ready market for maize produce at better prices through the cereals and produce the board.
- 4) Provide agricultural loans for maize farmers to furnish them with loans in orders to be able to buy inputs and also lease bigger parcels of land for maize production.

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