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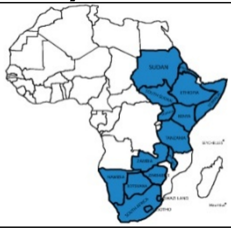

Factors Influencing Maize Production in the Coastal Zone of Mainland Tanzania during Long Rainy Season

[1]Wema K. Sichone , [2]Siamarie Lyaro

Eastern Africa Statistical Training Centre P. O. Box 35103, Dar es Salaam, Tanzania
*Corresponding Author Email: siamarie.lyaro@eastc.ac.tz

KEYWORDS

Maize production, Production cost

ABSTRACT

This study sought to assess the factors affecting maize production in the Coastal zone of Mainland Tanzania, using data from the 2019/2020 National Sample Census Agriculture. Correlation and multiple linear regression were employed for analysis. The findings from correlation analysis indicated that maize output was significantly correlated with land area cultivated (r=0.94), seed quantity (r=0.97), and fertilizer quantity (r=0.57) at the 5% significance level. Furthermore, results from the multiple linear regression revealed that land area cultivated (p=0.00), use of household labour compared to non-household (p=0.00), seed quantity (p=0.00), and fertilizer quantity (p=0.00) positively influenced maize production, while pesticide use (p=0.00) had a negative effect on quantity of maize harvested. The results also showed that total production costs increased with output (p=0.00) and that household with educated fared better compared to non-educated households (p=0.01). The study concluded that strategies for improving maize yield in a cost-effective way should be developed by incorporating optimization techniques. Furthermore, the study recommended to the government the need to formulate strategies for commercializing small-scale maize production to improve welfare of farmers.

1.0 INTRODUCTION

Maize (Zea mays) also called corn is widely produced cereal crop both for human and animal consumption. In 2022, United States of America was a leading maize producer by producing 30% of the world production. Furthermore, in 2022, China ranked second in maize production by producing 20% of the world production, while Brazil ranked third in maize production by producing 10% of the world production (FAO, 2023). Currently, maize is cultivated in 165 countries distributed across the Americas, Asia, Europe and Africa (Erenstein *et al*., 2022). In Africa, maize was first introduced to West Africa, then spread inland and southward, and last reached East Africa and deeper Central Africa, and East and Southern Africa have higher production of maize compared to other regions of Africa (Woomer *et al*., 2023). Figure 1 shows that from 1990 Eastern Africa led in maize production compared to other regions of Africa.

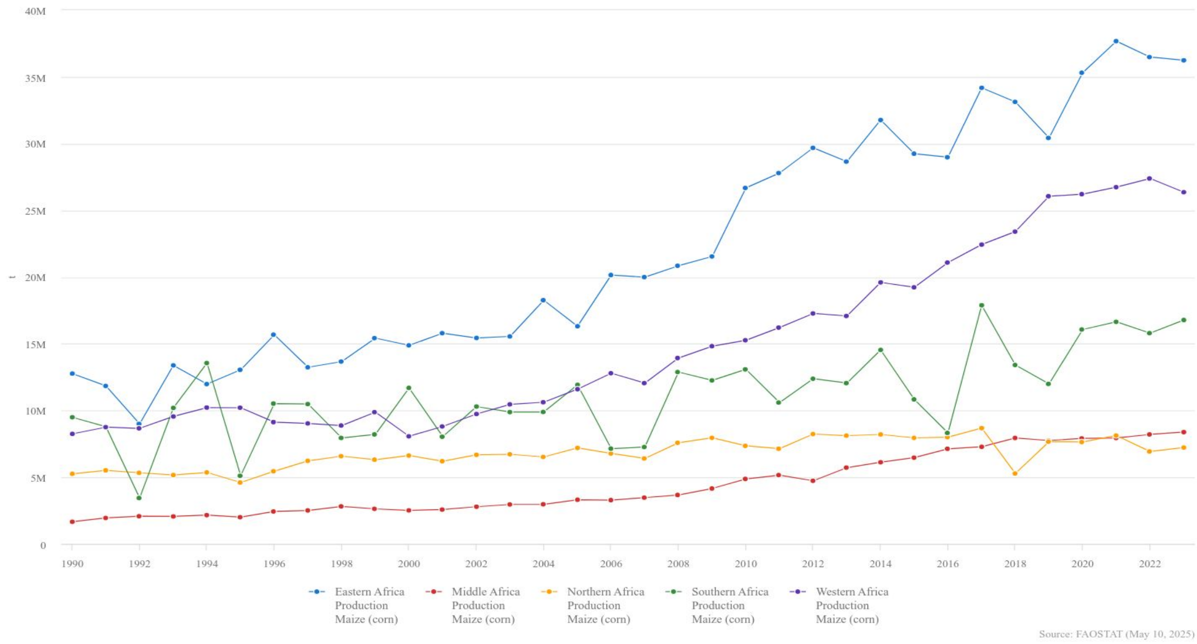

Figure 1: Maize production in African regions.

Source: FAOSTAT (2025).

Within Eastern Africa, Tanzania, Kenya, and Uganda accounts 94% of maize produced within the region (EAGC and AGRA, 2025). For the case of Tanzania, quantity of maize produced has been increasing from 1990-2024, while maize yield decreased between 2002 and 2003, and begun to increase gradually from 2004-2024 as shown in Figure 2. Maize yield in Tanzania is less than the recommended global average yield of 4.3 tonnes per hectare (Utonga, 2022).

Presence of maize yield variability in Tanzania led to the formation of initiatives such as the Agricultural Sector Development Strategy (ASDS) in 2001 originated from the Agricultural and Livestock Policy and the Cooperatives Development Policy, both of 1997. Thereafter, Agricultural Sector Development Programme (ASDP) was launched in 2006 and was implemented in two phases. ASDP Phase I started from 2006/2007 to 2013/2014, while ASDP Phase II having two phases each of five years whereby Phase 1 started from 2017/2018 to 2022/2023, and Phase II started from 2024/2025 and shall end on 2028/2029 (URT, 2025).

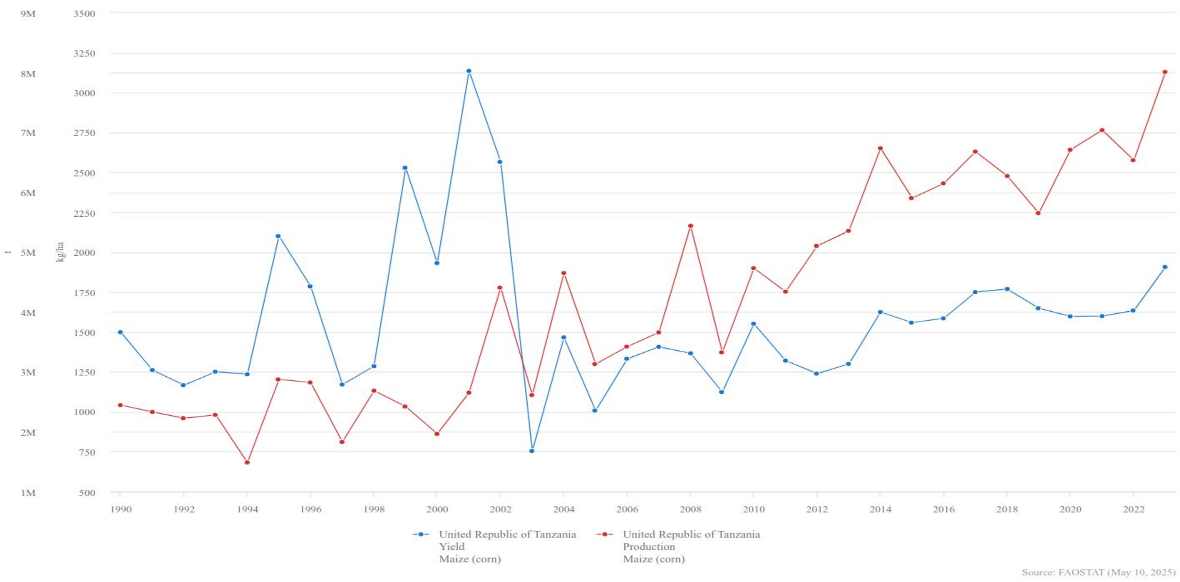

Figure 2: Maize yield and production in Tanzania

Source: FAOSTAT (2025).

In the presence of above initiatives, still production of maize varies within regions forming a single agro-ecological zones of Mainland Tanzania. For example, in the Coastal zone, maize harvested in Tanga region amounted 205,966 tonnes, while maize harvested in Pwani region amounted 19,769 tonnes during the long rainy season (NBS, 2021). This implies that there are underlying factors which influence maize production in the Coastal agro-ecological zone. Hence the present study was designed to fulfil the gap by determining factors which affected maize production and cost of maize produced in the Coastal zone during the long rainy season. The study involved variables such as quantity of maize harvested, land area cultivated, type of farm labour used, pesticide use status, seed quantity, fertilizer quantity, total costs, education level, and access to extension services from the 2019/2020 National Sample Census of Agriculture.

2.0 METHODOLOGY

2.1 Study Area

The study was conducted in the Coastal agro-ecological zone of Mainland Tanzania which includes Dar es Salaam, Lindi, Tanga, Mtwara and Pwani regions. Production of maize demonstrates high variability in the zone such that Tanga region harvested about 205,966 tonnes making the region being among the top ten regions with high quantity of maize harvested during the long rainy season. On the other hand, maize harvested in Pwani region amounted 19,769 tonnes making the region being among the ten regions with low quantity of maize harvested during the long rainy season (NBS, 2021).

2.2 Research Design

The study employed quantitative research design. Quantitative research methods involves application of statistical concepts and model building (Ghanad, 2023).

2.3 Population of the Study

Population of the study consisted of all smallholder maize farmers during the long rainy season in Mainland Tanzania. This population was capable of providing agriculture details regarding maize production as currently about 99% of planted area with maize was occupied by smallholder farmers (NBS, 2021).

2.4 Sampling Techniques

The 2019/2020 National Sample Census of Agriculture adopted a two-stage design with census enumeration areas as Primary Sampling Units (PSUs) and households as second-stage units (NBS, 2021). Based on the sampling conducted, 4,772,012 smallholder maize farmers in Mainland Tanzania were selected for the 2019/2020 National Sample Census of Agriculture of which 722,836 constitute smallholder maize farmers in the Coastal zone (NBS, 2021). With 722,836 units, the Sample Size Table recommends a sample size of 384 units at a 95% confidence level and a 5% margin error. However, due to missing data, 330 small-scale maize farmers formed the study sample by providing a complete data matrix.

2.5 Data Analysis

2.5.1 Descriptive statistics

Descriptive analysis was applied in the study to analyse measures of central tendency and measures of dispersion. The study computed descriptive statistics such as mean, maximum, minimum, frequency distribution, percentages and standard deviation. Analysis was performed using STATA Statistical Package version 17.

2.5.2 Correlation analysis

Correlation is a measure of association that aims at measuring the degree or strength of relationship between variables (Ele *et al*., 2023). The study employed Pearson correlation to examine the relationship between quantity of maize harvested and inputs used by smallholder maize farmers.

2.5.3 Regression analysis

Regression analysis is a commonly used technique for examining multi-factor data. Its popularity and utility stem from the straightforward approach of using an equation to represent the relationship between a target variable and a set of related predictor variables (Montgomery *et al*., 2021). A regression model with a single independent variable is referred to as a Linear Regression model, while one with multiple independent variables is known as a Multiple Regression model.

The general regression model was specified as follows in equation 2.1

$$Y_i = \beta_0 + \beta_i X_i + \varepsilon_i \quad \text{……………………………… ……….. ……….. ……….………} (2.1)$$

Whereby:

Y_i is the variable of interest (response)

β_0 is the intercept

β_i are the coefficients of X_i and

ε_i is the error term

According to PSU (2018) and Williams *et al.* (2013) assumptions of multiple linear regression model are as follows:

i. The mean of the response, E(Y_i), at each set of values of the predictors, (x_{1i},x_{2i},…), is a Linear function of the predictors.
ii. The errors, ε_i, are Independent.
iii. The errors, ε_i, at each set of values of the predictors, (x_{1i}, x_{2i},…), are Normally distributed.
iv. The errors, ε_i, at each set of values of the predictors, (x_{1i},x_{2i},…), have Equal variances (denoted σ^2).

The multiple linear regression for analysing factors affecting maize production was specified as follows in (2.2):

$$lnQMH=\beta_0+\beta_1 lnLAC+\beta_2 FLU+\beta_3 lnSQ+\beta_4 lnFQ+\beta_5 PU+\varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots. (2.2)$$

Whereby:

ln = Natural logarithms

QMH= Quantity of maize harvested in kilograms

β_0 =Intercept

β_1 .., β_5 . = Coefficients

LAC =Land area cultivated in acres

FLU=Type of farm labour used (1= If a farmer used household labour, 0= Otherwise)

SQ= Seed quantity in kilograms

FQ=Fertilizer quantity in kilograms

PU= Pesticide use status (1= If a farmer used pesticide, 0= Otherwise)

ε_i =Error term

The model for determining factors affecting cost of production was specified as follows in (2.3):

$$TC = \beta_0 + \beta_1\, QMH + \beta_2\, EDS + \beta_3\, EXS + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.3)$$

Whereby:

TC= Total cost of maize production in Tanzanian shillings

β_0 = Intercept

β_1 .., β_5 . =Coefficients

QMH= Quantity of maize harvested in kilograms

EDS=Education status (1=If a farmer has formal education, 0= If a farmer has no formal education)

EXS=Access to extension services (If a farmer accessed extension service, 0= Otherwise)

ε_t = Error term

3.0 RESULTS AND DISCUSSION

3.1 Descriptive Statistics of the Studied Variables

Results presented in Table 1 showed that 34.85% of maize farmers did not use pesticides, while about 65.15% of maize farmers used pesticides. This corresponds to 115 and 215 maize farmers respectively. Also, about 36.36% of maize farmers used household labor while 63.64% of maize farmers did not use household labor. This corresponds to 120 and 210 maize farmers respectively. Again, about 34.85% of maize farmers had no education, 31.52% of maize farmers had primary school education and 33.64% of maize farmers had secondary education. This corresponds to 115 maize farmers who had no education, 104 maize farmers who had primary school education and 111 maize farmers who had secondary school education. . Also, about 60.30% of maize farmers had access to extension services whereas about 39.70% of maize farmers had no access to extension services. This corresponds to 199 maize farmers who had access to extension services and 131 maize farmers who had no access to extension services. These findings aligns with findings by Panga and Lyaro (2023) who reported that about 19.17% of root-vegetables growers had no formal education; while about 53.3% had primary school education; and 27.5% growers had secondary school level education or higher.

Table 1: Frequency distribution table of the studied variables

Variable	Frequency	Percent
Pesticides use status		
No	115	34.85
Yes	215	65.15
Total	330	100
Type of farm labour used		
Household labour	120	36.36
Non- household labour	210	63.64
Total	330	100
Education level		
No formal education	115	34.85
Primary education	104	31.52
Secondary education	111	33.64
Total	330	100
Access to extension services		
Yes	199	60.30
No	131	39.70
Total	330	100

Source: Authors' compilation (2025).

Also, Table 2 presents summary of statistics for the quantitative variables for the study. Results in Table 2 showed that mean of land area cultivated was 1.52 acres with a maximum of 4.80 acres and a minimum of 0.50 acres, and a standard deviation of 1.06. Furthermore, mean of maize harvested was 2299.73 kilograms with a maximum of 9600 kilograms, and a minimum of 20 kilograms, and a standard deviation of 2548.91. Also, results showed that mean of seeds used was 13.69 kilograms with a maximum of 48 kilograms, and a minimum of 0.50 kilograms, and a standard deviation of 11.51. Lastly, results showed that mean of fertilizer used was 137.53 kilograms with a maximum of 480 kilograms, and a minimum of 5 kilograms and a standard deviation of 116.70.

Table 2: Summary statistics for the quantitative data variables

Variable	Mean	Std. Dev.	Min	Max
LAC	1.52	1.06	0.50	4.80
MQH	2299.73	2548.91	20	9600
SQ	13.69	11.51	0.50	48
FQ	137.53	116.70	5	480

Source: Authors' compilation (2025).

3.2 Correlation Analysis

Results presented by Table 3 showed that quantity of maize harvested correlates positively with land area cultivated (r=0.94), seed quantity (r=0.97), and fertilizer quantity (r=0.57) and the relationship is significant at 5% level. This implies that quantity of maize harvested tend to increase with land area cultivated, seed quantity, and fertilizer quantity. On the other hand, there is a positive relationship between fertilizer quantity and both land area cultivated (r=0.52) and seed quantity (0.56). Based on production theory, land area cultivated, seed quantity, and fertilizer quantity are inputs which could not be substituted with one another (Msuya and Ashimogo, 2005; Kamau *et al.,* 2020).

Table 3: Pearson Correlation analysis

Variables	QMH	LAC	SQ	FQ
QMH	1.00			
LAC	0.94	1.00		
SQ	0.97	0.00	1.00	
FQ	0.57	0.52	0.56	1.00

Source: Authors' compilation (2025).

3.3 Factors Influencing Production of Maize

The results presented by Table 4 showed that land area cultivated, type of farm labour used, seed quantity, fertilizer quantity and pesticides use status were significant factors which influenced production of maize in the Coastal zone. Also, the results showed that the model adjusted R^2 was 0.79. This implies that 79.00% of the total variation in the dependent variable (quantity harvested) is explained by variation in the independent variables in the model.

Table 4: Regression table showing factors affecting maize production in the Coastal zone

Variable	Parameter	Coefficient	Std. Err.	T	P > |t|

LnLAC	β_1	0.49	0.07	6.52	0.00***
FLU	β_2	0.31	0.09	3.26	0.00***
LnSQ	β_3	0.95	0.06	15.55	0.00***
LnFQ	β_4	0.27	0.05	5.52	0.00***
PU	β_5	-0.86	0.13	-6.81	0.00***
Constant	β_0	3.84	0.19	19.96	0.00***

Note: Significance levels of 1%, 5%, and 10% are indicated by ***, **, and * respectively.

Source: Authors' compilation (2025).

R^2 = 0.80

Adjusted R^2 = 0.79

Mean VIF=1.60

Results presented in Table 4 showed that the regression coefficient with respect to land area cultivated was positive and significant at 1% level. This implies that for every one percent increase in land area cultivated holding other independent variables constant, there was increase in maize output by 0.49% at 1% level. These findings concur to Utouh (2024) who found that farm size (0.01, p<0.01) had a significant statistical influence on the level of maize production. This also reflects increase in the productivity of maize in the Coastal zone something which supports attainment of the third target stipulated by SDG 2 and the fifth goal of the of Agenda 2063 (UN, 2025; AU, 2025).

Furthermore, results presented in Table 4 showed that the regression coefficient with respect to type of farm labour used being household labour compared to non-household labour was positive and significant at 1% level. This implies that for every one percent increase in type of farm labour used being household labour holding other independent variables constant, there was increase in maize output by 0.31%. These findings concur to FAO (2025) that smallholders use mainly family labour for production.

Also, results presented in Table 4 showed that the regression coefficient with respect to quantity of seed used was positive and significant at 1% level. This implies that for every one percent increase in quantity of seeds used holding other independent variables constant, there was increase in maize output by 0.95 at 1% level. These findings are similar to studies conducted by Moshi *et al.* (2023) who found that seed quantity had positive impact on maize production.

Also, results presented in Table 4 showed that the regression coefficient with respect to quantity of fertilizer used was positive and significant at 1% level. This implies that for every one percent increase in quantity of fertilizer used holding other independent variables constant, there was increase in maize output by 0.96% at 1% level. These findings concur to Otieno (2016) who found that fertilizer propagated maize production.

Lastly, results presented in Table 4 showed that the regression coefficient with respect to pesticide use compared to non-pesticide use was negative and significant at 1% level. This implies that for every one percent increase in pesticide use holding other independent variables constant, there was decrease in maize output by 0.86 %. Decrease of maize output due to pesticide use could happen when smallholder farmers do not follow rules for safe handling of pesticides (MOA, 2024). For example if farmers used incorrect ratios when weighing and mixing of pesticides they are ought to affect plant health and its productive capacity.

3.4 Determinants of Maize Production Cost

Results presented in Table 5 showed that total cost of maize production increased significantly ($p<0.01$) when output increased. This implies that for a unit increase in the output of production, the cost of production increases by 1913.57 units, and this was significant at ($p<0.01$). This concurs to the production cost theory that total cost increases with output in the short-run (Pindicky and Rubinfeld, 2013).

Table 5: Regression table showing factors affecting total cost of maize production in the Coastal zone

Variable	Coefficient	Std. E	T	p>| t |
MQH	1913.57	145.24	13.17	0.00***
EDS	776931.70	780275.50	1.00	0.01**
EXS	-100744.60	759156.40	-0.13	0.89
Cons	5006993	821538.80	6.09	0.00***

Note: Significance levels of 1%, 5%, and 10% are indicated by ***, **, and * respectively.

Source: Authors' compilation (2025).

R^2= 0.65

Adjusted R^2 = 0.63

Also, showed that total cost of maize production increased when head of the household has formal education compared to those without formal education and this was significant ($p<0.05$).This implies that for a unit increase in formal education level, the cost of production increases by 776931.70 units, and this was significant at ($p<0.05$). This could have been so due to the fact that additional skills tend to increase wages or salaries in a firm. Therefore if educated household heads tend to compensate themselves based on skills they possess, or employ workers based on skills they possess, then they tend to increase total costs. As high wage expenses put pressure on farming management, family farms have to analyse productivity and profitability associated with labour as a factor of production (Yamane, 2021; Kusz *et al.,* 2022).

4.0 CONCLUSION AND POLICY IMPLICATIONS

This study assessed factors affecting maize production in the Coastal zone of Mainland Tanzania during the long rainy season. The study used data from the 2019/2020 National Sample Census of Agriculture. Findings from correlation analysis indicated that quantity of maize harvested correlated positively with land area cultivated (r=0.94), seed quantity (r=0.97), and fertilizer quantity (r=0.57) and the relationship is significant at 5% level. This implies that smallholder maize farmers need optimize the use of these inputs so as to maximize quantity of maize harvested. Furthermore, results from multiple regression showed that quantity of maize harvested increased significantly with land area cultivated (p=0.00), use of household labour (p=0.00), seed quantity (p=0.00), and fertilizer quantity (p=0.00), and decreased significantly with pesticides use (p=0.00). This suggests that smallholder maize farmers need skills for utilizing agrochemicals and other inputs to improve maize productivity while at the same time protecting the environment. Also, results showed that total cost of maize production increased significantly with output (p=0.00) and as well as when head of the household has formal education (p=0.01). This implies that smallholder maize farmers need to monitor productivity of every input used so as to manage profitable maize production. Therefore, study recommends to the government of Tanzania the need to formulate strategies for commercializing smallholder maize production so as to improve yield and profitability in the long-run.

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