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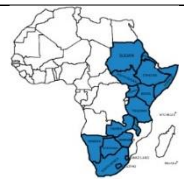

Factors Affecting Productivity and Labor Use on Small-Scale Maize Production in Tanzania

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KEYWORDS

Maize-Yield, Labour-use, Small-scale maize production, climate resilience, farm inputs

ABSTRACT

This study examines factors influencing maize productivity and labor use among small-scale farmers in Tanzania, highlighting the role of predictive inputs, methods, and policies that enhance resilience to climate change and support progress on achieving the UNSDGs in Tanzania. Using MANOVA and a Logit model, the study analyzes socio-economic and agricultural determinants of maize yield and labor use, based on cross-sectional data from the 2019/2020 National Agricultural Census and GIS data from NBS. The findings reveal that most farmers use local seeds rather than improved ones showing substantial differences in average maize-yield within the regions. Regionally, Lindi, Mtwara, Singida, Tabora and Morogoro have higher yields on local seed but lower yield on improved seed. However, several inputs and practices such as soil covering, inorganic fertilizers, extension services, and modern equipment significantly increase yield only when improved seeds are used. Off-farm income negatively correlates with maize yield, suggesting reduced on-farm commitment. Labor use is strongly influenced by the household head's education and credit access. Farmers with only primary education are more likely to hire labor than those with higher education, and those with credit access are far more likely to use hired labor. In addition, contract farming increases farm-size. The study recommends adoption of improved seed to maximize the benefits of fertilizers, modern tools, and climate-resilient practices. Expanding credit access could boost labor use and reduce unemployment. Furthermore, contract farming should be encouraged to help increase farm sizes. Finally, extension services need restructuring to address the distinct needs of both local and improved seed users.respective regions.

1.0 INTRODUCTION

Maize is one of the most important cereal plant for human and animal consumption and is grown for grains and forage. Production of maize requires a lot of inputs and facilitation. In mentioning few; the report by FAOSTAT (2000) explain that maize grow at above 15°C and frost-free areas. FAO (2024) explains that maize is an efficient user of water. Climatic distributions and climate changes are considered essential factors for maize cultivation. Erratic climatic conditions, inherent low fertility and nutrients depletion are among the most important biophysical constraints of food crops production in semi-arid African regions (Masele, 2023; Swamila M, 2023). However, the application of science and technology led to emergency of commercial based farming that meet food and nutritional needs (Thomas R. Odhiambo, 2001).

In a global perspective, Maize crop is grown in plantations and in small-scale as well. In the context of this study small-scale farmers referred to as “farmers, with at least 25 square meters of planted land and/or one cattle, 5 goats/sheep/pigs, 50 chickens/turkeys/ducks/guinea fowls/rabbits”. This definition was adopted from the National Sample Census of Agriculture 2019/2020 from NBS.

In Sub-Sahara Africa and Tanzania specifically majority of households are employed on small-scale farming. This reality immerse the need for strategized efforts to enforce achieving economic transformation and poverty reduction in Africa (Msangi, 2017). Currently, reports show relative transformation of labour force from agriculture to informal services and the questions arise whether the sector may contain enough farmers to ensure sustainable cultivation of crops especially maize. Is service sector wining up the majority of workforces? Recent reports and studies reveal that agricultural productivity is contracting and leading into job losses. The report by World Bank (World Bank, 2019). Maize cultivation and other agricultural activities face challenges such as declining soil fertility, poor land management, and climate-related disruptions, resulting in reduced yields and a shrinking agricultural labor force (Mkonda & Msafiri, 2022). In Africa, sectors like manufacturing and business services outperform agriculture in productivity (Sen et al., 2022).

In Tanzania for instance maize is grown in different regions with variety of climatic differences the farming methods should be customized to regulate the climatic differences especially temperature level in order to maximize the maize yield. The application of technological ways such as greenhouse facilities and irrigation schemes have been reported as usefully ways to cool the soil and enable the crops to grow effectively (Kamuzora, A.N, 2023; Marzouk et al. 2023; Mponda, 2021).

Currently, informal business and service sectors (social activities) takes large share of employment growth compared to agriculture (Deudibe et al. 2020). The shift from agriculture to business services is economic transformation due to a reason that non-farm employment is more productive and less risky (Adams et al. 2013; Deudibe et al. 2020; Totouom et al. 2019; World Bank, 2020).

Scholars have pointed fingers on several factors such as climate change disasters, soil fertility issues, inadequate education, poor farming practices and lack of appropriate inputs small-scale farmers need to nourish crops, these factors led to the poor performance in agriculture sector. For instance, The study conducted in Mbeya region and Morogoro region show that the proportions of households, which had access to improved maize, and rice seeds were 40.5% and 34.5% respectively (Monela, 2014). The research conducted by SUA on Maize and Rice support that loss of zinc and iron is a common issue in Tanzanian soils (Lamsili 2024; Rao et al. 2019; ORC and FiBL 2024).

In addition, existing studies have not sufficiently addressed the unique productivity and labor-use challenges faced by small-scale maize farmers across the entire country, who often differ in needs, compared large-scale producers. This study seeks to analyze the various factors influencing productivity and labor allocation among small-scale maize farmers in Tanzania under changing climatic conditions. The goal is to propose significant multivariate factors that can predict yield and labor efficiency and enable Tanzania’s progress on achieving UN Sustainable Development Goals (SDGs), especially Goal 2 (Zero Hunger), Goal 13 (Climate Action), and Goal 15 (Life on Land). To achieve this goal, this study follows specific objectives such as; a) To determine the effect of climate resilience on the maize yield for both local and improved seed. b) To determine the effect of farming inputs on the farm size. c) To find out the effect of farming practices on the maize yield for both local and improved seed. d) To examine association between social-economic factors and labor use in maize production.

2.0 METHODOLOGY

2.1 Variable measurement

The study rely on the variables shown in table 1, extracted from the National Agricultural Census Survey 2019/2020.

Table 1: Variables measurement

S/N	Variable	Measurement scale	Unit of measurement
1	Maize-Yield	Ratio	(Kg/Acre)
2	Farm size	Ratio	scale
3	Labour use	Nominal	1=Hired-labor, 0=Household-members
5	Contour farming	Nominal	1=Yes, 0= No
6	Irrigation	Nominal	1=Yes, 0= No
7	Fallowing	Nominal	1=Yes, 0= No
8	Soil covering	Nominal	1=Yes, 0= No
9	Planting legumes	Nominal	1=Yes, 0= No
10	Access to extension services	Nominal	1=Yes, 0= No
11	Insecticides/Pesticides/Herbicides	Nominal	1=Yes, 0= No
12	Region name	Nominal	Nominal(Names)
13	Access to credit	Nominal	1=Yes, 0= No
14	Types of seeds (local or improved)	Nominal	1=Yes, 0= No
15	Access to fertilizer (Types of fertilizers)	Nominal	1=Yes, 0= No
16	Education level	Ordinal	1= Primary, 0= Secondary/College/University
17	Contracting farming	Nominal	1=Yes, 0= No
18	Off-farm income	Nominal	1=Yes, 0= No
19	Main source of income	Nominal	1= Sale of Agricultural products 0=Other/business/Salary/Wage
20	Land Tenure	Nominal	1= Certified occupancy 0= Not certified occupancy/ other granted rights
21	Gender	Nominal	1= Male, 0=Female

Source: Author’s compilation, 2025

2.2 Research Design

This study adopted Correlational research design to discover or establish the existence of a relationship /association /interdependence between two or more aspects on maize cultivation. This study adopted quantitative approach to examine the multivariate effect of factors on the maize productivity and labour use (Chetty, 2016).

2.3 Data Sources

The study used raw data collected from National Agricultural Census Survey 2019/2020 and administrative data such as regional GIS shape files from NBS.

2.4 Data analysis methods

The study computed and discussed both descriptive statistics and inferential statistics. Descriptive statistics explains the situation of the maize productivity across different regions and inferential statistics were used to make conclusion about the study hypotheses.

2.4.1 Descriptive statistics

The study computed mean of the maize-yield by regions using STATA 17 and spatial maps from QGIS software was used to visualize average maize-yield distribution for both local and improved seed.

2.4.2 Inferential analysis

3.3.2.1 Multivariate Analysis of Variance (MANOVA)

Model specifications;

$Y = \beta X + \varepsilon$,…………………………………………………………………………………..(1)

Whereby;

Y: Represents the matrix of dependent variables (Maize-yield and Farm size).

X Stand for the matrix of independent variables (Climate resilience, farming inputs and practices).

B: Stand for the model coefficients or parameters to be estimated (these represent the effect of the independent variable on each dependent variable).

ε: Stand for the error matrix (residuals or errors for each observation and dependent variable).

3.3.2.2 Binary logistic Regression (Logit model)

Model specification;

Binary Logit model

$$\text{Logit (P)} = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1\text{Main-income} + \beta_2\text{Credit} + \beta_3\text{Extension} + \beta_4\text{Edu} + \beta_5\text{Gender} + \beta_6\text{Certified\_Occupancy} + \beta_7\text{Off\_farm\_income}, \quad \ldots\ldots(2)$$

Whereby:

P: Probability of labor use (Labor use=1)

β_0: Intercept (baseline log-odds of labor use when Main-income, Credit, Extension, Edu, Gender, Certified occupancy and Off-farm income are all 0).

β_1, β_2, β_3, β_4, β_5, β_6 and β_7: Coefficients for Main-income, Credit, Extension, Edu, Gender, Certified occupancy and Off-farm income respectively.

Odds and Odds Ratios:

$$\text{Odds} = e^{-(\beta 0 + \beta 1\text{Main-income} + \beta 2\text{Credit} + \beta 3\text{Extension} + \beta 4\text{Edu} + \beta 5\text{Gender} + \beta 6\text{Certified\_Occupancy} + \beta 7\text{Off\_farm\_income})}$$

Odds Ratio:

For each independent variable, the odds ratio measures the change in odds for a one-unit increase in that variable.

$e^{\beta 1}$: Change in odds for a one-unit change in Main-income.

$e^{\beta 2}$: Change in odds for a one-unit change in Credit access

$e^{\beta 3}$: Change in odds for a one-unit change in Extension service.

$e^{\beta 4}$: Change in odds for a one-unit change in Education level of head of household

$e^{\beta 5}$: Change in odds for a one-unit change in Gender.

$e^{\beta 6}$: Change in odds for a one-unit change in certified occupancy

$e^{\beta 7}$: Change in odds for a one-unit change in Off-farm income

3.0 RESULTS AND DISCUSSION

3.1 Descriptive analysis and spatial distribution of maize-yield by region

The descriptive statistics were analyzed from 6,196 households engaging in small-scale maize farming in Tanzania for 2019/2020 growing season. QGIS maps on figure 1 shows how production of maize is distributed across the small farmers by region with respective to seed type. The higher averages of the maize yields are regions with dark green and the lowest represented by white color.

The Southern East regions of Mtwara and Lindi, the regions around Lake Victoria such as Kagera, and Geita shown higher averages of the maize yield grown with local seed type compared to other areas. On other side, regions such as Mwanza, Dodoma, Geita, Kigoma, Njombe and Mbeya are shown to have higher averages of maize-yield with improved seed farming. Notably, Geita and Kigoma regions appeared to have good performance on both local and improved as well. However, the results indicate that some regions have higher yields on local seed but lower yield on improved seed, that regions are Lindi, Mtwara, Singida, Tabora and Morogoro.

On other side, results on table 2 illustrates the t-test for mean comparison between local seed maize-yield and improved-seed maize-yield. The result suggest marginal statistically significant difference at 5 percent significance level (P=0.0598). The observed difference size (Mean difference= 154) is not zero (0). Under few observations, the result suggests potential difference in the maize productivity between the seed variety.

Table 2: T-test of the mean difference between local and improved yields

Variable	Observation	Mean	Std. Error	SD	(95% Conf. interval)
Local-seed Yield	31	223.1	134.1	746.7	-50.8, 496.9
Improved-seed Yield	31	69.1	44.2	246.0	-21.2, 159.3
Difference	31	154.0	96.1	535.3	-42.3, 350.4

Ha: mean (diff) > 0, t = 1.6023, Pr (T > t) = 0.0598

Source: Author's compilation, 2025

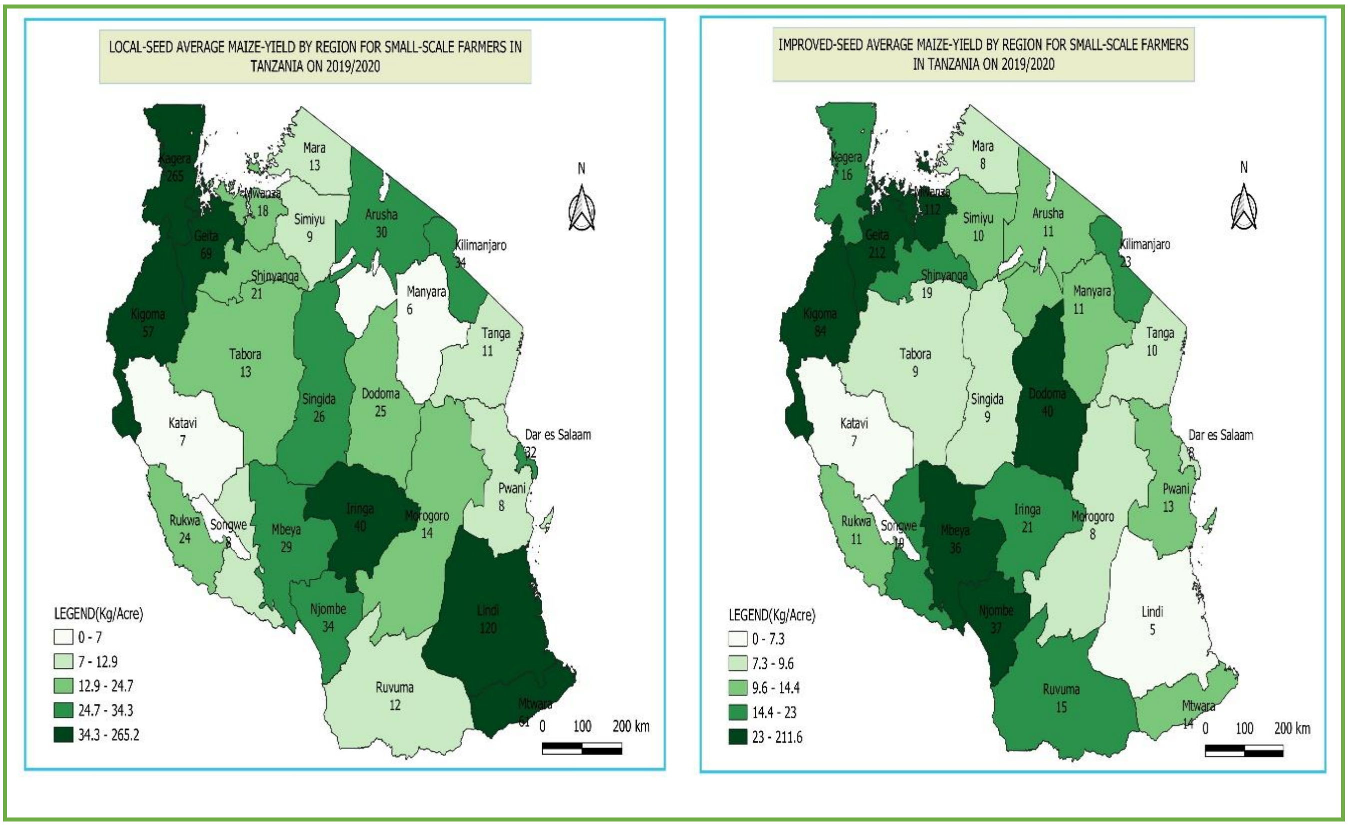

Figure 1: Spatial distribution of average maize-yield by region and seed type in 2019/2020

Source: Author's compilation, 2025

3.2 Inferential analysis

This subsection presents results of inferential tests that were used to answer and conclude research hypotheses on each specific objective of the study. The analysis rely on the experiences of about 6,196 households that practice small-scale maize farming in the entire country meeting up all thirty one (31) regions of Tanzania. These regions possess different climatic conditions in terms of weather, altitudes, soil textures and fertility, but also different farming practices and education levels of the head of households. However, this study has come up with the common factors that affects the maize yield across all regions taking a reference of 2019/2020 growing season.

3.2.1 The effect of climate change resilience on the maize yield

The MANOVA results in table 3 illustrate the effect of various conservational farming practices on the maize yield across the small-scale farmers. These conservational methods are the resilience against climatic changes and loss of soil fertility in the crops production.

The results show that at 95% confidence level, the relationship between maize-yield and covering of soil with grasses or leaves is statistically significant only if the seed used is improved type since P-value ≤ 0.05. That means a unit increase of soil covered with grasses or leaves with effectively increase yield of an improved seed by 29.6 percent. Off-farm income of the head of household significantly affect the maize-yield but the relationship is negative. This implies that when small-scale maize farmers generate off-farm income their attitudes on farm management change and affect the yield. The relationship is significant when the seed is of improved type. The study conducted by (Ntengo and Revocatus (2014) found that climate change related risks affect off-farm income sources by 43 percent.

On other side, irrigation practice has a positive relationship to maize-yield though such relationship is not significant at 95 percent confidence level. However, results show that interaction between irrigation and farming with inorganic fertilizers on the improved seed bears negative relationship to maize yield. The study conducted by Mourice et al. (2014) in Morogoro found that interaction between irrigation and nitrogen significantly ($P \leq 0.05$) increase maize grain yield only if it is rainy season and concluded that application of recommended Nitrogen rate did not result into yield increase when water was limiting. This implies that irrigation practices has not been so effective enough to determine maize-yield unless the soil is fed with enough rainy water or fed with improved irrigation schemes otherwise.

The results also indicate that none of the resilience had significantly affected the maize-yield in a condition of local seed type and other variables such as contour farming for upland areas, planting of legumes and an intensive use of organic fertilizer shown no significant relationship to the maize-yield in both seed variety. This study revealed that contour farming has positive effect to maize-yield because maize cultivation is highly affected by rainfall related climate risks (Ntengo and Revocatus 2014). The practices to conserve and mitigate climate risks influence farmers to used more than one strategy (Kabote et al. 2024).

Table 3: MANOVA analysis on the effect of climate change resilience on maize yield

Variable	Seed Type	Coefficient	Std. err	t	P>|t|
Contour farming	Improved	0.052	0.156	0.330	0.741
	Local	-0.052	0.176	-0.300	0.768
Planting of legumes	Improved	-0.022	0.189	-0.110	0.909
	Local	-0.175	0.165	-1.060	0.291
Intense use of organic fertilizer	Improved	0.154	0.151	1.020	0.309
	Local	-0.200	0.165	-1.210	0.228
Covering soil with grasses/leaves	Improved	0.296	0.151	1.960	0.050
	Local	0.067	0.170	0.390	0.694
Off-farm income	Improved	-0.199	0.095	-2.080	0.038
	Local	-0.110	0.104	-1.060	0.289
Irrigation	Improved	0.779	0.616	1.260	0.207
	Local	-0.585	0.408	-1.430	0.153
Interaction (Irrigation and Inorganic fertilizer)	Improved	-1.588	0.751	-2.110	0.035
	Local	-	-	-	-

Source: Author's compilation, 2025

3.2.2 Relationship between farming inputs and farm size

In this study, the farm size refers to the area planted crops. Results in table 4 reveal that in those households used grow maize using any variety of seed type the use of inorganic fertilizer has positive relationship with farm size. This indicates that at 95 percent confidence level a unit increase in the use of inorganic fertilizer significantly relate to the farm size and lead to 57.5 percent increase in the farm size for local seed farmers and 44.4 percent increase in farm size for improved seed farmers. Contract farming significantly increase farm size by 66 percent for local seed farmers while it is not significant on improved seed users though the relationship remain positive as well.

On other side, access to extension services has negative relationship with farm size. This means as farmers receive extension advices they reduce the farm size by 32.9 percent significantly but this happen to the households using improved seed while on the local seed users extension service has no significant effect on the farm size the effect remain negative as well. This implies that modern farming methods or extensions emphasizes small farm sizes among the small-scale farmers. On other side, access to extension services is associated with maize productivity. Study findings show that farmers' access to extension services was positively and significantly ($p<0.001$) (Mphepo and Urassa, 2022).

Results also indicate that availability of off-farm income for the head of household significantly reduce farm size by 36.6 percent, implying that off-farm income sources undermine investment in maize farming but only for local seed growers.

An access to credit has positive relationship to farm size. This indicate that any change to access credit lead to 10.6 percent increase in farm size on improved seed farmers and 23 percent on local seed farmers. However, such effect is not statistically significant at 95 percent confidence level.

Table 4: MANOVA analysis on the relationship between farming inputs to farm size

Variable	Seed Type	Coefficient	Std. err	t	P>|t|
Off-farm income	Improved	0.209	0.113	1.850	0.065
	Local	-0.366	0.108	-3.390	0.001
Credit	Improved	0.106	0.231	0.460	0.648
	Local	0.230	0.224	1.030	0.303
Extension	Improved	-0.329	0.112	-2.950	0.003
	Local	-0.129	0.113	-1.150	0.252
Inorganic fertilizer	Improved	0.444	0.118	3.780	0.000
	Local	0.575	0.113	5.070	0.000
Contract farming	Improved	0.306	0.588	0.520	0.603
	Local	0.660	0.277	2.390	0.018

Source: Author's compilation, 2025

3.2.3 The effect of farming practices and maize yield

On the farming practices, Results table 5 illustrate that growing maize with the use of inorganic fertilizer has positive effect of 37.7 percent increase in maize-yield among the improved seed farmers and the relationship is statistically significant at 95 percent confidence level. This finding is similar to the results of Mourice et al. (2014). This situation is contrary to local seed farmers, which possess negative effect and such relationship is not significant at 95 percent confidence level.

The use of Hired labor in the small-scale farming is not significant to affect the maize-yield since P-value > 0.05, though the relationship between the two variables is positive indicating that one more attempt to use hired labor force will increase maize-yield by 8.6 percent on improved seed farmers and 16.1 percent on local seed farmers. In addition, the interaction between the use of hired labor force and access to credit among the farmers who use improved seed, the maize yield will increase by 75.8 percent significantly since P-value < 0.05.

Access to extension service has significant effect on maize-yield for both local seed and improved seed farmers. This is justified by P-value<0.05. Extension service affect positively maize-yield meaning that one more access to extension service lead to 26.2 percent increase in the maize-yield only if the seed used was improved type. This result is similar to the study conducted in Malawi by Mphepo and Urassa (2022). However, the extension service have shown negative relationship with maize-yield on the local seed users in Tanzania.

The results illustrate that the use of advanced equipment such as Tractors, power tillers, water-pump, sprinklers etc. has positive relationship with maize-yield only for improved seed variety compared to traditional tool like hand-hoe, panga, hand-sprayer, Oxen cart, threshers and so forth. This implies that as farmers keep on using advanced tilling and irrigation systems the yield will increase. This relationship is not statistically significant (P>0.05) among the small-scale farmers but it indicate long-run effectiveness. However, between the local seed users, results shown negative relationship meaning that the use of advanced equipment has not improved their production yet and specific extension service is necessary for local-seed farmers. On other side, practices such as contract farming and the use herbicides and insecticide have no significant effect on the maize-yield across all seed variety on the small-scale maize farmers.

Table 5: MANOVA analysis on the effect of farming practices on the maize yield

Variable	Seed Type	Coefficient	Std. err	t	P>|t|
Contract farming	Improved	0.651	0.497	1.310	0.191
	Local	-0.489	0.265	-1.840	0.066
Fallowing	Improved	-0.001	0.161	-0.010	0.994
	Local	0.003	0.209	0.020	0.987
Inorganic fertilizer	Improved	0.377	0.099	3.800	0.000
	Local	-0.016	0.109	-0.150	0.880
Hired-labour	Improved	0.086	0.140	0.620	0.539
	Local	0.161	0.254	0.630	0.527
Extension	Improved	0.262	0.094	2.780	0.006

Variable	Seed Type	Coefficient	Std. err	t	P>|t|
	Local	-0.235	0.108	-2.170	0.030
Advanced-equipment (Tractors, Sprinklers, etc)	Improved	0.049	0.092	0.540	0.590
	Local	-0.217	0.105	-2.080	0.039
Interaction (Hired-labour and Credit)	Improved	0.758	0.339	2.240	0.026
	Local	0.170	0.531	0.320	0.749
Interaction(Herbicides and Insecticides)	Improved	0.173	0.356	0.480	0.628
	Local	0.220	0.611	0.360	0.719

Source: Author’s compilation, 2025

3.2.4 Association between social-economic factors and labour use in maize production among the small-scale farmers.

The study analyzed several socio-economic factors to find out which among them influence labor use in small-scale maize production. The factors under study are gender of the head of household, education level of the head of household, farm tenure of occupancy, off-farm income, and main source of household income, access to credit, and access to extension service.

By using logistic regression model, table 6 results show that access to credit and education level of the head of household significantly influence the use of labor force among the small-scale maize farmers in Tanzania. This is justified since P-value <0.05. Other factors have not demonstrated significant association with labor use.

The Odds ratio show that if head of household is a male then the chance of using labor is lower compared to female heads since male odds ratio 0.642 < 1. On the education factor, Primary education has higher odds (2.597) compared to higher levels like secondary, college and university which have lower odds (0.385). This means that there is higher chance of using labor among the households with primary education level compared to households by which the head of household got higher level of education. This happens among the small-scale maize farmers implying that higher-level educated head of households have attitude to work by themselves with few laborers. However, the use of hired labor is practical when the farmers get access to credit as indicated in table 4 above. Farmers with access to credit have higher chances of using hired labor (Odds ratio = 6.253) compared to farmers who do not access credit (Odds ration = 0.160).

The farmers with Certified Occupancy of the farmland have higher chance to use hired labor compared to other kind of occupancy since odds ratio > 1. On other side, when the main source of household income comes from other business, Salary or Wage, the chance to use hired labor is high (odds ratio > 1) compared with households depending on Sales of Agricultural products (includes crops and livestock products). This implies that sales in agricultural products bear low profit and if they could use hired labor to get higher yield, they would have to ask for credits.

The results also show that households with off-farm income has odds ratio 1.138 > 1, indicating higher chance to use hired labour in maize production than the households without off-farm income. On other side, farmers who receive extension service has lower chance of using hired labour compared with those who have not yet received extension services. This justified with low odds ratio (0.890 < 1). This means that once the small-scale farmers got extension knowledge (technology or facilities) they have lower chance of hiring labourers.

Table 6: Logistic regression on association between socio-economic factors and labor use

Variable	Odds ratio	Std. err	z	P>|z|	[95% conf. interval]	
Gender						
Male	0.642	0.167	-1.700	0.089	0.386	1.070
Female	1.557	0.405	1.700	0.089	0.935	2.594
Education level						
Primary	2.597	0.712	3.480	0.001	1.517	4.445
Secondary/College/University	0.385	0.106	-3.480	0.001	0.225	0.659
Tenure system						
Certified Occupancy	1.002	0.374	0.010	0.996	0.482	2.084
Not Certified Occupancy/ Other granted rights	0.998	0.373	-0.010	0.996	0.480	2.076
Main Household income						
Sale of Agricultural products	0.994	0.239	-0.030	0.979	0.620	1.592
Other business/Salary/Wage	1.006	0.242	0.030	0.979	0.628	1.613
Off-farm income						
Yes	1.138	0.302	0.490	0.627	0.676	1.915
No	0.879	0.234	-0.490	0.627	0.522	1.479
Credit Access						
Yes	6.253	1.883	6.090	0.000	3.465	11.283
No	0.160	0.048	-6.090	0.000	0.089	0.289
Extension service						
Yes	0.890	0.205	-0.500	0.615	0.567	1.399
No	1.123	0.259	0.500	0.615	0.715	1.765

Dependent variable: Labor use (Hired labor), Pseudo R^2 = 0.0859, Observations = 820

Source: Author's compilation, 2025

4.0 Conclusion and Recommendation

4.1 Conclusion

The study concludes that soil cover with grasses or leaves, when combined with improved maize seeds, significantly increases maize yield. Similarly, inorganic fertilizer use has a strong positive impact on both maize yield and farm size, especially among improved-seed users. Off-farm income, however, negatively affects maize yield and farm size, while irrigation alone does not significantly influence productivity. The role of contract farming is notable, positively influencing farm size when improved seeds are used. Extension services have mixed effects: they reduce farm size regardless of seed type, but they positively influence yield among improved-seed users and negatively among local-seed users.

On the labor use, access to credit and primary education level significantly increase the likelihood of hiring labor, whereas higher education levels correspond with more mechanized, labour-saving practices. Other factors such as gender, income source, and land tenure showed no significant relationship with labor use.

4.2 Recommendations

Recommendations focus on improving access to and use of improved seeds, inorganic fertilizers, and credit facilities. Emphasis is placed on promoting contract farming, improving extension services, and investing in sustainable irrigation infrastructure to combat climate change and declining soil fertility. The study also recommends targeting extension content toward users of both improved and local seeds, addressing the gap in service effectiveness. To boost employment and productivity, enhancing the availability of hired labor through credit access and tailored training is suggested.

4.3 Area for further research

Further research is recommended for Zanzibar, due to its underrepresentation in national data, for more understanding of regional differences in small-scale maize farming.

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