



Empirical Analysis of the Factors that Affecting Maize Production of Farmers among Smallholders: The Case of Eastern Oromia, Ethiopia

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ABSTRACT

In Ethiopia, maize is the second largest in production areas and first in its productivity but there are high yield gaps between the actual yield currently producing and the potential yield. Therefore, this study was aimed to identify factors that affecting maize production of smallholder farmers at the farm level in the Meta district in the east Hararge zone, Oromia, Ethiopia. A two-stage random sampling technique was employed and a total of 200 smallholder farmers were randomly and proportionally selected to collect primary data. Multiple linear regression models were used to analysis factors that affect maize production among smallholder farmers. The result showed that the production of maize was influenced by several factors. The coefficient provided that as the farmers obtained 1 dollar from non-farm activity, the maize production of farmers increased by 293.2 kg, keeping other factors constant. Thus, the farmers who had money from non-farm sources used as additional income to gain agricultural inputs for maize production and thus generate more maize quantity. The result was pointed out that the size of the cultivated areas of land had a positive influence on the quantity of maize production of farmers. The coefficient entailed that as the size of the cultivated areas of land increased by one hectare, the farmer's quantity of maize production increased by 140.4 kg by keeping other factors constant. The result was also indicated that other factors being constant, the maize crop production of smallholder farmers of Meta district was decreased by 4 kg as Development Agent's (DA's) office distance increased by one minute. The possible explanation was that extension services were a critical source of information on agronomic practices. Therefore, policy makers should encourage the current maize production and supplying improved seed and chemical fertilizer which support to improve smallholder farm households' welfare by increasing their sources of income.

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Introduction

Ethiopia is one of the nations among developing countries in the world and characterize by the low income and lower technology. The country was mainly depending on agricultural activities and provided with good climatic conditions and fertile soil for crop production. The farmers in developing countries are depending upon a farm income and they are characterizing by the low income and scarcity in the supply of food. This is because of technological backwardness, speedy population growth and turn down in productivity of crops and livestock endeavor (Agatamudi and Hirko, 2016).

Maize production is a vital component of food security and livelihoods among smallholder farming societies in Ethiopia. Being the staple food of the overriding mass of people in the country, maize is the mainly important products in terms of food security. The majority of smallholder farmers grow maize principally for survival purposes (FAO, 2018). Maize crop was the third most

significant cereal crop in the world after wheat and rice and the most extensively grown crop from lowland to highland agro-ecologies in Ethiopia (Gebre et al., 2019). Among cereal crops, maize accounts for the largest donated in the country's crop production and is grown more than any other crop by farmers. Between 2006 and 2017, the national average yield was 2.6 tons/ha (CSA 2015a, 2017), which is higher than the sub-Saharan African average of 1.98 tons/ha (FAOSTAT, 2018). In sub-Saharan Africa, global statistics show that more and more land is being used for small-scale maize production to congregate future food demands (Romy, 2020). From 2007 to 2017, the area on which maize is grown in sub-Saharan Africa has increased by almost 60% (FAOSTAT, 2019). Ethiopia is the only country in Sub-Saharan Africa that has shown substantial advancement in maize productivity and input use (EEA, 2017).

Ethiopian Economic Association reported that after a period of limited growth, yield more than doubled from around 1.5 ton/ha in 2000 to over 3 tons/ha in 2013. Despite the recent progress in productivity, yield levels in Ethiopia are still very low relative to what could be produced (EEA, 2017). According to Food and Agricultural Organization Statistics (FAOSTAT), national maize production in Ethiopia is on average 6.7 million tons for the period 2013-2015 present production. The analysis shows that relieving economic constraints should have the greatest contribution to maize production, although improving efficiency of input use, more efficient markets and adoption of advanced technologies also result in higher national production (FAO, 2015).

Maize is vital to the livelihoods of smallholder farmers in Ethiopia since the crop with the major smallholder exposure at 8 million holders compared to 5.8 million for teff and 4.2 million for wheat. Moreover, maize plays a central role in Ethiopia's food security. It is the lowest cost source of cereal calories, providing 1½ times and two times the calories per dollar compared to wheat and teff respectively. An efficient maize area could force Ethiopia's food production to rapidly reduce the national food shortage and keep rate with a growing population (Shahidur et al., 2010).

Maize is the most important staple in terms of calorie intake in rural Ethiopia. Maize becomes a more low-priced crop relative to other staples such as wheat and teff to rural and urban consumers through increased production forcing market prices down. It is now gradually more used both separately as well as in mixed flour with other more expensive cereals in traditional Ethiopian diets (Tsedeke et al., 2015). The 2004/2005 national survey of consumption expenditure indicated that maize accounted for 16.7% of the national calorie intake followed by sorghum (14.1 %) and wheat (12.6%) among the major cereals (Berhane et al., 2011). The familiarity of maize in Ethiopia is to some extent because of its high value as a food crop as well as the growing demand for the Stover as animal fodder and source of fuel for rural families. Approximately 88 % of maize produced in Ethiopia is consumed as food, both as green and dry grain. Maize for industrial use has also supported growing demand. Very little maize is currently used as feed but this too is changing in order to support a rapidly growing urbanization and poultry industry (Zerihun et al., 2017).

In Ethiopia, maize is the second next to teff in the production area and the first in its productivity. Of the total grain cereal crop area, 79.4% (9,848,746 ha), maize took up 16.1% of cultivated areas and its national productivity reaches up to 3.24 ton per hectare. Oromia state accounts for about 54.3% of the total area of cultivation to the nation and the productivity in this region is presently 3.31 tons per hectare (Zerihun et al., 2017). However, Western parts of sub-humid regions are mostly producing maize harvest and accounts for more than 60% of the total production of the region. Most of the Western parts of Oromia in their locality of production percentage include Jima zone (13.8%), East Wollega (11.5%), West Shewa (9.2%), Ilu Aba-bor (8.7%), West Wollega (6.5%), Kelam Wollega (5.2%) and Horro Guduru (4.6%) zones. The production area increased from year to year and from location to locations (Derib et al., 2017).

Even though maize covers the second largest production areas and first in its productivity compared to other cereal crops, there are still high yield gaps between the actual yield currently producing and the potential yield that is documented by different research institutions. For instance, long maturing hybrid maize varieties will produce up to 9.5-12 tons per hectare at the research field and 6-8.5 tons per hectare at on farm fields if the production and management are done in integrated approaches (Tittonell and Giller, 2013). Whereas, the national and regional current maize productivity is below half of the dormant yield of most of the hybrid seeds, 3.2 tons per hectare. This high yield gaps are most probably caused by many abiotic and biotic factors which permanent maize based mono cropping and poor soil fertilities are the major problems limiting the productivity of the crops (Harold, 2015).

In the features of budding food consumption and altering food routine of the people, the maize has prospective function to play as a food crop in Ethiopia. Maize occupies significant site in the food chain after rice and wheat since people can consume maize by different ways and in terms of human consumption. So, it is essential to develop the area under maize farming for ensuring the food security and upholding sustainable development of agriculture (Uddin et al., 2017). Therefore, a comprehensive understanding of factors determining quantity of maize production is important to improve the response instruments related to the production of maize crop development. This study was focused on factors affecting maize production at the farm household level in eastern Ethiopia at large and in the Meta district of the eastern Hararge zone in particular. The objective of the study was, therefore, to identify the factors affecting maize production among smallholder farmers in the Meta district, Oromia Ethiopia.

Materials and Methods

Description of Study Area

The study was conducted in East Hararge zone, Ethiopia. East Hararge is located between latitudes 7° 32' and 9° 44' North and longitudes 41° 10' and 43° 16' East. This wide range of agro-ecological zones allows the area to produce a variety of products, including cereal crops such as sorghum, maize, wheat, and teff; vegetables such as potatoes, onions, shallots, and cabbage; as well as perennial crops such as coffee and *Khat (Catha edulis)*. Among the cereals grown, sorghum and maize constitute the dominant crops, particularly in terms of the size of cultivated land and the number of households growing (Sileshi et al., 2019).

Meta district is one of the districts among 21 districts of eastern Hararge zone of Oromia regional state, Ethiopia. Based on data from the Central Statistical Agency (CSA) in 2015b, this district has an estimated total population of 240,285 of whom 117,864 are men and 122,421 are women; 12,459 or 5.19% of its population are urban residents, which is less than the Zonal average of 6.9%. Meta has an estimated population density of 365.7 people per square kilometer, which is greater than the Zone average of 102.6. In general, the district is nominated as dearth flat and various crop breakdowns are a common

problem usually leading to food famine. The land use plan of the Meta district consists of 52% arable and 21% pasture and forest, and the rest 27% considered as degraded (CSA, 2018). Sorghum, maize, barley, wheat, and teff are the major food crops in the district, whereas Khat and coffee are the major cash crops. The farming system of the administration consists of crop production (4.1%), livestock production (7.9%), and householders that are engaged in mixed crop and livestock production (88.0%) (Beyan and Nano, 2018).

Sources of Data and Methods of Data Collection

In the study, both primary and secondary data sources were employed. The primary data were collected in the 2019 production year using a semi-structured questionnaire that was administered by the trained enumerators to 200 smallholder maize farmers. The secondary data were collected from relevant sources such as published and unpublished documents from the internet, administration offices of the district and other relevant institutions for a general description and to augment primary data.

Sampling Technique and Sample Size

A two-stage sampling procedure was employed to select potential maize producer smallholder farmers. The term Kebele referred to a localized group of people under District in Ethiopia. In the first stage, two potential maize producer kebeles from the District were selected through purposive sampling method. During the selection, the kebele’s potential for maize production and accessibility were taken into consideration. In the second stage, using the population list of maize producer farmers from sample kebeles, the proposed sample size was determined proportionally to the population size of maize producer farmers. Then, 200 representative households were randomly selected using a simple random sampling technique using Yamane (1967) formula;

$$n = \frac{N}{1 + N(e^e)}$$

Where, *n* is the sample size, *N* the population size (total household size) and *e* the level of precision. The population is homogeneous in terms of maize production in the sample kebeles. Due to the homogeneity of the population, 7% precision level was used for this study to avoid acquiring extra costs and captivating more time for collecting the same set of information on different smallholder maize producer farmers. Based on the number of the total households (9118) in the sampling frame, the formula calculated and reached a minimum of 200 respondents to be drawn.

Method of Data Analysis

Both the descriptive statistic and econometric model were used to analyze the collected data. Descriptive statistics are mean, percent, and frequency were used to describe the socio-economic data and available opportunities to maize production while multiple linear regression models were applied to identify determinants of maize production development among smallholder farmers in the Meta district.

Model Specification

Production of maize crops owned by sampled household head is a continuous dependent variable of the model that was measured in kilogram. The appropriate econometric technique to deal with the continuous dependent variable is using multiple linear regression models and it was the most familiar statistical models used to analyze the data. It is a general statistical technique through which one can analyze the relationship between a continuous dependent variable and a set of dummy/categorical/continuous independent variables (Alexopoulos, 2010). Multiple linear regression models are given as follows;

$$Y = \beta_0 + \beta_1 X_1 + \dots + \beta_{12} X_{12} + \epsilon \tag{1}$$

Where the dependent variable was *Y*, the maize production of farmers in kg and independent variables were *X*₁ age of household head in years, *X*₂ family size of household in number, *X*₃ educational level of household head measured in number of year spend in schooling, *X*₄ non-farm income of household in dollar, *X*₅ cultivated area of land in hectare, *X*₆ distance to the market in minutes, *X*₇ distance to DA's office in minutes, *X*₈ economically active members in numbers, *X*₉ amounts of fertilizer used in kg per hectare, *X*₁₀ amounts of organic fertilizer used in kg per hectare, *X*₁₁ access to market information (1= if has market information, 0 = otherwise), *X*₁₂ is social status of household head in the community (1=if participated, 0 = otherwise) and ϵ is a random disturbance.

Table 1. Hypothesis testing for significance of regression

Model	SS	DF	MS	F tab
Regression	SSR	k-1	MSR=SSR/k-1	$F_{cal} = \frac{MSR}{MSE}$
Error	SSE	n-k	MSE=SSE/n-k	
Total	SST	n-1		

SS: Sum of squares, DF: Degree of freedom, MS: Mean sum of square

Hypothesis: Ho: $\beta_1 = \beta_2 = \dots = \beta_{12} = 0$ versus $H_1: \beta_i \neq 0$, for at least one *i*. The total sum squares is given by:

$$SST = SSR + SSE \tag{2}$$

Where SSR is sum square of regression, SSE is sum square of residual (errors).

To test Ho: $\beta_1 = \beta_2 = \beta_3 = \dots = \beta_{12}$, first we compute F calculated and F tabulation as follow.

$$F_{cal} = \frac{MSR}{MSE} \tag{3}$$

Where MSR is mean square regression and MSE is mean square residual. We compare *F*_{cal} with *F*_α (*k*, *n-k-1*) and we reject Ho If *F*_{cal} > *F*_α (*k*, *n-k-1*). Where ‘*k*’ represents the number of independent variables and ‘*n*’ is the number of observations, if *H*₀ was rejected, it means that the contribution of explanatory variables (*X*_{*i*}) in estimating maize production (*Y*) was significant. If *H*₀ was failed to reject, it means that the contribution of explanatory variables (*X*_{*i*}) in estimating maize production (*Y*) was not significant (Hiba, 2017).

Test of Individual Regression Coefficients

Null hypothesis: $H_0: \beta_i=0$ (individual factors have no effect) Alternative hypothesis: $H_1: \beta_i \neq 0$, where $i=1, 2, \dots, 12$ (individual factor has effect on the response variable).

$$\text{Test statistic } t_{\text{test}} = \frac{\beta_i}{\text{se}(\beta_i)} \quad (4)$$

Decision rule: reject H_0 if

$$t_{\text{cal}} > |t_{\alpha/2}^{(n-1)}|,$$

if H_0 was rejected, it means that the contribution of explanatory variables (X_i) in estimating maize production (Y) was significant. If H_0 was failed to reject, it means that the contribution of explanatory variables (X_i) in estimating maize production (Y) was not significant.

Use of F-test: To test for the significance of the overall model, before considering the significance of individual variables.

Use of t-test: It is used to determine if the individual coefficient for each independent variable represents a significant contribution to the overall model.

The Coefficient Determinations (R^2)

It is the amount of variation explained by the regression model. R^2 depends on the number of data pairs (n) and the number of variables (k) whereas adjusted R^2 depends on the number of degrees of freedom. Adjusted R^2 is less than R^2 and take account of the fact when n and k are approximately equal (Sabine and Brian, 2003).

Model Diagnosis

Normality of Error Term: The error terms are normally distributed with mean zero and variance σ^2 can be tested by plotting residual against the cumulative probability or tested by a histogram.

Homoscedasticity: Error terms have constant variance and points in the graph are detached at in a random manner have no trend; this indicates that the assumptions of homoscedasticity hold.

Autocorrelation: The error terms should be independent. There is no relation between successive error terms. The Durbin Watson (DW) statistic was used to test autocorrelation in the residuals from a statistical regression analysis. The Durbin-Watson statistic was always having a value between 0 and 4. Values from 0 to less than 2 indicate positive autocorrelation and values from 2 to 4 indicate negative autocorrelation.

Multicollinearity: Co-linearity, or multicollinearity, is the existence of near-linear relationships among the set of independent variables. The presence of multicollinearity was tested by the variance inflation factor, given by:

$$\text{VIF} = \frac{1}{1-R_1^2} \quad (5)$$

Where R_1^2 is coefficient of determination obtained from X_1 on the other explanatory variables. If the value of VIF less than 10 (tolerance greater than 0.1), then there is no multicollinearity in the data.

Result and Discussion

Descriptive Analysis

The main objective of this study was to identify factors that affect the yield of maize crop in Meta distinct. The primary data were used that collected from 200 households on the yield of maize crop issues during 2019.

According to the result of Table 2, the average age of the sample household heads was 41 years where the minimum was 20 years and the maximum was 80 years out of 200 sample household respondents. The average family size of the sample households was 5 persons, with 1 and 9 were being the minimum and the maximum family size out of sampled household respondents, respectively. The average level of education attending the formal schooling of the sample farmers was grade 2. The study also showed that the average non-farm income of the sample households was 29.39 in dollar whereas the average of economically active members of the sample respondents was 3 persons. Further, the study indicated that the average cultivated land of the sampled households was 0.41 in hectare whereas the average amounts of chemical fertilizer used by the sample respondents were 211.19 kilograms. Whereas the average amounts of organic fertilizer used by the sample respondents were 492 kilograms. The average distance between the villages and the market in minutes for the sample households was found to be 68.88 in minutes. As indicated in the study result, the mean distance between the home of household and the DA's office in minutes for sample households was 27.62 in minutes.

As indicated in the Table 3, out of the total sample respondents, 80 percent have been access to market information since access to market center was a determinant of profitability and sustainability of agricultural produce or proxy to agricultural marketing services while out of the total sample respondents, 34.5 percent of households were participated in social organizations.

Multiple Linear Regression Analysis for Maize Production

Analysis of factors affecting the quantity of maize production was found to be imperative to identify factors confining maize production. Multiple regression models were used to determine the factors that affect the production of maize crop. Before the results of model coefficients were employed, the overall model adequacy was checked. The model summary table indicated that the strength of the relationship between the explanatory variables and the response variable.

According to the model adequacy in Table 4, the value of the correlation coefficient (R) was 0.85 this indicated that there was a strong relationship between the production of maize and other independent variables and also the value of the coefficient of determination (R^2) was 72.25%, indicated that 72.25% of the variation in the production of maize crop was explained by other the explanatory variables. Therefore, the model was adequate.

Hypothesis Testing for The Model

The overall hypothesis testing was a method that was used to test the joint effect of the independent variables on the dependent variable.

Table 2 Descriptive statistics for continuous variables.

Variables	Mean	Std. Deviation	Minimum	Maximum
Age in years	41.59	11.58	20	80
Family Size in number	5.82	1.66	1	9
Educational level in grade	2.44	3.59	0	12
Non-farm income in dollar	29.39	107.156	0	807.508
Cultivated land in hectare	0.41	0.53	0.06	5
Distance to market in minute	68.88	27.27	30	120
Distance to DA's office in minute	27.62	13.82	2	60
Economic active in number	3	1.01	1	6
Fertilizer used in kg per hectare	211.19	164.08	0.00	800
Organic fertilizer used in kg per hectare	492	511	0.00	2000

Source: (Own computation, 2020).

Table 3. Descriptive statistics for dummy variables

Variables	Sample Households	Number	Percent (%)
Market information	Yes	160	80
	No	40	20
Social status	Participated	69	34.5
	Not	131	65.5

Source: (Own calculated results, 2020).

Table 4. Model adequacy checking summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.850 ^a	0.7225	0.689	14.67493	2.034

Source: (Own computed results, 2020).

Table 5. Overall Result of Analysis of Variance (ANOVA)

Model	Sum of Squares	Df	Mean Square	F	Sig.	
1	Regression	82569.277	12	6880.773	32.478	0.004 ^b
	Residual	39616.911	187	211.855		
	Total	41860.189	199			

Source: (Own computation, 2020).

ANOVA was a useful test for the ability of the model to explain any variation in the dependent variable; it does not directly address the strength of the relationship between the variables. As indicated in Table 5, the overall regression model was statistically significant that means at least one of the parameters or coefficients of explanatory variables was different from zero.

As depicted in Table 6, the model was statistically significant at 5% level of significance indicated that the goodness of fit of the model to be explained the relationships of the hypothesized variables. The coefficient of determination (R^2) was used to check the goodness of fit for the regression model. Hence, R^2 indicated that 72.25 percent of the variation in the quantity of maize produced was explained by the variables included in the model. This finding was reliable with (Beriso, 2018) that investigated Factors Affecting Smallholder Farmers Potato Production. He found that the coefficient of determination was used to check the goodness of fit for the regression model. And also, consistent with the finding of (Bezawit, 2011), (Mesfin and Leykun, 2017).

As revealed in Table 6 that non-farm income of the household, the cultivated area of land, distance to Developmental Agent's (DA's) office, economically active members, amount of fertilizer used, amount of organic fertilizer applied, and Social status of household head in the community were statistically significant at 5% level significance. This indicated that those variables were

considered as important determinants that affect the farmer's maize production quantity. Also, the remaining explanatory variables: age of household head, family size of households, educational level of households, distance to nearest market and access of market information were found to be not statistically significant at a 5% level of significance.

Non-farm income: Non-farm income of farmers had a positive influence on the maize production at a 5% significance level as shown in Table 6. This implies that as the respondents got more dollars from non-farm activity the quantity of maize production was increased by 293.2 kilograms, keeping other factors constant. This might because farmers who had money from these sources used as additional income to acquire inputs like improved seed, fertilizers, chemicals and farm equipment for maize production and thus generate more maize quantity than those who had not additional income because they were business oriented. This finding was consistent with (Beriso, 2018). His finding revealed that participation in non/off-farm activity had a positive influence on the potato production at a 5% significant level.

Size of cultivated land: The size of cultivated land had a positive persuade on the farmers' quantity of maize production in the study area and it was significant at a 5% probability level. An increase in the size of cultivated land had a positive relationship with the quantity of maize production.

Table 6. Multiple regression analysis for variables predicting the production of Maize crop

Variables	Coef.	Std. Error	t-stat	Sig.	Tolerance	VIF
(Constant)	148.7	78.221	1.901	0.838	-	-
Age in year	104.7	41.997	2.493	0.622	0.881	1.135
Family size in number	105.5	41.421	2.547	0.648	0.850	1.176
Non-farm income in dollar	293.2*	88.021	3.331	0.041	0.929	1.076
Education level in grade	-0.051	0.425	-0.120	0.904	0.461	2.169
Cultivated land in hectare	140.4*	24.661	5.693	0.009	0.942	1.062
Market Distance in minute	38.5	48.185	0.799	0.425	0.439	1.566
Distance to DA's office in minute	-4.4*	8.073	-0.545	0.036	0.885	1.131
Economic active in number	131.1*	25.991	5.044	0.028	0.675	1.481
Fertilizer used in kg per hectare	80.2*	79.880	1.004	0.017	0.568	1.761
Organic fertilizer applied in kg per hectare	130.8*	16.047	8.151	0.001	0.580	1.725
Market information	-170.2	27.201	-6.257	0.717	0.906	1.103
Social status	-28.5*	6.916	-4.121	0.040	0.864	1.157
Number of observations		200				
F(12, 188)		32.478				
Prob>F		0.000				
Durbin-Watson		4.52				
R-Squared		0.7225				

Source: (Own computation, 2020) Note that: * indicate that significant at 5% probability level

This implied that increasing field scale result with increased yields of maize production. The coefficient implies that with all other factors kept constant, the farmer's quantity of maize production increased by 140.4 kilograms with an increased in the size of cultivated land by one hectare. This result was in line with the finding of (Beyan, 2016).

Developmental Agent's (DA's) office distance: It had been a negative and significant impact on the quantity of maize production at a 5% significance level (Table 6). From the model coefficient result, other factors being constant, the maize crop production of smallholder farmers of Meta district was decreased by 4 kilograms as DA's office distance increased by one minute. The possible explanation was that extension services were a critical source of information on agronomic practices. The accessibility of improved agricultural information and pragmatic sustain on agricultural activities helps farmers to produce alternative crop variety and to obtain higher production maize crops. The related result was reported by other researchers (Beyan and Nano, 2018).

Economically active members: The result in Table 6 showed that the numbers of economically active members were statistically significant at a 5% level of significance and it had been a positive influence on the maize production of smallholder farmers. This revealed that as the numbers of economically active members in the household were increased by one number of members, the quantity of maize production of households was increased by 131.1 kilograms, other factors kept constant. This was because most of the economically active members of farmers were on the ways of improving agricultural production and productivity. This in turn helps them to get better production, and then this most likely leads to obtain more income to fulfill their family requirements by enhancing their agricultural production skills, knowledge, and experiences. The result of the study is inconsistent with the findings of (Beyan and Nano, 2018).

Amount of fertilizer used: The amount of fertilizer used had been a positive impact on the yield of maize crop indicated that there was a direct relationship between

chemical fertilizer and the production of maize crops. As the amount of fertilizer used was increased by one kg, the quantity of maize production of smallholder farmers' was increased by 80.2 kilograms, as other explanatory variables were kept fixed. This result was persistent with the finding of (Agatamudi and Hirko, 2016) that they result revealed that if the effects of the remaining independent variables were fixed, then for each change of one unit in fertilizer, the yield of the wheat crop was changed by 40.118 units (kg).

Amount of organic fertilizers applied: As observed from Table 6, the number of organic fertilizers had been positively affecting the maize production of smallholder farmers and statistically significant at 5% probability level. The result indicated that as the number of organic fertilizers was increased by one kg, the quantity of maize production of farmers was increased by 130.8 kilograms, as keeping other explanatory variables constant. This result was consistent with (Adugna and Wagayehu, 2012).

Membership to social status: As expected from Table 6, this variable was found to have a negative and statistically significant influence on maize production of the household at a 5% level of significance. The coefficient told that holding other variables constant, being a member of social status was decreased the probability of production of maize crop among smallholder farmers by 28.5 kilograms. This was because cooperatives serve as a means of gaining off/non-farm employment opportunities. In addition, a social capital that promotes the sharing of knowledge, information, and experience regarding the value of off and non-farm activities that help them to improve their livelihood. This finding was inconsistent with the findings of (Adugna and Wagayehu, 2012).

Model Adequacy Checking

Normality: The error terms were normally distributed with mean zero and variance σ^2 can be tested by plotting residual against the cumulative probability. This was in line with the finding of (Agatamudi and Hirko, 2016)

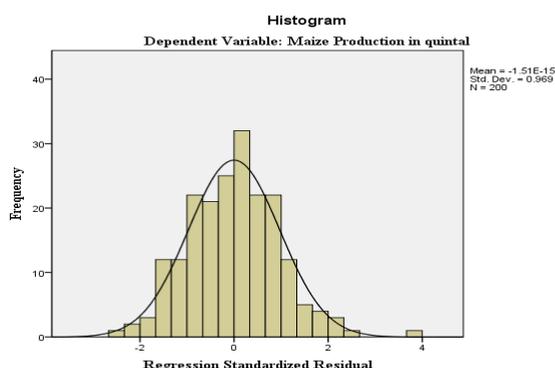


Figure 1 Histogram of residual against frequency of maize production

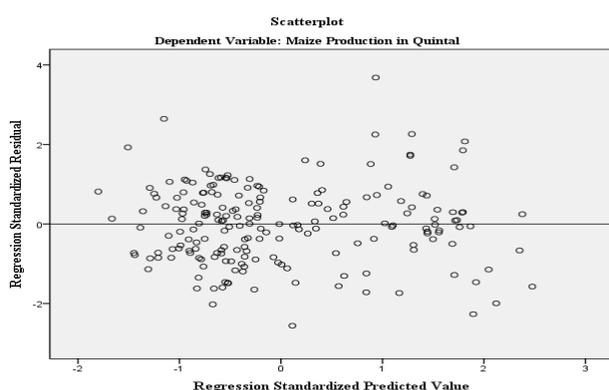


Figure 2 Scatter plot of standardized residual versus standardized predicted value

Figure 1 revealed that the error terms were normally distributed approximately with mean zero and constant variance. This indicated that the error terms and explanatory variables were not correlated to each other. This means the models were well defined. The shape of the histogram should approximately follow the shape of the normal curve. Therefore, the assumption of normality was fulfilled.

Homoscedasticity: The scatter plot should always be examined for the constant variance. The preferred pattern of the plot was a point cloud or a horizontal crowd. A wedge pattern is an indicator of non-constant variance, a violation of homoscedasticity assumption. The sloping plot with increasing or decreasing variability suggests non-constant variance and inadequate specification of the model.

As seen from Figure 2 of the residuals versus the fitted value (the production of maize crop), there was no relationship between the residuals and the fitted value of maize production. This indicated that there was no heteroscedasticity in the data. This means that the error term ε_i 's were independently and identically distributed having a normal distribution with mean zero and constant variance σ_ε^2 .

Multicollinearity: If there was a presence of multicollinearity between independent variables, it was impossible to separate the effect of each parameter estimate on the dependent variables. It was important to test multicollinearity between explanatory variables. As indicated in Table 6, that there was no serious multicollinearity problem among the explanatory variables

included in the model because all VIF values were less than 10 and all values of tolerances were greater than 0.1.

Autocorrelation: It was a test that the residuals from multiple linear regressions are independent. There was no relationship between successive error terms. As pointed out in Table 6 that there was no autocorrelation between the error terms because the Durbin Watson statistic was 4.52 which was outside of the acceptance region (greater than 4).

Conclusions

To increase the income and reduce rural poverty among smallholder farmers, endurance agriculture needs improvement through increasing production and productivity of cereal crops. Therefore, improving the smallholder farmers' maize production was required, to improve access to food and sustainable livelihoods. Therefore, this study was carried out to identify the household level factors that affecting maize production of smallholder farmers in the Meta district, East Hararge zone, Oromia, Ethiopia. The data were collected from 200 sample households in the 2019 crop production year. Multiple linear regression models were used to identify factors that affect the production of maize among smallholder farmers.

The result indicates that the average non-farm income of the sample households was 29.39 in dollar whereas the average of economically active members of the sample respondents was 3 persons. The result point out that on average cultivated land of the sampled households was 0.41 in hectare whereas the average amounts of organic fertilizer used by the sample respondents were 492 kg. Furthermore, the estimation results revealed that non-farm income of the household, the cultivated area of land, distance to DA's office, economically active members, amount of chemical fertilizer used, amount of organic fertilizer applied and social status of household head in the community are significantly determining the quantity of maize production. Therefore, these variables require special attention to increase the farmer's quantity of maize production.

The estimation result showed that as non-farm income increase by one unit/dollar, the quantity of maize production is increased by 293.2 kilograms, keeping other factors constant. This implies that the farmers who got money from non-farm activity used as additional income to gain inputs like improved seed, organic fertilizers, chemical fertilizers, and farm equipment for maize crops and generate more maize quantity than those who had not additional income. As membership to the social status of the household is influenced maize production negatively and statistically significant at a 5% level of significance. The results enlighten that, holding other variables constant, being a member of social status is the probability of maize production among smallholder farmers by 28.5 kg. The estimation results also indicate that as the number of organic fertilizers increase by one kg, the quantity of maize production of farmers increased by 130.8 kilograms, as keeping other explanatory variables constant and the quantity of maize production of smallholder farmers' increased by 80.2 kilograms as the amount of chemical fertilizer used increased by one kg.

Therefore, it can be concluded that maize productivity of smallholder farmers is crucial in increasing households' food security status and reduce poverty which in turn could affect the welfare of farm households. Therefore, government and non-government as well as other stakeholders should encourage the current maize production and supplying improved seed, chemical fertilizer, and other improved technology which assist to improve their farm households' welfare by increasing their sources of income.

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