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Analysis of Productivity and Efficiency of Maize Production in Gardega-Jarte District of Ethiopia

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Abstract: The aim of the study was to estimate technical efficiency of smallholder farmers in maize production in case of Jardega Jarte districts with specific objectives to estimate the level of technical efficiency and to identify factors affecting technical efficiency in the study area. The study used cross-sectional data and the data were collected from sample representative respondents of 168 randomly selected farm households. Cobb-Douglas production function and the Stochastic Frontier Model were used to identify factors influencing productivity and efficiency. The hypotheses tests confirm that, the adequacy of Cobb-Douglas the appropriateness of using SFA the joint statistical significance of inefficiency effects; the appropriateness of using Half- normal and Exponential distribution for one sided error; and nature of the stochastic production function. The maximum likelihood parameter estimates showed that all input variables have positive and significant effect on production. The estimated Cob Douglas production function revealed that all inputs labor in hour, maize cultivated land, Dap, Urea, Seed, oxen have positive significant and increase production Efficiency of Maize producer farmers. The study finds that maize output responds positively to increases in inorganic fertilizers, seed quantity, the use of labor and area planted. The technical efficiency analysis suggests that about 90% of farmers in the sample are between 60 and 61.8% efficient, with an average efficiency in the sample of 38.2%.The analysis showed that the mean technical efficiency of farmers is 0.618 percent implying that output in the study area can be increased by 38.2 percent at the existing level of inputs and current technology by operating at full technical efficient level. The estimated stochastic frontier production function revealed that all determinants (except sex of households', Pesticide, Extension contact, Slope of Land and Training) have significant effect on efficiency of Maize producer farmers. The significant determinants of technical efficiency were the gender of the household head, household size, frequency of extension visits, farm size and the farming region. The results imply that the average efficiency of maize production could be improved by 38.2% through better use of existing resources and technology. The sign coefficients of determinants is found as hypothesized except Education of household heads. Family size, having more livestock, proximity to marketing, use of inorganic fertilizer. The results highlight the need for government and private sector assistance in improving efficiency by promoting access to productive resources and ensuring better and more reliable agricultural extension services.

Key words: Efficiency · Cobb-Douglas · Maize · Stochastic Frontier

INTRODUCTION

Maize production is an important component of food security and livelihoods among smallholder farming communities in the world. Maize is the single most important crop in terms of both number of farmers engaged in cultivation and crop yield. The smallholder farmers that comprise about 80 percent of Ethiopia's population are both the primary producers and consumers of maize[1]. Eight million smallholders were involved in maize production during 2008/09 production season compared to 5.8 million for teff and 4.5 million for sorghum

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the second and third most cultivated crops in Ethiopia, respectively. In 2007/08, maize production was 4.2 million tons, 40 percent higher than teff, 56 percent higher than sorghum and 75 percent higher than wheat production [2].

The Ethiopian government has put a lot of much effort in promoting agricultural productivity and efficiency of smallholder farmers since agriculture continues to be the dominant sector in Ethiopia's economy [3] showed that cereals account for 65 percent of the agricultural value added, equivalent to about 30 percent of the national GDP. The role of maize is central to agricultural policy decisions as a prime staple food for food security and overall development of the agricultural sector. The increase in crop production in the past decade has been due to increases in area crops cultivated areas. But to what extent the area cultivated can continue to expand remains an important question. Even expansion of cultivated area will have to come almost exclusively from reduction in pasture land. Given also high population growth and the limits of area expansion, increasing productivity by enhancing efficiency and intensive usage of resources will lead to achieve more yield and food supply to overcome malnutrition and poverty. Hence improvements in resource usage efficiency and increasing productivity will reduce encroachment of population to marginal agricultural lands.

Fundamentally, agriculture is a core driver of Ethiopian economy. Economic growth of the country is highly correlated to the success of the agricultural sector. It accounts for about 41 percent of the Gross Domestic Product (GDP), provides employment to more than 83 percent of total population that is directly or indirectly engaged in agriculture, generates about 90 percent of the foreign exchange earnings of the country and raw materials for 70 percent of the industries in the country [4].

Though it is contributing a lot to the Ethiopian economy, the sector is characterized by low productivity, caused by lack of knowledge on the efficient utilization of available and limited resources (especially land and capital), poor and backward technologies, limited use of modern agricultural technologies (fertilizer, high yielding varieties, pesticide, *etc*), lack of transportation and storage facilities, natural calamities and poor and biased agricultural policies [5]. Moreover, the availability of chemical fertilizers and improved seed is limited despite government; efforts to promote the adoption of modern and intensive agricultural practices. The smallholder farmers, who are providing the major share of the agricultural output in the country, commonly employ less modern production technologies and limited external inputs [6]. Hence, being agriculture dependent country with a food deficit gap, increasing crop production and productivity is not a matter of choice rather a must to attain food self-sufficiency.

To reverse the situation, the Ethiopian government has designed a five years Growth and Transformation Plan which aims at boosting the national Gross Domestic Product (GDP). According to the plan, smallholder farmers are among the major target groups where increased agricultural productivity is believed to be achieved [7]. One of the basic strategies of the Ethiopian government in improving agricultural productivity is to adopt new technologies and use modern inputs. Jardega Jarte district is one of the districts of Horro Guduru Wollega Zone which known by cereal production especially maize. Out of the total cultivated 37,968 hectares of land in the district, maize occupied 34.26 percent. The total productivity of maize during 2015/2016 production year of the district was 34.5 qt per hectare. Therefore, knowledge about the level of Technical inefficiency of smallholder maize producers in the production and the underlying socio-economic and institutional factors causing inefficiency may help to assess the opportunities for increasing agricultural production. This study thus aims to contribute towards a better understanding of potential production capacity of this crop using extended efficiencies measurement techniques.

Statement of the Problem: The growing gap between food demand and supply in Ethiopia is mainly attributed to the very low productivity of the agricultural sector. The serious reliance on obsolete farming techniques, poor complementary services such as extension, credit, marketing, infrastructure and poor and biased agricultural policies are among the major factors that have greatly constrained the development of Ethiopia's agriculture. Among crops grown in Ethiopia, maize is the most important cereal crop in terms of production, area coverage and better availability and utilization of new production technologies [8].

During the past years, the government and non-governmental organizations have undertaken various development innervations to enhance agricultural productivity particularly that of cereal crops so as to achieve food security and to reduce poverty in the country. The available studies on the productivity of cereal crops in general and maize production in particular in Ethiopia found low productivity in comparison with the international standards [9]. The current average national maize productivity of Ethiopia (32.25 quintals per ha) is better than the national productivity of many African countries (for instance the average maize yield of Kenya (16.72), Malawi (21.71), Uganda (27.48), Zambia (25.38) and Tanzania (23.38 quintals per ha) but, it is still low compared to that of the world average maize productivity (55 quintals per ha) in 2013/14 (FAOSTAT, 2015). Besides, spatial variability in maize productivity is another concern for maize productivity enhancement in Ethiopia. For instance, in 2015/16, average maize productivity in Oromia region was 35.12 quintals per ha (Horo Guduru Wollega Zone). Jardega Jarte district is the district which has suitable agro ecology for maize production, produce 34.5 quintals per hectare in the year of 2015/16 (District Agricultural Office). Among the cereals grown in the study area, maize is the major crop in terms of volume of the production and area cultivated. It is also the major source of stable food to the farmers among the crops grown in the area. Accelerating the adoption of improved technologies by small-scale farmers is believed to result in higher output. Moreover, there is no study done on Technical efficiency of smallholder maize producers in the study area. Hence, there is a need to fill the existing knowledge gap by addressing issues related to technical efficiencies of smallholder farmers maize production in the study area by providing empirical evidence on smallholder resource use efficiency.

Objectives: The general objective of this study were to examine the Productivity performance of maize production small holder farmers in Jardega Jarte district.

The specific objectives of the study were:

- To estimate the level of productivity and technical efficiency of maize production by smallholder farmers in Jardega Jarte District.
- To identify the factors affecting productivity of maize production of smallholder maize producers in the study area.

Research Methodology: In this chapter physical feature of the study area, sampling technique, techniques of data collection and methods of data analysis and definition of variables hypothesized are presented.

Description of the Study Area: The study was conducted in Jardega Jarte Woreda, Horro Guduru Wollega Zone and Oromia Regional State Of Western Ethiopia. Know a day, the district is sub-divided into 24 kebeles associations for administrative purposes of which three of them are urban and Alibo is the capital town, about 55 km far from the zonal capital Shambu and 369 from Addis Ababa in north western parts. It is bordered on the East by Abay Chomen, on the South by Horro, on the Southwest by Abe Dongoro, on the West by Eastern Wollega Zone, on the Northwest by Amuru on the North by the Abay River which separates it from the Amahara region.

The District was located within 9°10' 53"N- 10°17' 03"N latitudes and 36°39' 36"E-37°40' 13"E longitudes. The national census reported a total population for this district 48,943, of whom 24,475 were men and 24,468 were women; 4,757 or 9.72 percent of its population were urban dwellers. Farming system in the study area consists of a number of interdependent cropping and livestock activities and they are strongly influenced by the respective natural and economic environment. Crop production is the principal source of food and income to the farmers. The main stable food crops grown around the study area are cereals such as maize, Teff, wheat; pulse and oil like haricot, soybean, bean, Niger seed (nug) and horticultural crops like pepper, mango, tomato, sweet potato and sugarcane as cash crop. Annual crops especially cereals are predominant and rain-fed agriculture is mainly practiced using animal power.

Types, Sources and Methods of Data Collection

Types and Sources of Data: For this study, both primary and secondary data from different sources were used. The primary data were collected from sample households through face to face interviews using a semi-structured questionnaire. The questionnaire included information on the socio-economic characteristics, demographic characteristics and farm characteristics, institutional supports, agricultural policy related factors, environmental hazard, price data, farm assets, input types, input amount used and output obtained by sample households. The secondary data which are relevant to the research topic would be used as additional information to strengthen the primary information provided by the sample households for rational conclusion. These include both published and unpublished documents from local administration offices, district agricultural and cooperative office and documents of Central Statistical Agency [10].

Methods of Data Collection: The required data were collected through household survey using a semi-structured questionnaire. Actual data collection was preceded by selection and recruitment of appropriate enumerators from DA's who knows the local language and trained on the objectives, contents and methods of

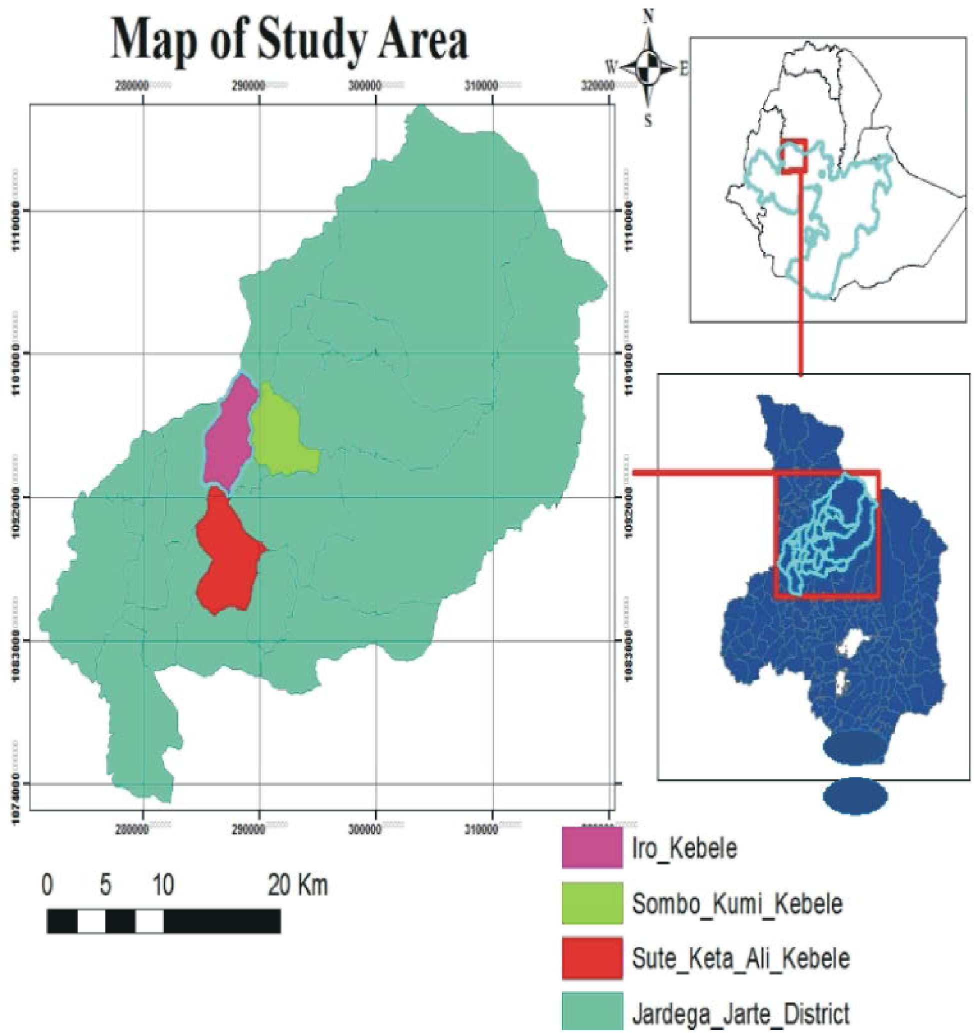

Fig. 1: Map of study area
Source: GIS Output

survey collection. The questionnaire was pre-tested to check its appropriateness for gathering all the required information and to make an improvement on some of the questions based on the feedback to be obtained from the pre-testing exercise. Field enumerators was involved in data collection with the close supervision of the researcher. Then, both qualitative and quantitative data were collected and used for this study. Thus, focus group discussions are held with three groups (10-12) members in three kebeles based on predetermined checklists and a total of 15 key informants would be interviewed from 3 different Organizations and institutions. The time allotted for each discussion was 3 to 4 hours; but it was extend in some locations depends on suitably, the data generation at various levels by field observations and triangulate with other data.

Sampling Techniques and Sample Size Determination

Sampling Techniques: For this study, three- stage sampling techniques were employed to draw appropriate sample households from the total producers. In the first stage, Jardega Jarte district was purposively selected based on the level of production potential of maize producing households and its extent of production in the area. In the second stage, with the consultation of district agricultural expert, of 21 rural kebeles, 19 of them have higher area under maize production then, of 19 kebeles, three representative sample kebeles were selected randomly. In the third stage, from the sampled Kebeles, 168 sample smallholder producers were selected randomly based on proportional to the population size of the three selected Kebeles.

Table 1: Sample distributions producers of Maize in the study area

Name of selected Keble	Total number of Maize Producers	Number of sample Households
Sutekatali	344	59
Sombokum	321	57
Irro	293	52
Total	958	168

Source: own Sampling Design 2018

Sample Size Determination: The Sample size was determined by using Yamane formula [11] at 95 percent confidence level and level of precision equal to 7 percent are used to obtain a sample size required which represents a true population.

$$n = \frac{N}{1 + N(^{2}_{e})}$$

where,
N=Total population of maize producers
n =Sample size,
e=precision level,

$$n = \frac{958}{1 + 958(o,o7)2} = 168$$

Method of Data Analysis: In this study, descriptive statistics and econometric methods of the data analysis were employed. Accordingly, descriptive statistics such as mean, maximum, minimum, standard deviation, frequency and percentage value of variables are computed to characterize the farming system of the study area and in the econometric analysis a stochastic frontier approach was used to estimate the level of maize production efficiencies. This is because, in the context of developing world where random errors (measurement error, weather and natural disaster) were common, SFPF is a relatively better measure of efficiency [12].

Specification of the Econometric Models: This study aimed to estimate the productivity performance (technical efficiencies) and to identify the various determinants of productivity in maize production among smallholder farmers and stochastic frontier production model were adopted. The stochastic frontier production function was autonomously developed by Aiger *et al.* and Meeusen and van den Broeck and Greene [13-15]. It was used for its key features that the disturbance term is composed of two parts, symmetric and a one sided component. The symmetric component captures the random effect outside of the control of the decision maker including statistical noise (such as weather, topography and measurement error), etc which are uncontrolled and exogenous to the farmer contained in every empirical relationship, particularly those based on cross-sectional household survey data. The one sided component captures deviations from the frontier due to inefficiency. Besides, the technique is consistent with most of the agricultural production efficiency studies [16].

Hence, economic efficiency measures obtained from stochastic frontiers are expected to reflect the true ability of the farmer given the resources. The assumption that all deviation from the frontier are associated with inefficiency, as assumed in DEA, is difficult to accept, given the inherent variability of agricultural production due to a lot of factors like weather, pests, diseases. Furthermore, smallholder farmers in Ethiopia in general and in the study area in particular are characterized by low level of education and keeping of records is thus non-existent. Moreover, there is high variability of agricultural production due to weather fluctuations. Therefore, within the stochastic frontier framework, the stochastic efficiency decomposition methodology is chosen as more appropriate for this study.

Following [13-15], the general functional form of stochastic frontier model for this study will be specified as follows:

$$Yi = f(x_i, \beta) + \square \tag{1}$$

where i = 1, 2, 3,..., n; Y_i represent the observed output level of the i^{th} sample farmer; $f(X_i; \beta)$ is convenient frontier production function (eg. Cobb-Douglas or translog); X_i denotes the actual input vector by the i^{th} farmer; β stand for the vector of unknown parameters to be estimated; $_i$ is a composed disturbance term made up of two error elements (v_i and u_i) and n represents the number of farmers involved in the survey. Stochastic frontier functional approach requires a *priori* specification of the production function to estimate the level of efficiency. Among the possible algebraic forms, Cobb-Douglas and translog functions have been the most popularly used models in the most empirical studies of agricultural production analysis. Some researcher argue that Cobb-Douglas functional form has advantages over the other functional forms in that it provides a comparison between adequate fit of the data and computational feasibility. It is also convenient in interpreting elasticity of production and it is very parsimonious with respect to degrees of freedom.

According to Coelli, Sandura and Colin [12] the Cobb-Douglas functional form has most attractive feature which is its simplicity. A logarithmic transformation provides a model which is linear in the logs of inputs and hence it lends itself to econometric estimation. Moreover, translog production function is more complicated to estimate having serious estimation problems. One of the estimation problems is as the number of variable inputs increases, the number of parameters to be estimated increases rapidly. Another problem is the additional terms require cross products of input variables, thus making a serious multicolliniarity and degrees of freedom problems.

Even through Cobb-Douglas model assumes unitary elasticity of substitution, constant production elasticity and constant factor demand; if the interest is to analyze the efficiency measurement and not analyzing the general structure of production function, it has adequate representation of technology and insignificant impact on measurement of efficiency [12]. When farmers operate in small farms, the technology is unlikely to be substantially affected by variable returns to scale. Moreover, Cobb-Douglas production function has been employed in many researches dealing with efficiency [17]. Therefore, it will also be adopted for this study

The linear form of Cobb-Douglas production function for this study is defined as:

$$\ln Yi = f(xi, \beta + \square$$
$$\square \varepsilon_i = \text{Vi} = \text{Ui} \quad (2)$$

where in denotes the natural logarithm; j represents the number of inputs used; i represents the i^{th} farm in the sample; Y_i represent the observed maize output of the i^{th} sample farmer; X_{ij} denotes j^{th} farm input variables used in maize production of the i^{th} farmer; β stands for the vector of unknown parameters to be estimated; $_i$ is a composed disturbance term made up of two error elements (v_i and u_i). The symmetric component (v_i) is assumed to be independently and identically distributed as N $(0, \sigma^2_i)$. On the other hand, u_i captures the technical inefficiency of the farmer and the distributional assumption of the technical inefficiency term, u_i, was estimated using the likelihood ratio test.

Aiger *et al.* and Meeusen and van den Broeck and Greene [13-15] proposed the log likelihood function for the model in equation (2) assuming half normal distribution for the technical inefficiency effects (u_i). They expressed the likelihood function using λ parameterization, where λ is the ratio of the standard errors of the non-symmetric to symmetric error term (i.e. $\lambda = \sigma_u/\sigma_{v)}$. However, there is an association between γ and λ. The reason is that λ could be any non-negative value while γ ranges from zero to one and better measures the distance between the frontier output and the observed level of output resulting from technical inefficiency. According to Bravo-Ureta and Rieger [18] gamma (γ) can be formulated as;

$$\gamma = (\lambda^2 / 1 + \lambda 2) \quad (3)$$

The parameter γ measures the discrepancy between frontier and observed levels of output and is interpreted as the total variation in output from the frontier attributable to technical inefficiency. It has a value between zero and one. The value of zero indicates that the non-negative random variable, u_i is absent from the model while the value of one shows the absence of statistical “Noise" from the model and hence low level of farm’s production compared to the "best" practice (the maximum output) of the other farm that is totally a result of farm specific inefficiency. Likewise, the significance of σ^2 indicates whether the conventional average production function adequately represent the data or not. In fact, in this study the likelihood ratio test was conducted to select the appropriate functional form that best fits the data. The value of the generalized likelihood ratio (LR) statistic to test the hypotheses that all interaction terms including the square specification is equal to zero (HO: βij=0) will be calculated as follows:

$$LR = -2\,(LC - LT) \quad (4)$$

where:
LR = Generalized log-likelihood ratio;
LC = Log-likelihood value of Cobb-Douglas frontier; and
LT = Log-likelihood β value of Translog frontier.

This value is then compared with the upper 5 percent point for the x^2 distribution and the decision was made based up on the model result. If the computed value of the test is bigger than the critical value, the null hypothesis was rejected. The linear functional form of Cobb-Douglas production function used for this study is given as:

$$Ln(output) = \beta 0 + \beta 1 \ln(land) + \beta 2 \ln(labo) + \beta 3 \ln(oxen) + \beta_4 \ln(UREA) + \beta 5 \ln(Dap) + \beta 6 \ln(seed) + \beta \ln 7(chemical) \quad (5)$$

$TE = \frac{Yi}{Y*}$ .. where Y* is potential output and Yi is observed output.

After we got efficiency score for each sample household the second step is regressing explanatory variable(factors affecting efficiency) on the result of efficiency score. Those Explanatory variables are Age of the household, Educational level of household head, family size, sex of the household head, off/non-farm activities, total cultivated land, land ownership, credit, extension contact, slope, proximity, livestock holding and soil fertility status.

Definition of Output and Input Variables Used in the Production Models

Output: This is the endogenous variable in the production function. It is defined as the actual quantity of maize produced and measured in quintals during the 2017/18 production year.

Input: Defined as the total inputs used in the production of maize namely: land, labor, oxen, fertilizers, seed and chemicals used during 2017/18 production year.

Land (LAND): This represents the total physical unit of land under maize in hectare. The land may belong to the farmer; it may be obtained through renting or through share-cropping arrangements.

Human labor (LABOR): Represents the total human labor employed in the production process. The type of person participated in the given activity by categorizing as children, men and women. Labor inputs used for major agronomic activities were converted into adult-equivalent by taking an average age. The adult-equivalent was computed by taking into account the age and sex of the labor used following standard conversion factor developed by Stork *et al*. (1991). Therefore, the human labor input will expressed in terms of total adult-equivalent employed to perform land preparation, planting, input application, cultivation, harvesting and threshing.

Oxen Power (OXEN): Given small scale farmers and less mechanized farming exercise in the study area, oxen power are among major inputs of production. In the study area, task of ploughing and hoeing are often done using oxen. Hence, oxen power was measured using the total amount of oxen days allocated for ploughing and hoeing activities of maize production. It was measured in oxen-days (one oxen-day is equivalent to eight working hours). It will affects positively.

Urea and DAP (UREA, DAP): Fertilizer is a key input and its application along with other technologies which have a great potential to increase crop productivity. Urea is applied on the maize plot once or using split application, but DAP is usually applied during planting time only. As input variables, the total amount of Urea and DAP will be used (kg) maize production during the 2016/17 production year were considered in this study.

Chemicals (CHEM): This is a physical quantity of chemicals such as herbicides, insecticides and pesticides applied by the sample households for protection of weed, insects and pests in maize production, respectively. The variation in rates of herbicides, insecticides and pesticides application among sample households affect maize productivity negatively in the study area.

RESULT S AND DISCUSSION

This section is divided into two main sections: descriptive statistics and econometric (stochastic frontier) results. The first section reports the descriptive results to describe Technical efficiency variables used in the study. The second part of this section presents the econometric results of the Cobb-Douglas stochastic production function.

Socioeconomic Descriptive Characteristics of Sample Households: The average Maize output was approximately around 40 quintal per hectare from Jardaga Jarte Woreda during the last Maize production season of 2016/2017. The minimum and maximum productivity of maize is between 40 and 60 quintal respectively. However this finding contrasts with secondary data report from the district which is about 60 quintal per hectare in average. The production of maize indicated that it is relatively quite labor consuming; indeed, the productivity of Maize are largely influenced by the level of labor being devoted for the maintenance of matured Maize plants.

The average land allocated for farmer was 0.2 hector with minimum 0.5 and maximum 1.2 hector per individual household head in study area in contrast to 1.01 ha which is the national average hectare of land. Almost all farmers adopted raw planting of Maize since it was more profitable than broadcasting method even though raw planting is

Table 2: Descriptive statistics of production function of inputs and output variables

Variables	N	Minimum	Maximum	Mean	Standard Deviation
Land in hectare	168	.2	1.2	.524256	0.207231
Oxen In Hour Of Ox Plough	168	1	6	2.89881	1.08136
Seed in quintal	168	12	56	30.76786	11.93645
Labor hours work per day	168	3	16	8.375	2.702156
DAP in quintal	168	4	30	14.8006	5.234941
UREA in quintal	168	4	27	8.771429	3.4234941

Source: own computation, 2018.

Table 4: Reason for not to use organic Fertilizer

Reason not use organic Fertilizer	Frequency	Percentage
bulky transport	53	31.74
lack of awareness	56	33.53
Users	57	34.13
Other problems	1	0.6
Total	167	100

Source :own computation, 2018.

too cost interims of labor they rarely prefer broadcasting. Production of Maize was usually high or harvest yearly in case of fertile soil, irrigation area and around sufficient rain areas of semi desert in Ethiopia. On average, a farmer who use diversification seed production on the same mostly produce more maize (more efficient than household) who produce maize less diversifying crops producer farmers.

Average land of Maize farmer slightly between 0.2 hector (ha) and 1.2 hector with average 0.5 hector even though; there are those who rent land for maize productions. The farmers use labor hour between 3 up to 16 hour per day for production of maize with average 8.3 hour per day per household head during production season. In addition to this, almost all of farmers use DAP and UREA intensively with average 14.7 KG and 8.7 KG per hector respectively. This indicates us the majority of farmers in area produce more Maize by labor intensity input; indeed, the productivity of Maize is largely influenced by the level of Fertilizers being devoted for Maize production.

Even though Jardaga Jarte District has abundant producer of maize the farmers may face different problem to produce at optimal frontier line. Some of the problems are 31.74 and 33.5 percent of non-user are due to bulky transport and lack of awareness respectively while 34 percent are users of organic fertilizer (Table 5).

Econometric Result: Econometrics analysis used cross sectional data set covering 168 respondents to estimate combined frontier -inefficiency model. Stata 14 software programmed was used for estimation ofdifferent parameters that affect the production efficiency of maize. From literature there are two common functional forms of production function employed in studying production efficiency using stochastic production frontier function namely cobb-Douglas functional form. In this chapters Translog production function and Cob-Douglas production function were established and the model which describes the data set adequately was selected among the two model specification using hypothesis testing.

Lambda □ which shows the variance parameter of ratio between the normal error term and half normal positive error term is statistically significant. This verifies the fact that there are measurable inefficiencies in maize production. Estimate of Lambda (□) = 2.335 (the variance of parameter showing the ratio between the normal error term ui and half normal positive error term vi) is statistically significant and large. Furthermore, sigma (δ = .1071018) is large and significantly different from zero indicating good fit and correctness of specified distributional assumptions. As well as, the estimated value of the variance parameter gamma (γ) = .9945767 for the stochastic frontier production function is close to one and significantly different from zero. This result show the existence of production inefficiencies in maize production. Thus, null hypothesis stating joint impacts of production inefficiency effects are zero is rejected for the value of lambda (□) is greater than one.

But this sigma and lamda variables didnot tell us the significance of efficient variables wether difference between efficiency is from stochastic error or due to operational inefficiency. One attractive feature of SFA is, it is possible to test various hypotheses, which are not possible in non-parametric model [19, 20]. The following specification tests are performed using generalized likelihood ratio tests: LR denotes log likelihood =-2[L(H0) - L (H1)], where L (H1) and L (H0) are the values of the log likelihood functions under the alternative and null hypothesis, respectively.

The first hypothesis testing is choosing the appropriate functional form for the data from the Cobb-Douglas and Translog frontier. The calculated likelihood ratio value (LR) equals to 352.5 was accepted at Prob > chi 2 = 0.0000 thus we accept null hypothesis which implies that the Cobb Douglas functional form adequately captures the Maize production behavior of farmers in the study area. Therefore conventional inputs are estimated after converted to logarithm as per the rule of stochastic instruction file.

The Second hypothesis testing is for about the distributional assumption of the one sided error term. Given Cobb-Douglas stochastic frontier production function best fits the data; the researcher tests hypothesis whether the technical efficiency level is better estimated using a half- normal (μ=0) and exponential distribution or a truncated normal distributional assumption on of Ui (μ>0). The calculated likelihood ratio value (LR) equals to 11.654 while the critical value (xC) at 1 degree of freedom with upper 1percent level of significant equals to -4.218. Since the calculated LR value is greater than the critical value of $x2$ rejecting the null hypothesis implies that half-normal distributional assumption of one sided error term is more appropriate for the farmers in the study area than truncated-normal. Thus half normal and exponential distributions are chosen. The sum of the partial elasticity of all inputs equals to 1.73.This means an increase in all inputs at the sample mean by one percent will increase crop production in the study area by 1.73 percent. This revealed that the production function is characterized by increasing returns to scale. The MLE result showed that all convectional inputs, except lands were found to have the expected positive signs and determine productivity.

Firstly, In the half-normal model, gamma 74 percent of total variation in production of Maize is caused due to specific performance of farmers while the rest 26 percent is due to random shocks.

DAP: This variable is significant at 1 percent significance level implies that, as a one unit increase amount of DAP, increase efficiency by 0.288% it can be true that, application of improved technologies have a great potential to increase crop productivity.

Table 4.1: Half normal distribution frontier model result

Input Name	Coef. Std. Err. Z	P>z]
Land	.0097699 .009043 1.08	0.280
DAP	.0288503 .0091569 3.15	0.002
UREA	.0513663 .0077104 6.66	0.000
Manure	.0293962 .0116726 2.52	0.012
Oxen/days	.0865986 .0188299 4.60	0.000
Labor	.0300352 .0084671 3.55	0.000
Maize seed	.035865 .00728 4.93	0.000
Capital	.0693895 .0180539 3.84	0.000
_cons	3.54335 .0575587 61.56	0.000
Prob > chi2	=0.0000	

Source: own computation, 2018.

UREA: The result revealed that, the estimated coefficient of this variables have positive significant effect at 1 percent of significance level implies that a one unit increase in Urea applied on the maize plot increase efficiency by 0.77% of maize.

Labor Hour (Labor): Labor was found, in line with our prior expectation, to have positive and significant effect on farmers' productivity at 1 percent significance level. This implies that a 1 percent increase in labor usage lead to a 0.02 percent increment in value of output, holding other factors constant. This revealed that agriculture is labor intensive.

Maize Seed: Maize seed was found to have positive significant effect on farmers' productivity at 1 percent significance level which implies that a 1 percent increase in the use of seed will lead to a 0.07 percent increment in value of output, holding other factors constant. This result is in line with empirical studies like [20].

Oxen (Measured in Drought Hour): The sign of the coefficient of Number of Oxen is positive and statistically significant at 1 percent level of significance, this indicates that increase in number of oxen also increase production efficiency of Maize. This may be because of most Maize producer farmer who owns more oxen can effectively produce Maize by using oxen for production of Maize and other crops easily than inefficient farmers.

Capital (K): Capital used in production of maize measured in birr to buy chemicals and other input. In addition, Others like capital investment, DAP and UREA were found to have same significant and positive effect on farmers' productivity at 1 percent level of significance. This implies that, holding other factors constant, a 1percent increase in the usage of Capital in birr lead to only 0.005 percent increment in value of maize output.

In other ward, increase in use DAP and UREA on per hector of land for maize production by 1 percent of KG will also increase output by 0.046 and 0.056 percent respectively. This imply land productivity was inelastic to fertilizer because land productivity of maize become addicted to fertilizer which serious problem for the society.

Labor: The coefficient on labor has a negative sign and is found to be significant at 1percent level of significance in the production functions. The negative relationship between labor and production efficiency can be explained by the fact that increase in labor increase cost and dependency rate which decrease production efficiency of Maize. This imply Maize production should be capital intensive than labor intensive strategy, which incur high wage expenses with low efficiency. This negative impact of labor on the efficiency could be due to a large amount of disguised labor that is employed on relatively small amount of capital.

Empirical Results of Stochastic Frontier Analysis (SFA) Multicolliniarity, Hetroscedasticity and Omitted Variable Tests: The first test used is multicolliniarity test which had been undertaken using variance inflation factor (VIF). The result of VIF for Cobb-Douglass production function was found as 107 which reveals Multicolliniarity problem. Thus remedial measure have been given by excluding variables that has highest VIF . Since there is sever multicolliniarity problem and two variables total cultivated land and Maize cultivated land have found having high VIF. After total cultivated land was excluded from regression VIF for Conventional input of Cobb-Duoglas became Mean of 1.o4. and problem of Multicolliniarity has been solved.. The second test used is Heteroscedasticity test using Breusch-Pagan test. Heteroscedasticity test shows that there is no heteroscedasticity problem in the model. Since this test Accept the null hypothesis that claims constant variance at 1 percent, we used OLS regression directly. The Ramsey test for omitted variable test also reveals that no omision of variables . Since the p-value of this test was found to be insignificant even at 10 percent, then null hypothesis that claims as the model has no omitted variables could not be rejected.

Stochastic Frontier Production Function Results: As already stated above, the present study employs one stage maximum likelihood estimation procedure to simultaneously estimate the parameters of both stochastic frontier production function and inefficiency effect model. The result revealed that all input variables, except Labor, became significant effect on maize production in the study area. Contrary to the prior expectation, labor with positive sign turned out to be insignificant and use of manure insignificant variable become significant at 5 percent level of significance. For the case of inefficiency effect model, all determinant variables except sex of household head, slope of land topography, access to training on maize and frequency of extension contact are significantly responsible for technical efficiency variation of maize among the farmers. The sign coefficients of both input variables and inefficiency effects have been as prior expectation except educational level of household head and use of pesticide. Thus we have to use Truncated and half normal inefficiency frontier analysis. For Half -normal and truncated normal distribution about 74 percent and 89 percent of total variation is due to inefficiency respectively.

Demographic Characteristics

Age of household Head: Age have been found to be significant variables in explaining the variation in technical efficiency among maize producer farmers. Age of the head of household, which is considered as proxy of farmers' experience in farming, is hypothesized to have negative effect on efficiency and at 1 percent level of significance . The result indicated that as age becomes older decreased labor forces and efficiency of maize decreased by 0.0267 percent.

Family Size of Household Head: The number of persons living in the household is hypothesized to determine efficiency positively. The result shows that family size has positive and significant effect (at 1percent level of significance) on efficiency. This means that households with large family size would manage Maize production on time than their counterparts. This is because at the time of peak seasons, there is shortage of labor. This is possible since more labor can be deployed during peak season in order to timely undertake the necessary farming activities like ploughing, weeding and harvesting that raise efficiency.

Educational Level of Household Head: Number of literate of family members is hypothesized to have positive effect on technical efficiency. The result also shows that literacy of family members is found to be significant and increase technical efficiency of farmers (at 1 percent owned is found to be positive and significant (at 1 percent level of significance) in determining efficiency variation among

Table 5: Stochastic Frontier Production Function Results

Stoc. Frontier	Normal/exponential model			Number of obs =168
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Log likelihood	= 741.79842 Wald chi2(9) =239.74			Prob > chi2 =0.0000
Dept.LnQ	Coef.	Std. Err.	Z	P>z]
SEX	-.0993926	.1211056	-0.82	0.412
Educ	-2521689	.0558773	-4.51	0.000
FSZ	.0858812	.0160805	5.34	0.000
Age	-.0262875	.0040473	-6.50	0.000
NONFARM	.6157305	.0992909	6.20	0.000
EXCONT	.1223746	.1017967	1.20	0.229
Training	-.111284	.0933499	-1.19	0.233
TYPFERTL	-.7729969	.0857183	-9.02	0.000
PESTICIDE	.1031826	.884604	4.56	0.62
Slope	-.1276699	.0670075	-1.91	0.057
SOIL FERTSTU	.4829015	.0880489	5.48	0.000
MKTPROXIMITY	.2522464	.038515	6.55	0.000
CREDIT	. 0.04747	0.01490	9.59	0.042
LV	-.9177789	.0999228	-9.18	0.000
_cons	5.81477	.039661	5.59	0.000
sigma_v	.1479555	.003220	1.141777	
Mean Efficiency	0.618			

Source: own computation, 2018

the farmers. This is due to the fact that in rural areas as Household head become literate more literacy rate also increase which leads to decrease time for Agricultural activity. In addition more schooling implies those students become dependent on family in short run period which decrease production efficiency of Maize since maize is labour intensive output.

Livestock Level of Household: It is obvious that the crop husbandry is highly supplemented and complemented by the animal husbandry. It has systematic effect on efficiency i.e. the farmer who possesses more number of livestock will have more money to purchase agricultural inputs and again has the chance to get oxen for draught power. Thus this finding shows increase in livestock increase production efficiency of maize output.

Soil Fertility Status (SOILFERT): It was treated as a dummy variable that takes the value of 1 if a household head perceives his land as fertile and 0 otherwise, The more the land is fertile, the better the gain will be [21]. Therefore, it was hypothesized that a farmer with a fertile land may be more efficient than a farmer with less fertile land.The result also supports the hypothesis that land fertility is found to have positive and significant effect (at 1 percent level of significance) on efficiency. This is because fertile lands are expected to increase productivity. A farmer endowed with fertile land were more technically efficient than infertile lands and medium fertile land. This is in line with other empirical findings like [22, 23, 24].

Non-Farm Income: The result revealed that Non-farm income activity has positive and significant effect (at 1percent level of significance) on farmers' Maize production efficiency. Of course being involved in off/non- farm activities may have a systematic effect on the technical efficiency of farmers. This is because farmers may allocate more of their resource to off/non-farm activities and thus may increase agricultural activities. On the other hand, incomes from off/ non-farm activities may be used as extra cash to buy agricultural inputs and al so improve risk management capacity of farmers. This result is consistent with other empirical works like [25].

Credit (CREDT): The result revealed that credit affect positively at 5 % level of significance. This implies that as farmers become access to credit by a unit of birr efficiency of maize increased by o.o474% of quintals. for farm related purposes by farmers. This result is in line with Okoye, Onyenweaku and Asumugha [26] credit access is an important source of financing for agricultural activities of smallholder farmers.

Kebele Association (KBL): It is catagorical variables represented by 0 for Sobokumi, 1 for Sutekatali and 2 for Iro. Variation in area of peasant association in different kebele also the cause for in efficiency variation in woreda. This empirical findings reveals that subokumi kebele is 0.187 times more likely efficient than others sute and iro. This also supported by mean difference test and krsuskal wilxcon rank test.

Proximitymkt (Proximity to Market): The sign of the coefficient of distance is positive and statistically significant, this indicated that there is significant difference in production efficiency score prevail between farmers those their plots are nearby markets and far from market accessibility. This may be because most of the Maize producer farmers faces problem of transportation and market problem but production efficiency increase when distance from market increase which is in contrast to our previous hypothesis. There may be due to the fact that if distance from market increase probability of farmers frequency to go town decrease and save the time for work which increase production efficiency..

CONCLUSION

Based on frontier analysis of half normal and truncated frontier model on production Efficiency of farmers the study concludes the following conclusions and findings based on data collected from respondents in the study area, only 54 percent of farmers use chemical pesticide effectively while others not using due to lack of awareness, timely unavailability and expensiveness of chemical pesticide. The log likely hood ratio test estimated by maximum likelihood estimation showed that production processes of maize were better specified by cob Douglas production function and appropriateness of using SFA over OLS; the joint statistical significance of inefficiency effects; the appropriateness of using half- normal and exponential distribution for one sided error; and nature of the stochastic production function. Mean efficiency score of frontier model showed that farmers are efficient about 61.8 percent implying that output in the study area can be increased by 38.2 percent at the existing level of inputs and current technology by operating at full technical efficient level. The estimated stochastic frontier production function revealed that all determinants (except households' sex, pesticide, extension contact, slope of land and training) have significant effect on efficiency of maize producer farmers. The sign of coefficients of determinants is found as hypothesized except Education of household heads. Family size, credit access, protestant religion, being married, having more livestock, proximity to marketing, using inorganic fertilizer, Sobokumi kebele and land fertility are found to enhance efficiency. In contrast, having non-farm income and increase in educational level are found to increase inefficiency. The maximum likelihood parameter estimates by Cobb-Douglas production function showed that capital decrease technical efficiency of farmers while labour hour, maize cultivated land, Dap, Urea, Seed, oxen have significant and increase production efficiency of maize producer farmers.

Recommendation: Since maize has indispensable role improving food security and socioeconomic of society, It is relevant to suggest less efficient farmers properly use their resource and undertake *maize* production technologies in line with their potentials and farmers should produce maize on fertile land. Agricultural research and other institutions should do extensive research on comparative advantage in production efficiency of maize so as to adopt specialization on production of maize and other crops like Teff, Niger seed and wheat. Since there is significant mean difference on efficiency and production of maize among kebele association, there should be experience sharing and specialization among Kebele association to maximize their absolute and comparative cost advantage. As it has already been observed, there is a potential to increase production through improving technical efficiency of maize producers. Thus, policy makers should pursue the way to utilize both stochastic and conventional input effectively.

Study found that The main problem of maize producer farmers are weed infestation, crop diseases and crop pest in respective area, Agricultural office should give training on how to overcome these all problems. Corrective measure should be done on supply of chemical pesticide and awareness creation for farmers regarding use of this chemical pesticide.Since Cross sectional data does not consider other factors such as risks, market imperfections that revealed by time series data, panel data should be used for further researchers on production/technical efficiency of maize and to evaluate how technical efficiency has changed over time.

The study, however, could only assess technical efficiency in smallholder maize production in the study area at a point in time. Given the importance of staple maize production to food security in both rural communities, smallholder farmers would need to operate as efficiently as possible with the available inputs. Results indicated some key sources of inefficiency in the current maize production system which can be targeted by policy to improve productivity in the maize production sector. Continuous improvement in the technical efficiency of maize production could promote income growth and reduce poverty. As remedy, ongoing monitoring of technical efficiency in maize production is therefore necessary to assess changing agricultural contexts and inform policy actions. This calls for more and ongoing research.

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Appendix: Technical Efficiency of small holder Maize farmers

1-.2153846	44-.6153846	87-.6153846	129=.6
2-.6615385	46-.6923077	88-.8615385	130-.5538462
3-.6461539	47-.6769231	89-.5384616	131-.5846154
4-.4	48-.5538462	90-.5538462	132-.5692308
5-.6923077	49-.3384615	91-.6461539	133-.5384616
6-.6769231	50-.8615385	92=.8923077	134-.5692308
7-.6923077	51-.8615385	93-.9230769	135-.5538462
8-.6153846	52-.6153846	94-.7692308	136--.6461539
9-.6615385	53-.6153846	95-.6615385	137-.6153846
10-.6615385	54-.6153846	96-.4923077	138--.5384616
11-.8307692	55-.9230769	97-.5692308	139-.6923077
12-.3538462	56-.523077	98-.8615385	140-.523077
13-.9230769	57-.3384615	98-.5384616	141-.6615385
14-.5846154	58-.5384616	99-.5076923	142-.5846154
15-.4923077	59-.6461539	100-.6153846	143-.4
16-.6923077	60-.523077	101-.6923077	144-.6615385
17-.523077	61-.3384615	102-.9230769	145-.6461539
18-.5384616	62-.6769231	103-.5538462	146-.6153846
19.6615385	63-.9230769	104-.6615385	147-.523077
20-.5692308	64-.6923077	105-.6923077	148-.6615385
21-.6923077	65-.5384616	106-.5538462	149-.4769231
22-.8923077	66-.3846154	107-.6769231	150-.6769231
23-.6923077	67-.6615385	108-.6615385	151-.6
24-.8923077	68-.9230769	109-.6923077	152-.6461539
25-.4923077	69-.5692308	110-.523077	153-.5692308
26-.6923077	70-.7692308	111-.523077	154-.3692308
27-.6615385	71-.6923077	112-.6923077	155-.4153846
28-.7692308	72-.523077	113-.5538462	156-.6461539
29-.9230769	73-.7692308	114-.8615385	157-.6461539
30.6615385	74-.5846154	115-.523077	158-.3846154
31-.3692308	75-.6153846	116-.5538462	159-.4923077
32-.6153846	76-.6923077	117-.6769231	160-.6615385
33-.6923077	77-.8615385	118-.6615385	161-.4923077
34-.6615385	78-.6	119-.6923077	162-.3538462
35-.8307692	79-.6461539	120-.8307692	163-.4461538
36-.5538462	80-.5692308	121-.5384616	164-.5538462
37-.6461539	81-.6153846	122-.5384616	165-.4307692
38-.6923077	82-.5846154	123-.6615385	166-.523077
39-.4461538	83-.9230769	124-.4923077	167-.3692308
40-.7230769	84-.523077	125-.6923077	168-.50769
41-.4769231	85-.6615385	126-.5846154	Mean=.6179487
42-.3692308		127-.4923077	
43-.6153846	86-.8307692	128-.3076923	