Analysis of Technical Efficiency of Coffee Production on Small Holder Farmers in Case of Sasiga & Limu Districts of East Wollega Zone

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Abstract
The study entitled on Analysis of production Efficiency of coffee was conducted using cross-sectional data collected in 2013/14 production year from a total sample size of 200 households from Limu and Sasiga district of East Wollega zone. The aim of the study was to measure production efficiency of Coffee and to identify the principal factors affecting efficiency among Coffee producing farmers in the study area. The results of production efficiency were obtained using parametric stochastic production frontier (SPF) model. The results indicate that there was inefficiency in the production of Coffee in the study area and Farmers are efficient for Half -normal and truncated normal distribution about 74% and 89% average score of efficiency respectively while 26% and 21% of output lost due to random shocks. The mean technical efficiency was about 88%. Econometric results obtained from half -normal and truncated –normal frontier model indicate that labour and land has significant at 1percent level of significance but negative sign which imply efficient farmers has employed lower amount of land and labour inputs. In other case seed and oxen are significant and positive at 1 percent and 5percent respectively implying efficient farmer has higher units of oxen and seed. Increased distance between of plots and Female household head are more efficient than male household head because of better in management of resources. Woina dega/dega farmers are 0.25 times efficient than cola farmers. There exists of a positive and negative association between land square and fertilizer square with production efficiency and The second order parameter of interaction between livestock and labour, seed and land , land and fertilizer are significantly different from zero . The mean production efficiency levels further suggest that Coffee growing farmers in the study area could increase their production by 22% given the existing technology and inputs by avoiding production inefficiency. Thus the results suggest that there need to be policies geared towards enhancing production efficiency of farmers so as to enhance their productivity and export-competitiveness of this commodity.

1.0 INTRODUCTION

The original birthplace of coffee is known to be in Oromia Region, in the previous Kaffa province (currently Jimma Zone) of Cocce Guddaa locality. The discovery dates back to around 1000 AD according to legends (Oxfam International, 2002). Coffee has become the country's commodity for over 500 years (EEPA, 2002). Coffee in dollar terms is the second most traded product in the world after petroleum. Coffee produces income for millions of small farmers and their families, who are often totally dependent on the crop for their livelihood (Oxfam International, 2002).

As a nucleus of the Ethiopian economy, it accounts for approximately 60% of the country's export merchandise. It is estimated that there are 1.2 million coffee farmers and approximately 15 million households depend on coffee either directly or indirectly (Oxfam International, 2002).It is estimated that about 25% of the country's population is engaged in coffee industry, 95% of whom are small scale farmers working on more than 380000 hectares of land. Nearly half of the country's annual production is domestically consumed. In the harvest year of 2001, of the total production of 231310 metric tons, 108244 were locally consumed (EEPA, 2002).

Coffee is growing in many parts of the country but, the major producing areas are Sidamo, Kefa, Wollega, Iluabbabora, and Hararghe which were taken together account for more than 85 percent of national production (World Bank, 1987). The same source indicated that more than 90 percent of national coffee was produced by small scale farmers, 2 percent by cooperatives, 5 percent by state farms and the rest 3 percent was estimated to be the wild coffee.

In most of the areas, coffee is inter-cropped with staple food crops used as subsistence or as cash crops separately. Currently, the area covered by coffee plant is estimated to be 600,000 ha (Alamayehu, etal 2010). The annual yield is estimated at 350,000- 400,000 ton which makes Ethiopia the third largest producer in Africa. Even though, there is good environmental condition and potential genetic diversity, average yield at national level is 472kg/ha (Wokafaces and Kassu.2000).

The Oromia Regional Government possesses the largest part of coffee plantation of the country, amounting to about 328870 hectares. In addition to this, potential coffee cultivable land is estimated to be about 187230 hectares. The Regional Government's official report records that annual average production of Oromia is about 120000-150000 tones. Of the fourteen zonal administrations, coffee grows in thirteen zones and eighty-eight districts of the region (OBAD, 2001). There are variations in genotypes, eco-physiology and the biosphere of

coffee under different production systems. Plantation coffee can be regarded as an intensively technician system. The small scale farmers are the major producers, whereby about 140 local coffee land races known to grow as garden with owing on average 0.5 ha of coffee farming systems (Gebrehawaria, G 2012).

According to the Oromia Bureau of Agricultural Development, organic coffee is produced in five districts of East Hararge, three districts of Borena, and one district in each East and West Wollega, two districts of Illuu Abbaa Boraa, accounting to sixteen districts in the Region. The average annual production of organic coffee by the Union members from a totally cultivated area of 50692 hectares is 30415 tones. In Oromia, organically cultivated area is 15.4% of the total coffee plantation of the region. Thirty-five cooperatives with a total membership of 23691 households are engaged in this undertaking (OBAD, 2001).

Statement of the problem analysis on the bases that Ethiopia is the home and cradle of biodiversity of Arabica coffee seeds. More genetically diverse strains of Coffee Arabica exist in Ethiopia than anywhere else in the world, which has lead botanists and scientists to agree that Ethiopia is the centre for origin, diversification and dissemination of the coffee plant (Fernie, 1966; Bayetta, 2001).

Various efforts were made in the past to improve the productivity level of coffee and other oil seeds mainly though the introduction and dissemination of agricultural technology especially organic coffee. (Gebreegzabhier, etal 2004) Theoretically, coffee marketing and production in the country can possibly be raised (1) by allocating more resource for production (2) by developing and adopting new coffee technologies and/or (3) by utilizing the available resources more efficiently. 4) by promoting liberalization to boost export of coffee and advertise the advantage of coffee for protect climate change and change livelihoods of society. Thus, statement of problem lies on whether coffee producer farmers are efficient in coffee production or not in East Wollega zone.

General objective of the study was to know Determinant of the Production efficiency of smallholders Coffee production in Eastern Wollega Administration Zone

Specific Objective

1. To measure the level of production efficiency of the Coffee producers in the study area.
2. To explore problems and constraints relevant with coffee production and marketing.
3. To assess the level of production inefficiency of coffee and identify production inefficiency variables (inputs).
4. To highlight policy implications regarding the agricultural production of coffee.

This study has both a practical and theoretical importance. At the practical level, measuring the production efficiency of coffee plantations, and identifying the factors that affect it, may provide useful information for the formulation of economic policies likely to improve producer technical efficiency.

They can play an important role in informing inefficient farmers to derive lessons about better Production practices from more efficient farmers operating in the same environment and at a given level of technology.

The outcome of the study would serve as guide to public policy design and implementation.

1.2. Conceptual frame work

The different methods used to technical efficiency can be broadly classified into two groups parametric and non-parametric (DEA) (coelli etal,1998).

The main advantage of DEA is,it does not impose any functional form on data.

Its disadvantage is its assumption of constant returns to scale.

- ❖ Lacks the statistical procedure for hypothesis testing.
- ❖ It does not take measurement errors and random effects into account; in fact, it supposes that every deviation from the frontier is due to the firm's inefficiency.
- ❖ Is very sensitive to extreme values and outliers.

As of 2001, more than 1000 references are listed in this field. This is an impressive number considering that DEA was first proposed 29 years ago. One of the main reasons why DEA is so commonly used is its ability to convert multiple inputs into multiple outputs, especially when one lacks a clear functional relationship between inputs and outputs (Murillo-Zamorano, 2004).

The second approach is the parametric approach.

It is based on econometric estimation of a production frontier whose functional form is specified in advance. In this approach, the stochastic frontiers method is the most popular. Also referred to as "composed error model", the stochastic frontiers method has the advantage of taking into account measurement errors or random effects.

Criticism of this method resides in the need to specify beforehand the functional form of the production function and the distributional form of the inefficiency term. it is advantage than no parametric and accommodate non constant returns to scale and classified into deterministic Versus Stochastic Frontier Models

In fact, the stochastic frontiers method makes it possible to estimate a frontier function that simultaneously takes into account the random error and the inefficiency component specific to every plantation. Thus, the efficiency scores in this study are relative values of the best coffee producers in the study area. This efficiency score might be reduced if more efficient producers from other area were included in the study. Likewise,

it could increase if less efficient producers were included. However the result of the study was useful to all farmers of the zone as there is no high variation among farmers of the zone.(coelli .etal,1998) as:

1.3. Research methodology

Primary Data: Primary data requirement is to identify information on selected district in east Wollega region of oromia regional state. The researcher tries to collect Information based on recording of the day to day activities, information exchange and treatment, time series data of (purchases, sales, members (composition), prices, assets, liabilities, credits taken, repayments, dividends, profits/ losses and defaults should be collected from coffee producer farmers and relevant offices ,Marketing issues ,acquisition of inputs , income derived from the irrigation scheme ,financial and economic analysis , employment ,labor and wealth creation of both Sasiga and Limu Woredas

Purposive sampling method is used to select ten kebeles among 17 coffee growing kebeles from Sasiga and Five kebeles among ten known coffee producing kebeles from Limu based on their coffee production. From each kebeles Farmers were selected randomly by using random sampling technique so that coffee producing farmers of the two districts and selected kebeles have equal chances to be selected proportional based on number of farmers.

Total of 200 farmer households (Sasiga-120 and Limu 80) have been randomly selected for 2012/13 cropping season based on proportion of number of target population of each kebeles.

Sample size determination formula According to Kothari (2004) the following sample size calculation

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

formula is given by following calculation of sample size was done.

Where n= estimated sample size, e = the level of precision= 7%   N= number of population in the study area. Using the formula and, the information from Sasiga and Limu District, the sample size for this study is calculated as follows. N=6890 Number of farm households of selected kebeles. The sample size is calculated as

$$n = \frac{6890}{1 + 6890(0.07)2} = 199 = 200$$

follows.

From Each woredas ten kebeles from Sasiga and Five kebeles from Limu Woreda were purposively selected based on production of coffee while each respondent were randomly selected from recorded secondary data of kebele's.

The data have collected by diploma level enumerators first trained and who know local language and lives with population serve as experts of DAS in the area. The collected data has included different social, economic, and institutional variables from sample respondents. Also, there is also non participatory observation and informal group discussion with target farmers.

Dependent variable Yield: This is the endogenous variable in the production function. It is defined as the actual quantity of coffee produced per hectare of land and measured in quintals.

By multiple regressions, we mean models with just one dependent (small scale irrigation schemes) and two or more independent (explanatory) variables (socio-economic factors).

The Multiple Regression Model: The multiple regression equation of Y on X1, X2…., Xk is given by: Yi = A + b1 X1 + b2 X2 + …………………… + bn Xn+e

Explanatory variable: Xi's is the function of Independent variables, and it is the estimated value of smallholder irrigation schemes. A is constant. Here bo is the intercept and b1, b2, b3-----, bk are analogous to the slope in linear regression equation and are also called regression coefficients.X1 through Xn represents socio-economic variables and E is the error term. The most socio economic variable (X1) is first picked and regressed against smallholder irrigation schemes and then X2,X3 etc in the order of the strength of the variable . '

1. Labor: represents the total human power employed in the production process. The input may consist of family and hired labor. It is expressed in terms of total man equivalent employed to perform pre-harvest agronomic and harvesting activities.

2. Oxen; since number of oxen decrease time and cost on other productivity it was hypothesized to have positive effect.

3. Livestock holding of household head: This refers to the total number of livestock measured in tropical livestock unit (TLU). Livestock is important source of income, food and draught power for crop cultivation in Ethiopian agriculture.

4. Seed: amount of seed can be positive or negative depend on proprtion opf input utilization.

5. Land: This refers to the area in hectare that is committed to coffee production. The land may belong to the farmer; it may be obtained by means of hiring, leasing or through share-cropping arrangements

6. Fertilizer: this is one of the principal inputs without which production is unthinkable. It refers to the coffee study

area, farmers may apply commercial fertilizers (DAP and Urea) for production. However, the rate of application of these productivity enhancing inputs clearly matter on the level of output attainable in a given area of land. In this study, fertilizer refers to the commercial type and measured in kg/ha. In efficiency variables capacity is declining and farmers learn through time. Technical inefficiency

$$u_i = Z_i \delta + w_i$$

Z0=constant, Z1=credit, Z2= Education, Z_3=soil fertility Z4=Age of the household Z5= place resident.

Wi= an error term that follows a truncated normal distribution δ = inefficiency parameters to be estimated. Thus, the model for estimating the determinant of inefficiency is defined as: U =α +α Z1+α Z2+α Z3 +α Z4 +α Z5 +Wit Where: α is the intercept term; α (j=1,2,3….9) are the parameters for the explanatory variable

1. Access to credit facility (Z1): Educational level of the household heads (Z_2): place of resident (Z_3); Sex of the household head (Z4): Marital status (Z5), None /off farm income (Z6). Contact with extension agents (Z7), Age of household and coffee (Z_8), Family size (Z9), Distance from market (Mkt) and plot from home (Z10) while wit -error term that follows truncated form.

1. 4. Results and Discussion

The average coffee output is approximately around 5.6 quintal per hectare picked from matured coffee trees (i.e.38 years on average) during the last coffee production season. This indicates us that the maintenance of matured coffee trees are quite labor consuming; indeed, the productivity of coffee trees are largely influenced by the level of labor being devoted for the maintenance of matured coffee trees.

The average land allocated for farmer was 2.4ha compared to the national average of 1.01 hectare of land. In the study area most of the sample households reported that Coffee is planted as sole crop during survey time. However, farmers believe that sole cropping of coffee could be more profitable than intercropping but due to risks of drought and other challenges, they prefer intercropping. Productions of Coffee mainly high and harvested yearly in areas of fertile soil, Irrigation place, moisture area and shadow with less sun light. On average, a farmer who owned coffee trees of age between 25 to 30 years old tends to be more efficient than household who owned coffee trees of age 30, the average coffee trees of production inefficient farmers. Accordingly, coffee trees could yield more output when it is at age between15 to 20 years in contrast to finding Alemayehu Ethiopia who found 30 to 40 years age.

The proportions of male-headed household were 86.5 percent and that of female-headed households (13.5 percent) with standard deviations of 0.34. The mean age of experience of a typical household head's farming experience is about 18 years with the minimum being 8 and the maximum 60 years while standard deviation is 7.8 percent. On average, a typical household heads attended formal education ranges from zero to12 years of schooling with mean of 4.695standard deviation 0f 3.5. Average household that have non-farm income 1.8 with standard deviation 0.4. Average land of coffee farmer slightly between 2.3 hectare (ha) and 6 hectare in average even though there are those who do not own land

This indicates us that the maintenance of matured coffee trees are quite labor consuming; indeed, the productivity of coffee trees are largely influenced by the level of labor being devoted for the maintenance of matured coffee trees. One of the key assumptions to be satisfied in order to proven the reliability of the statically tests like t-test, correlation coefficient etc is normality test. The significance test for Kurtosis and Skewness of variables of stochastic production frontier all variables of stochastic frontier model are statistically significant and not normally distributed. In order not to affect the normality of statically tests, this confirms that the data should be transformed. The statistical summary provided in classification table shows that the Dependent variable represented by households production Efficiency of Coffee. It is continuous variable Efficient if it is greater than Average and inefficient if it is below average.

Table 1 Mean difference test on technical efficiency

Test	Efficiency	land	Labour	capital	off income	experience	fertilizer	sex	land	education	credit
Mean	.81	2.4	3.1	64	33.6	28.0	2.3651	.865	2	5.5	10
Df	1	2	4	2	1	2	1	1	1	1	1
CHi^2	.06	.00	.000	.000	.000	.000	.000	.22	.00	.000	.000

There is statistically significant mean difference between efficient and inefficient farmers on land, labor, capital, experience, fertilizer, sex, education and credit as shown in above chi square estimation table.

Table 2 Frequency of production efficiency estimates of producing coffee in Sasiga and Limu Woreda

EFFECIENCY RANGE	FREQUENCY	%
0.90-1	49	24.5
0.80-0.89	51	25.5
0.7-0.79	35	17.5
0.6-0.69	25	12.5
0.5-0.59	19	9.5
0.4-0.49	14	7
0.2-0.39	5	2.5
0-0.19	2	1

Source own computation,(Survey data 2014)

1.5 ECONOMETRICS ANALYSIS

Methods of estimation: Econometrics analysis used cross sectional dataset covering 200 respondents to estimate combined frontier -inefficiency model. Stata 12 software programmed was used for estimation of different parameters that affect the production efficiency of coffee. From literature there are two common functional forms of production function employed in studying production efficiency using stochastic production frontier function namely cob-Douglas and general translog functional form. In this chapters log 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. The first step is to estimate two models to choose the correct functional form for production efficiency of coffee based on maximum likely hood estimation values. From two models we observe that most of variables are insignificant thus we use transformed one. (Abdurezack Hussein,2010)

Therefore conventional inputs are estimated after converted to logarithm as per the rule of stochastic instruction file. The estimate of production efficiency and the value of production inefficiency component were also predicted, without violating different distributional assumptions attached to Ui, using the maximum Likelihood method in Stata 12.0. Two different distributional assumptions, half-normal and truncated normal were made on distribution of error term.

Table 3 Maximum Likelihood estimates of Trans log Stochastic Production function under different distributional assumptions Parameters.

Regress frontier lnoutput lnoxen lnlivestock lnseed lnland lnfertilizer sed2 lnlabour2 lnoxen2 lnlivestock2 lnland2 lnfertilizer2 lo llvstock lsd lf olvstock landf credit education plr fertilizer sex marst offarm extensioncont technology age household . Stoc. frontier normal/half-normal model

Number of obs =   200   Wald chi2(27) =   184

Log likelihood = -266.2   Prob > chi2   =   0.0000

Lnoutput	Coef	Std. Err.	z	P>|z|
Lnlabour	-0.153	0.3804	-4.03	0.000
Lnoxen	0.1044	0.0461	2.26	0.024
Lnlivestock	0.031	0.051	0.61	0.542
Lnseed	0.079	0.026	3.1	0.003
Lnland	-1.045	0.14	-7.39	0.000
Lnfertilizer	-0.022	0 .05	-0.45	0.653
Sed2	-0.0012	0.0009	-1.34	0.18
Lnlabour2	0.00035	0 .004	-0.09	0.93
Lnoxen2	-0.0034	0.01665	-0.2	0.838
Lnlivestock2	-0.0013	0.00113	-1.22	0.221
Lnland2	0.14	0 .035	4.09	0.000
Lnfertiliz~2	-0.0006	0.0038	-1.65	0.099
Landf	0.0281	0.0095	2.94	0.003
Credit	-0.236	0.223	-1.05	0.291
Education	0.029	0.0289	1.02	0.310
Plr	0 .255	0 .14	1.82	0.069
Sex	- 0.975	0 .375	-2.6	0.009
Marst	- 0.5	0.19	-2.54	0.011
Offarm	-0.413	0.203	-2.03	0.042
Extensionc~t	0.112	0 .133	0.84	0.403
Technology	-0.0002	0.36	-0.00	0.999
Age	0 .0024	0.009	0.26	0.792
Household	0.0053	0.058	0.09	0.927
Distplot	0.0972	0.054	1.78	0.075
Cons	5.98	0.877	6.82	0.000
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/lnsig2v	.852	0.100	7.51	0.000
/lnsig2u	-9.20	133.273	-0.07	0.945
sigma_v	0.0651	0.146	0.416	1.013
sigma_u	1.0918	0 .277	0.663	1.79
sigma2	1.615	0 .439	0.754	2.476
lambda	1.677	0 .415	0.862	2.492

Likelihood-ratio test of sigma_u=0: chibar2(01) = 1.99   Prob>=chibar2 = 0.079

Survey data from stata Result of output 2014 collected data

In order to see the impacts of various distributions on the estimates of production efficiency, the model comparison in reference to half normal and truncated normal attached to Ui have been performed. The stochastic and inefficiency models estimated before the data are transformed show that most variables in error component model and production inefficiency effects model are statistically insignificant. sigma is large enough and significant that shows good fit and correctness of specified disributional assumptions and the estimated value of variance parameters among the three assumptions varies significantly among the two models.

Thus we have to use translog production function. But, lamda ⅄ 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 coffee production. Results from ANOVA further show significant difference over input utilization across the two groups. Estimate of Lamda (⅄)=1.677645 (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= 1.615594) 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) for the stochastic frontier production function is close to one and significantly different from zero. This results show the existence

of production inefficiencies in coffee production. Thus, null hypothesis stating joint impacts of production inefficiency effects are zero is rejected and the value of lamda (Λ) 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 operational inefficiency. Thus we have to use Truncated and half normal inefficiency frontier analysis. For Half -normal and truncated normal distribution about 74% and 89% of total variation is due to inefficiency respectively.

Firstly, In the half-normal model, gamma 74% of total variation in production of coffee is caused due to specific performance of farmers while the rest 26% is due to random shocks. This imply farmers are 74 percent efficient while 26% of Coffee output lost due to production inefficiency of farmers. From these we can observe that coffee production can be increased by 26 percent if we increase production efficiency or avoid all inefficiency variables.

Secondly, In the truncated-normal frontier model, gamma 89% of total variation in production of coffee is caused due to specific performance of farmers while the rest 21% is due to random shocks. This imply farmers are 89 percent efficient while 21% of Coffee output lost due to production inefficiency of farmers. From these we can observe that coffee production can be increased by 21percent if we increase production efficiency or avoid all inefficiency variables.

The finding also shed light on the possible source of this shocks which is mainly explained by two main factors that are problem of experimental research on agro-ecological variety of coffee seed and lack of any technological adoption (traditional way of production of coffee).

EARI at Jima has not yet studied any research on agronomy and variety of coffee seed produced in East Wollega Zone in general. But the research center found 37 type of known variety coffee seed since its establishment in 1968 G. and disseminated to farmers of Jima, Illu Ababor and west wollega zone around Haru projects. Among these 18 are improved varieties while 3 of them missed during Haile sillase regime and other 15 are continued until a period. Further more data from Jima Agricultural Research Institute also revealed that no any research have been done yet on which improved variety of coffee is more efficient and which variety is suitable for each agro ecological zone needs further studies. Jima EARI, 2010.

Even though, there are many potential of coffee production area in East Wollega zone and other areas of West Oromia farmers produce coffee with traditional technology. EARI 2010 in Jima also disseminates four variety of coffee seed 2 for East and 2 for West Wollega Zone.

Interpretation of Inefficiency variables and conventional inputs

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 coffee. This imply Coffee 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.

Oxen: The sign of the coefficient of Number of Oxen is positive and statistically significant at 5percent level of significance, this indicates that increase in number of oxen also increase production efficiency of coffee. This may be because most of the Coffee producer farmer who owns more oxen can effectively produce coffee by using oxen for production of coffee and other crops easily than inefficient farmers.

Seed: The sign of the coefficient of amount of seed is positive and statistically significant at 1 percent level of significance, this indicates that increase in amount of seed also increase production efficiency of coffee. This may be because most of the Coffee producer farmer who use seed can effectively produce coffee by using efficient combination of amount seed for production of coffee.

Land ;land size measured in hectar is significant at 1percent level of significance and has negative sign which indicate the more land size the more in efficient are farmers on coffee production. This may be due to excess land requires excess cost and inputs which decrease production efficiency of coffee for farmers.

The coefficient on Livestock and Fertilizer are statistically insignificant. This shows that Livestock and fertilizer inputs are not important to explain production efficiency.

On the other hand, when we see the interaction between variables, there exists of a positive and negative association between land square and fertilizer square with production efficiency. These behaviors can be explained by the fact that there exist inverted U-shape relationships.

The second order parameter of interaction between livestock and labor, seed and land , land and fertilizer are significantly different from zero .This indicates that the rejection of the Cobb-Douglas model as an adequate representation of the coffee production is justified because the function is non–linear to some extent and there exist important interaction among the variables. Besides these, unexpected signs and the insignificance of the coefficients can be attributed to the nature of translog functional form which causes multicollinearity problems arising from the inclusion of squared/ quadratic terms and cross –products of the input variables.

However, since the purpose of the study is to predict efficiency, multicollinearity will not be a serious

problem and some degrees of multicollinearity can be tolerated (maddala, 1992) .

Lastly, the paper examines the results of different determinant that affect the technical efficiency of Coffee production as follows:

Credit availability, Education in years of schooling, soil fertility, extension contact, technology, age of household head and proximity to Market are insignificant.

Place of resident: The sign of the coefficient of place of resident dummy is positive and statistically significant at10 percent level of significance. This can be explained by the fact that there is production efficiency difference between the Cola and woine Dega/Dega climate zone. It shows that 1 for woine Dega/Dega and 0 for cola. Woina dega/dega farmers are 0.25 times efficient than cola farmers.

Sex of household head: The sign of the coefficient of sex is dummy and negative . It is statistically significant at 1percent level of significance. It shows that 1 for Male and 0 for Female. This can be explained by the fact that there is production efficiency difference between the Male Female household head. Female household head farmers are 0.97 times efficient than Male household head farmers because Females are better in management of resources than Male.

Marital status and off farm income are also dummy variables 1 for married and farmers that has off-farm income sources while 0 for farmers those are single, widowed/divorce and no off-farm income sources. Most of the farmers considered in the sample have off farm income generated from various activities. Taking this in to consideration, in this study, farmers are categorized in to two as those farmers who are earning off farm income source or not in continuous period. since both coefficient of off-farm income and marital status are significant at5percent level of significance level, there sign is negative implies that Married household head and those who owned off-farm income sources are 0.5 times and 0.41 times less efficient than single, widowed, Divorce and those has not off-farm income sources respectively. These are due to the fact that married house hold and farmers those who has off-farm income sources are busy on other extra job activities.

Distance of plot: The sign of the coefficient of distance is positive and statistically significant, this indicates that there is significant difference in production efficiency score prevail between farmers those their plots are nearby each other and to their homes and far from each other. This may be because most of the Coffee producer farmers focus on the plots that live around the areas of their home where the plants are built. Increase in distant between plots also increase cost of transport and time that decrease production efficiency.

Generally, More production efficient farmers are found to use lower units of land, labor and higher units livestock compared to inefficient producers.

In other case, Efficient Farmers use more seed than inefficient farmers. This imply the actual output difference across farmers' production efficiency category could be due to the actual input utilization by farmers. The analysis of variance further elucidate that there is significant distinction between age of coffee trees owned by production efficient and inefficient coffee producers. Age of coffee square has positively affect production efficiency of coffee and significant. This may signify the biological cycle of coffee production which is similar with research by EARI of Jima Zone. Survey Research also shows there is positive relationship between age of coffee trees and production efficiency up to 15 years of biological life cycle of coffee but negative after that. The experience of household head shows positive correlation with age of coffee thus dropped.

1.5 Major findings and Conclusions

Based on frontier analysis of half normal and truncated frontier model on production Efficiency of farmers the study concludes the following conclusions

1. Alog likely hood ratio test estimated by maximum likelihood estimation showed that production processes of Coffee was better specified by Tran slog production function.
2. Gamma value showed that 89 and 74 truncated and half normal frontier model since inefficiency effects are 21 and 26 percent respectively.
3. Conventional inputs (variables) has significantly affect production efficiency of coffee farmers positively and negatively thus increased efficient input use necessary to increase yield, But, further studies are required to decide optimal level of these input variables based on variety and agronomy of the area.
4. An analysis of the determinants of production efficiency was carried out and it showed that production inefficiency in coffee production could be created by increased labour employment, increased per hectar of land and increased distance between of plots.
5. .Gender of household head found to be influence production inefficiency and negative relationship with production efficiency implying Female household head is more efficient than male household head. Female household head farmers are 0.97 times efficient than Male household head farmers because Females are better in management of resources than Male.
6. . Credit availability, Education in years of schooling, soil fertility, extension contact, technology, age of household head and proximity to Market are insignificant. While Place of resident shows that Woina dega/dega farmers are 0.25 times efficient than cola farmers. Since married house hold and farmers those who

owned off-farm income sources are busy on other extra job activities, they are less efficient than single, widowed, Divorce household and household those has not off- farm income sources respectively.

7. In other case, Efficient Farmers use more seed than inefficient farmers. This imply the actual output difference across farmers' production efficiency category could be due to the actual input utilization by farmers. The analysis of variance further elucidate that there is significant distinction between age of coffee trees owned by production efficient and inefficient coffee producers.

8. Age of coffee square has positively affect production efficiency of coffee and significant. This may signify the biological cycle of coffee production which is similar with research done by EARI of Jima Zone. Survey Research also shows there is positive relationship between age of coffee trees and production efficiency upto 15 years of boilogical life cycle of coffee but negative after that.

9. There exists of a positive and negative association between land square and fertilizer square with production efficiency and The second order parameter of interaction between livestock and labor, seed and land , land and fertilizer are significantly different from zero .

Given the empirical findings, the proposed recommendations are:

1. Since Coffee has indispensable role on protecting climate change and improving socioeconomic of society, It is relevant to suggest less efficient farmers properly use their resource and undertake *coffee* production technologies in line with their potentials and Extension workers should have to 'farmers' field day' and experience sharing within and out of the *woreda specially with Jima center of Ethiopian Agricultural research institute.*

2. EARI should do extensive research on production efficiency of coffee, on soil, agronomy and variety of coffee so as to adopt better variety of coffee as western Region, particularly in East wollega zone of Sasiga and Limu woreda including other potential coffee producing areas of Horo Guduru Wollega Zones.

3. As it has already been observed, there is a potential to increase production through improving technical efficiency of coffee producers. This does not mean however, that increasing package of new technology and improving traditional practices and instruments should be neglected. Output augmenting though improvement of technical efficiency of farmers at existing technology is of short run solution. Moreover, introducing of new technology for augmenting production is of long run solution. Thus, policy makers should pursue the way to utilize both effectively but priority may be given to technical efficiency improvements.

4. Government should support expanded Production of Coffee to other potential areas of East Wollega and others by taking further research on cost and benefit analysis of increasing coffee production, since Production of Coffee has multipurpose benefits such as environmental protection and economic development.

5. Finally, the application of fertilizer is very low in area and there is no well-developed system for recording and handling production data; it is difficult to get reliable time-series production data of individual small-scale farmers through interview so further study on soil type , data handling production on yearly base, best variety seed and agro-climatic conditions are needed to increase production Efficiency of coffee in general in area. Therefore, Cross sectional data is limited in the sense that it does not consider other factors such as risks, market imperfections thus panel data should be used for further researchers on production/technical efficiency of coffee and to evaluate how technical efficiency has changed over time.

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