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Research Article

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Studies on Economic Efficiency of Coffee Production in Ilu Abbabor Zone, Oromia Region, Ethiopia.

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The study was carried out in six districts of IluAbbabor zone of the production year of 2015/16. Coffee is the major crop but its productivity is low. This can be improved by using the available resource and technology. This study analyzed the efficiency of coffee production and assessing the potential for improvement. Cross-sectional data were used to analyze the economic efficiency of coffee production and identify its determinants factors from 200 farmers were selected using probability proportional sampling technique. The parametric stochastic frontier approach was employed to measure economic efficiency. The results indicate very low levels of technical, allocative and economic efficiency among coffee farmers. The production function indicated that labor was the only variable that had a positive and significant impact in determining coffee production. The mean technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE) of the household calculated from parametric approach of stochastic frontier analysis were 71.71%, 14.13% and 10.12% respectively. Relationships between TE, AE, and EE, and various variables were expected to have effect on efficiency were examined. An important conclusion emanating from this study is that AE appears to be more significant than TE as a source of gain in EE. From a policy point of view age of the household head, access to credit, land fragmentation, family size and total farmland are the variables found to be the most promising for improving efficiencies of coffee productions. Therefore, policies and strategies of the government should be directed towards the above mentioned determinants.

Keywords: Coffee, efficiency, Cobb-Dougals, Stochastic frontier, tobit

INTRODUCTION

The agricultural sector has a great importance in world's economy. In Ethiopia, it contributes to more than 50% of GDP, 80% of exports and 85% of employment (Mellor and Dorosh 2010). Coffee in agriculture is one of the crucial cash crops in Ethiopian economy as well as in the world economy. About 25% (15 million) of the Ethiopian population depend, directly or indirectly, on coffee production, processing and marketing (Mekuria*et al* 2004). The production of coffee cherry takes place between the Tropic of Capricorn and the Tropic of Cancer, where the humid and hot environment allows coffee trees to thrive. The three periods when it is optimal to harvest are April, July, and October, and each country falls within one of these groups. During these periods, the coffee cherry is harvested and processed into the well-known coffee bean, and then readied for the market in 60 kg bags containing the green coffee bean (Woodill and *et al* 2014).

Coffee is an important part of Ethiopian's agriculture sector. Farmers have been dedicated for generations to producing some of the finest coffees in the world. It is the origin and cradle of biodiversity of Arabica coffee seeds.

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More genetically diverse strains of *C. 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).

The estimated coffee production area (2% of total cultivated land) in Ethiopiais measured in the range of 320,000 to 700,000 ha (FAO, 1987), though potentially there exist about 6 million ha cultivable land suitable for coffee production. The coffee cultivation takes place from 900m in Magi (Kaffa) to 2300m above sea level in Gore (Illubabor) (Fernie, 1966), even if the optimum productive plantations are located between 1500 to 1800 m above sea level (Paulos,1994). The dominant coffee growing soil types are Nitosol (25%), Acrisol (17%), and Luvisol (14%) (Höfner, 1987). The soil texture class is varying from clay (13%), loamy clay (29%), silty clay (29%), to sandy clay (22%) in relative proportion. The soil pH-value ranges from 4.4 to 6.8. Diurnal and seasonal fluctuations in temperature (14 to 30°C), relative humidity (43 to 85 %) and heavy rainfall (1000 to 2000 mm) are very frequent in different coffee growing zones (Gamechu, 1977).

The forest and semi-forest (10%), garden coffee (85%), and plantation coffee (5%) are the major conventional production systems. There are variations in genotypes, eco-physiology and the biosphere of coffee under different production systems. Plantation coffee can be regarded as an Intensive traditional agroforestry 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 (Demel *et al*., 1998).

Coffee is the major agricultural export crop, providing currently 35% of Ethiopia's foreign exchange earnings, down from 65% a decade ago because of the slump in coffee prices since the mid-1990's in a country where about 44% of the population is under poverty (Woods, 2003). Ethiopia's most important export crop contributing 41 % of the country's foreign currency income was coffee (FAO and WFP 2006). Coffee cultivation plays a vital role both in the cultural and socio-economic life of the nation. It is the most important export commodity for Ethiopia agriculture and plays an important role in the country's economy. This is especially true for the Oromia, South Nations and Nationalities of people (SNNP) and Gambella Regional States.

According to International Coffee Organization (ICO), the world indicator price for coffee in 1984 was as high as 1.4463 USD/lb paid to producer countries (ICO, 2004). Governmental support for coffee production in the 1980s drove farmers in lesser-developed countries to increase plantings of this commodity. In the subsequent years, various forms of supports intended to increase coffee productivity resulted in oversupply of coffee that exceeded demand by 13 million bags by 2000 (ICO, 2004). As a result, an average price of coffee paid to producer countries in 2000 dropped to 0.3797 USD/lb.

Despite the pivotal role-played by coffee its production and price has a great fluctuation in the world as well as in Ethiopia these are resulted in negative influence in the economics of coffee production, productivity and efficiency. These fluctuations in production and price are improved and solved by efficient utilization of resources in production of coffee. Thus, this study focused on the analysis of technical, allocative and economic efficiency of coffee farmers in Ilu-Ababor zone that is one of the potential producers in Oromia region.

Objectives of the Study

The general objective of this study is to analyze economic efficiency in coffee producers' farmers in some selected districts of Ilu Aba Bora Zone. More specifically, the study aims to:

1). To estimate the level of technical, allocative and economic efficiencies in coffee production in some selected districts of Iluababor zone.

2). To identify factors that determines efficiencies of smallholder farmers in coffee production in the study areas.

3). To find out the coping strategies likely to increase the productivity and efficiency levels of coffee producers in the study areas

Efficiency Measurement Concept

The concept of production efficiency in general and the distinction between technical and allocative efficiency in particular is further explained using input-oriented and output-oriented approaches.

Original idea of representing the technology in a convex isoquant is an input-oriented measure of efficiency. Farrell (1957) illustrated the idea of input oriented efficiency using a simple example of a given firm that uses two factors of production, capital (K) and labor (L), to produce a single output (Y). And face a production function, $y = F(K, L)$, under the assumption of constant returns to scale, where the assumption of constant return to scale will help us to present all necessary information on a simple isoquant. The input approach addresses the question "by how much a production unit can proportionally reduce the quantities of input used to produce a given amount of output?" (Coelli *et al*, 1998). The two factors per-unit output that a firm uses can be presented on the two-dimensional input/input space. The isoquant SS' represents various combinations of the two input variables that at least a firm might use to produce a unit output. This is an isoquant that defines the input-per-unit of output ratios associated with the most efficient use of the input to produce the output involved. In an input-oriented measure of efficiency both allocative and technical efficiencies of a firm fall on or above the unit iso-quant of the input-per-unit of output space and cannot be below or to the left of it. A departure from the unit iso-quant indicates technical inefficiency and the more a firm are far from the unit iso-quant the more it is inefficient.

Efficiency Studies on Coffee Production

Researcher evaluates the economics of Coffee production in the DakLak province in Vietnam. The overall objective of the study was to estimate the technical efficiency of coffee production and determine which factors affect technical efficiency of small holder coffee farmers in the Krong Ana Watershed of the DakLak province. Based on the stochastic production frontier, the estimated mean technical efficiency scores were 0.7466 and 0.6836 respectively for the Cu Kuin district and the three combined districts (Krong Ana, Krong Bong and Lak). Formal education of the household head, amount of financial credit obtained, ethnicity, coffee farming experience of the household head, and agricultural extension service used were key factors that can increase technical efficiency in coffee Production **(**Thong Quoc Ho *et al*, 2013).

The study by AmadouNchare (2007) analyses the factors influencing the technical efficiency of Arabica coffee farmers in Cameroon. To carry out the analysis, a translog stochastic production frontier function, in which technical inefficiency effects were specified to be functions of socioeconomic variables, was estimated using the maximum-likelihood method. The results obtained show some increasing returns to scale in coffee production. The mean technical efficiency index is estimated at 0.896, and 32% of the farmers surveyed had technical efficiency indexes of less than 0.91. The analysis also revealed that the educational level of the farmer and access to credit are the major socioeconomic variables influencing the farmers' technical efficiency. Finally, the findings prove that further productivity gains linked to the improvement of technical efficiency may still be realized in coffee production in Cameroon.

Ana R. Rios and Gerald E. Shively (2005) studied efficiency of smallholder coffee farms in Vietnam. Data from a 2004 survey of farms in two districts in Dak Lak Province were used in a two-step analysis. In the first step, technical and cost efficiency measures were calculated using DEA. In the second step, Tobit regressions were used to identify factors correlated with technical and cost inefficiency. Results indicate that small farms were less efficient than large farms. Inefficiencies observed on small farms appear to be related, to the scale of investments in irrigation infrastructure.

From the review of literature, one can understand that most of the studies so far focused on technical efficiency of coffee farmers. Therefore, this study aimed at economic efficiency of coffee producers.

METHODOLOGY

Description of the Study Area

The vast area of Ilu Abba Bora Zone is located in southwestern part of Ethiopia in Oromia Regional State. The zone shares common frontier with East Wollega and Jimma zones in the East, and East Wollega in the North; with SNNPR in the south and with Gambella Regional State in the west. Exorbitantly, Ilu Abbabor is positioned between7027’40”to 902’10” Latitude N and 34052’12” to 41034’55” east longitudes. The total area of the zone is equal to 1,633,156.6 hectares that sub-divided into 24woredas and two special city administrations. The capital, Mettu town is 565 kilometers away from Addis Ababa (IZARDO, 2006).

Agriculture is the major source of livelihood for of Ilu Abba Bora. This agricultural activity comprises both crop production and animal husbandry. The major crops grown in the area are: maize, wheat, barley, teff, sorghum, dagujja, and other legume, coffee, vegetable and fruit varieties. Coffee is the principal cash earning crop among Ilu Abba Bora people. An available literature clearly shows that agriculture employees about88 percent of population in the study area (Yasin, 2009, p18, and Alemayo Haile, 2009).

Usually Ilu Abba Bora is divided into three major local climatic zones. The cool high land areas with an annual average temperature of 14-18^{0}C is usually called bädda whereas bädda-dare or däkka (is the immediate zone where huge number of the population settled have18-24^{0}C annual temperature) and gämojï, the hot valleys and plains attaining the highest temperature and lowest rain. (Ibid) In fact, the climatic condition of the zone does not have a climate zone that can be identified as hot desert.

Data Collection Techniques

This study used both primary and secondary data sources. The primary data was collected using semi structured interview (Bargali SS and Parihaar RS *et al*) and questionnaire administered by the trained enumerators. Before starting the actual data collection, some preliminary information about the overall farming system of the zone as a whole was assessed through informal survey and discussion was held with key resource persons in some of districts. Pre-testing the questionnaire was also one part of the informal survey so that appropriate refinements and modification in the questionnaire were made.The processes of primary data collection were conducted through multiple visits, which enable us to gather timely and reliable information on the overall farming operations in the study area.

Sampling

The data used in this study were collected from the coffee farmers who are found in kebeles of selected districts of Ilu-Ababor zone. Six districts was selected purposively who are producing coffee in 2015//16 production year. After the six coffee producing districts are selected eighteen coffees producing kebeles’ was selected randomly, the number of sample farmers from each kebeles was determined based on the proportion of the household heads living in the kebele and producing coffee. The sample size was determined by the formula given by (Yemane,1967).

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

Where, n is sample size, N is number of household head and e is the desired level of precision. By taking e as **8.3%,** total number of household head 126,452 the sample size would be **200.** The distribution of sample size in accordance with the size of the districts is presented in Table 1 and 2.

Methods of Data Analysis

To address the objectives of the research and to analyze the data descriptive, inferential statistics and Econometric methods was employed.

Efficiency Estimation

In this study, the stochastic production frontier was used for its key features that the disturbance term is composed of two parts: a symmetric and a one-sided component. Hence, efficiency measures obtained from stochastic frontiers was expected to reflect the true ability of the farmer with the given 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, etc (Coelli and Battese, 1995). Moreover, there is high variability of agricultural production due to weather fluctuations. Therefore, within the stochastic frontier framework, the stochastic efficiency decomposition methodology was chosen as more appropriate for this study.

The stochastic statistical frontier method requires a prior specification of the functional form, among others, Cobb-Douglas, Translog, etc. However, recent advances in developing new functional forms have been dominated by efforts to conceive “flexible” forms. As a result, flexible functional forms such as the Translog form are usually recommended rather than the restrictive Cobb-Douglas form (Greene, 1980).

Theoretical Model

Since the seminal article on efficiency measurement (Farrell, 1957), the basic stochastic frontier model was independently proposed (Meeusen and Van Den Broeck 1977). The efficient frontier can be considered as either the maximum level of output for a given set of inputs (an output orientation), or the minimum set of inputs required to produce a given set of output (an input orientation) (Tingley *et al* 2005).

A single-stage approach in which explanatory variables are incorporated directly into the inefficiency error component was adopted (Reifschneider and Stevenson1991). For this method, the variance of the inefficiency error component was hypothesized to be a function of firm specific factors. For such study, the following production model was chosen (Battese and Coelli 1995): $y_i = f(X_{ij}; \beta_j).\exp(V_i - U_i)$

Estimation of the Determinants of Efficiency

The most common procedure is to examine determinants of efficiency, in that the inefficiency or efficiency index was taken as a dependent variable and was then regressed against a number of other explanatory variables that were hypothesized to affect efficiency levels (Bravo-Ureta and Rieger, 1991; Sharma *et al.*, 1999).

Technical, allocative and economic efficiency estimates derived from Stochastic Production Frontier (SPF) were regressed, using a censored Tobit model on the following farm-specific explanatory variables that might explain variations in production efficiencies across farms. The rationale behind using the Tobit model was that there were a number of farms for which efficiency was one and the bounded nature of efficiency between zero and one (Jackson and Fethi, 2000).

RESULTS AND DISCUSSION

Descriptive Statistics Results

Before embarking on presenting and discussing the results obtained from the econometric models, it is important to briefly describe the socio-economic, demographic and institutional variables using descriptive statistics. This would help to draw a general picture about the study area and sampled households.

Fertilizers and seed: Fertilizers and seed were other major factors of production that were used in the study areas. The result of the survey indicated that the majority (89.5%) of the sample HHs use organic fertilizers. Regarding seed, of the total sample household majority (78%) of the sample household used improved seed and only 22% of the sample household used the existing local variety of coffee (Table 3).

Major crops production and their area coverage

The study areas are well known for its crop production. The major crops grown in the areas includes coffee, maize, teff, sorghum and barley. On average, sampled households allocated 2.29 hectare (28.76%) of the land for coffee production. Next to coffee, maize, teff and sorghum were crops that took the lion’s share of the farmer`s total cultivated land covering 1.96, 1.36 and 1.25 ha of land, respectively. Table 4 also demonstrates the average production of major crops in quintals. Given the difference in productivity among crops, sampled farmers on average got 25.35 quintals of maize, which is 27.80% of the total major crop production. The total average production of coffee was 17.87 quintals, which was 19.60% of the total major crop production. Sampled households on average also got 18.62, 18.23 and 11.12 quintals of barley, sorghum and teff respectively.

Production constraints

Crop diseases, insect-pests and seed shortage were the major production problems that farmers were facing in the study areas. Moreover, about 28%, 17.5% and 16.5% of the sample households were facing problems of crop disease, insect-pests and seed shortage respectively. Animal and labor shortage during peak agricultural production seasons was another constraint in the study areas. Besides, they also agreed that there were other constraints like timely unavailabity of inputs (Table 5).

Summary of variables used in the model

The production function for this study was estimated using five input variables. To draw some conclusion about the distribution and level of inputs, the mean and standard deviation of input variables have been discussed as follows:

On average, farmers got 17.87 qt of coffee, which is the dependent variable in the production function. The land allocated for coffee production by the sampled farmers during the survey period ranged from 0.5 to 10 ha with an average of 2.29 ha. The other very important variable, out of which production is impossible, is seed. The amount of seed that sampled households used were 0.98 Kg, on average. Like other inputs, human labor was also decisive. Sampled households, on average, used 40.55 man equivalent labors for the production of coffee during 2015/16 production season. In the study areas, farmers also used inorganic fertilizers for coffee production. On average, farmers used 28.26 kg of inorganic fertilizers for coffee production.

Fifteen variables were hypothesized to affect efficiency of coffee producers, of which six of them were dummy variables. Table 6 illustrates summary of these variables.
Education level of the household heads measured in years of schooling indicated that the average level of education was less than grade four (Table 6). The range in level of education varies from zero (referring to illiterate) to grade 12. Sampled households, on average, invest 27, 391.73birr/year for household consumption and other related costs. Sampled households, on average, travel 2.65km to reach their coffee farm. Out of the total respondents, 65% of them reported that they had an access to credit for coffee production during the survey period. About 52% of the sampled farmers reported to earn off/non-farm income. Similarly, 86.5% of the sample farmers reported that their land was fertile in their perceptions. It was also observed that sample farmers, on average, had 11.32 contacts with extension agents.

Econometric Results

The stochastic production frontier was applied using the maximum likelihood estimation procedure. The dependent variable of the estimated production function was coffee output (qt) produced in 2015/16 production season and the input variables used in the analysis were area under coffee (ha), labor (man-days in man-equivalent), quantity of seed (kg) and inorganic fertilizers (Kg). To include those farmers who did not apply inorganic fertilizers in the estimation of the frontier a very small value that approaches zero was assigned for non-users of fertilizers, to estimate their outcomes.

Prior to model estimation, a test was made for multicollinearity among the explanatory variables using the Variance Inflation Factor (VIF). In a production function analysis, correlation between some of the explanatory variables was expected and collinearity among economic variables was an inherent and age-old problem leading to problems of multicollinearity. Some, therefore, have suggested that multicollinearity is not necessarily a problem unless it is very high (Gujarati, 1995). However, the values of VIF for all variables entered into the model were very low and below 10, which indicated the absence of severe multicollinearity problem among the explanatory variables. In addition, Breusch-Pagan test was also used to detect the presence of hetroskedasticity and the test result indicated that there was no problem of hetroskedasticity (P-value=0.3430) in the models.Durbun-Wu-Hausman chi-square test by estatendog Stata command was used to test the endogeneity of the variables family size and total cultivated land. The test result indicated that there was no problem of endogeneity ($\chi 2$ =0.52201, P-value = 0.3210) in the models.

The result of the model showed that labou(MD) is the only input variable in the production that had a positive and significant effect on the level of coffee output. The coefficients of the production function are interpreted as elasticity. Hence, positive elasticity of output to labor (0.0004) suggests that coffee production was relatively sensitive to labor (MD).

The returns to scale analysis can serve as a measure of total factor productivity (Gbigbi, 2011). The coefficients were calculated to be 0.8474, indicating decreasing returns to scale (Table 11). This implies that there is still a potential for coffee producer farmers to continue to expand their production because they are in the stage II of production. In other words, a percent increase in all inputs proportionally will decrease the total production by 0.8474 percent. This result is consistent with Gbigbi (2011).

The dual frontier cost function derived analytically from the stochastic production frontier shown in Table 7 is given as:

$$\ln C_i = 8.1753 + 0.0832 \ln Y_i^* - 0.0699 \ln \omega_{land} - 0.7250 \ln \omega_{seed} + 0.0041 \ln \omega_{Inorgfertilizers} + 0.1316 \ln \omega_{labour}$$

Where C is the minimum cost of production of the i[th] farmer, Y^* refers to the index of output adjusted for any statistical noise and scale effects and ω stands for input prices.

Test of hypothesis

Before proceeding to the estimation of the parameters of the model from which individual level efficiencies were estimated, it is essential to examine various assumptions related to the model specification. To do this, two hypotheses were tested. The first test was to examine whether the average production function (without considering the non-negative random error term) best fits the data so as to verify whether there exists considerable inefficiency among farmers in the production of coffee in the study area. The other hypothesis that was tested was that all coefficients of the inefficiency effect model were simultaneously equal to zero (i.e. H_o: = $\delta_0 = \delta_1 = \delta_2 \ldots = \delta_{15} = 0$). In other words, it was to check whether the explanatory variables in the inefficiency effect model contribute significantly to the technical inefficiency variations among coffee growing farmers. Generally the log likelihood form can be defined as:

$$\lambda = -2[\log L(H_0) - \log L(H_a)]$$

Where, L (Ho) and L (Ha) are the values of the log-likelihood function under the null and alternative hypotheses, Ho and Ha, respectively.
The likelihood ratio test static obtained from the log likelihood functions of both the average response function and the stochastic production function was found to be greater than the critical value. Hence, the null hypothesis that the average response function (OLS specification) is an adequate representation of the data was rejected and the alternative hypothesis that stated there exists considerable inefficiency among sample farmers was accepted.

The other hypothesis was also tested in the same way by calculating the likelihood ratio value using the value of the log likelihood function under the stochastic frontier model (without explanatory variables of inefficiency effects (H_0) and the full frontier model with variables that are supposed to determine inefficiency level of each farmer (H_1). The λ value obtained was again higher than the critical χ^2 value at the degree of freedom equal to the number of restrictions. As a result, the null hypothesis is rejected in favor of the alternative hypothesis that the explanatory variables associated with inefficiency effects model are simultaneously different from zero. Hence, these variables simultaneously explain the differences in inefficiency among farmers. The model parameters were analyzed using STATA version 13 by employing a two-stage estimation procedure. In using the two-stage estimation procedure of efficiency level and factors determining it, the efficiency index was estimated by frontier in the first stage, then regressed against a number of other farm specific and socio-economic variables affecting efficiency index in the second stage.

Efficiency scores

The model output presented in Table 8 and 9 indicates that farmers in the study area were relatively good in TE than AE or EE. The mean TE was found to be 71.71%. It indicated that farmers on average could decrease inputs (land, labor and fertilizers) by 28.29% if they were technically efficient. In other words, it implied that if resources were efficiently utilized, the average farmer could increase current output by 28.29% using the existing resources and level of technology. Similarly, coffee producer farmers can save 85.87% of their current cost of inputs by behaving in a cost minimizing way. Conversely, EE of 10.12% prevails that an economically efficient farmer can produce 89.88% additional coffee.

In another form of analysis, the mean economic efficiency also showed that there was a significant level of inefficiency in the production process. That is the producer with an average economic efficiency level could reduce current average cost of production by 89.88% to achieve the potential minimum cost level without reducing output levels. It can be inferred that if farmers in the study area were to achieve 100% economic efficiency, they would experience substantial production cost saving of 89.88%. This implied that reduction in cost of production through eliminating resource use inefficiency could add about 89.88% of the minimum annual income.

The distribution of the TE scores showed skewed distribution to the right. The majorities (more than 75%) of the sampled households have TE score greater than 60. Nevertheless, there were also farmers whose TE levels were limited to the range 20% to 50% only. Farmer in this group has a room to enhance their coffee production at least by 50%, on average. Out of the total sample, only 10.5% of the farmers have TE of greater than 90% and 16.5% was operating below 50% of technical efficiency level. This implies that 89.5% of the farmers can increase their production at least by 10%. The result indicated that the potential to improve coffee productivity for individual farmers through improvement in the level of TE is the smallest as compared to AE and EE. Technical efficiency estimate is low compared with the results obtained by Jema (2008), Kaur *et al*. (2010),Dindigul (2011) and Essa (2011). However, high technical efficiency estimates according to Coelli *et al*. (1998) might also be related to the higher number of input-output variables. According to them, the higher the number of input-output variables, the higher the chance for the efficiency estimates to be biased upwards.

Determinants of efficiency differential among farmers

After determining the presence of efficiency differential among farmers and measuring the levels of their efficiency, finding out factors causing efficiency differentials among farmers was the next most important objective of this study. To see this, the technical, allocative and economic efficiency estimates derived from the model were regressed on socio-economic and institutional variables that explain the variations in efficiency across farm households using Tobit regression model. Table 10 illustrates the socio-economic and institutional factors that affect efficiencies in coffee production.

The estimates of the Tobit regression model showed that among 15 variables used in the analysis, age of household head, family size and access to credit were found to be statistically significant in affecting the level of TE of the farmers.

The model also revealed that age of household head and family size were important factors that influence allocative efficiency of farmers in the study area (Table 11). It also further revealed that among 15 variables used in the model, age of household head, land fragmentation and total area were found to be statistically significant in affecting the level of EE of the farmers.

Total Area: Total farm area was found to have significant and negative impact on EE at five percent significant level, which is in line with the hypothesis made. Even though it contradict with the argument of Andreu (2008), it might be because of farmers with larger area of land may face difficulty in managing that farm. Because of this, it could d-ecrease the efficiency of the farmer. Therefore, larger farms are relatively less efficient than small size farms.

Land fragmentation: The coefficient of land fragmentation for economic efficiency is negative and statistically significant at 5 percent. The result also confirms with the previous expectation, because fragmented land leads to inefficiency by creating shortage of family labor, wastage of time and other resources that should been available at the same time. Moreover, as the number of plots operated by the farmer increases, it may be difficult to manage these plots. In the study area land is fragmented and scattered over different places. Thus, farmers that have large number of plots may waste time in moving between plots. The result is in line with the finding made by Mustefa (2014) and Fekadu (2004).

FAMSIZE(MD):.The coefficient of family size for technical efficiency is positive and statistically significant at 5 percent significance level. The result is similar to the previous argumentation. It shows that farmers those having large family size are more efficient than those with small family size, because; family labor is the main input in crop production as the farmer has large family size he would manage crop plots on time and may able to use appropriate input combinations. This is in line with the findings of Mohammed *et al.* (2009), Essa (2011) and Oluwatusin (2011). In similar manner, the coefficient of family size for allocative efficiency is also positive and statistically significant at 1 percent. This might be because farmers with large family size had better capacity for optimal allocation of resources. This result is in line with the results of Okoruwa *et al.,*(2006).

Access to credit: The results also indicated that access to credit had a positive and statistically significant effect on technical efficiency at ten percent significant level. Credit availability shifts the cash constraint outwards and enables farmers to make timely purchases of those inputs that they cannot provide from their own sources. The result is in line with the arguments of Amadou (2007), Nyagaka *et al.* (2009) and Jude *et al.* (2011).

Coping Mechanism for inefficiency of coffee production

The study reveals that the coffee farmers and farms are inefficient in technical, allocative and economic efficiencies. The causes for this are inefficient are also identified. These are for the production function the dominant factor is human labor. For the technical efficacy, the determinant factors are age of the household, family size and credit access. For Allocative efficiency, the determinant factors are age of the household and family size. For economic efficiency, the determinant factors are age of the household, farmland fragmentation and total coffee land. Therefore, to decrease the inefficiencies of coffee production the following are some of the coping mechanism.

1. Since age of the household have positive relation with TE, AE and EE giving training for new coffee farmers on resource allocation is paramount important.
2. Family size has positive relation with TE and AE. Thus, using hires labor can reduce the level of inefficiencies of coffee producers.
3. Reducing farm fragmentation, improving the accessibility of rural finance and having medium coffee farmland can prevent inefficacy of the farmers.

CONCLUSSION

This study was undertaken with the objective of assessing the economic efficiency of coffee producers in IluAbbabor Zone of Oromia National State of Ethiopia. The study employed the stochastic frontier approach and both primary and secondary data were used. The Cobb-Douglas stochastic frontier production and its dual cost functions were estimated from which TE, AE and EE estimates were extracted. The positive coefficients of the labor indicate that increased use of labor inputs will increase the production level to a greater extent. The study also indicated that 71.71%, 14.13% and 10.12% were the mean levels of TE, AE and EE, respectively. This in turn implies that farmers can increase their coffee production on average by 28.29% when they were technically efficient. Similarly, they can reduce current cost of inputs, on average, by 85.87% if they were allocative efficient. In the other part of the analysis, relationships between TE, AE, and EE, and various variables that were expected to have effect on farm efficiency were examined. This was relied on Tobit regression techniques, where TE, AE, and EE were expressed as functions of 15 explanatory variables. The model also indicated that age of household head; land fragmentation and total area were important factors that affect economic efficiency of farmers in the study area.

According to the finding of this study, farmers producing coffee can increase their production at the existing level of technology and inputs through improving efficiency. Moreover, the study stresses the need for appropriate policy formulation and implementation, which enables farmers to reduce their inefficiency in production as this is expected to have multiplier effects ranging from farm productivity growth to economic growth and poverty reduction at macro level.

Finally, it is interesting to note that most efficiency studies in the developing countries have focused mainly on the measurement of technical efficiency, even though it is by improving the overall economic efficiency that major gains in production could be achieved.

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APPENDIX

Table 1. Total number of sample household heads

Districts	Total household heads	Sample
Mettu	25225	35
Bedele	21354	35
Chora	21042	35
Didesa	20437	33
Hurumu	19298	32
Gore	18896	30
Total	**126,252**	**200**

Table 2. **Land distribution and farming characteristics of sampled households**

Variables	Minimum	Maximum	Mean	Std. Deviation
Total cultivated land (ha)	1	17.5	4.56	3.12
Home to farm distance(Km)	0.02	5	2.65	1.31
The number farm plots at various locations (Number)	1	3	1.24	0.53
Farming experience (years)	3	61	27.87	9.66
Coffee production experience (Years)	2	35	21.04	8.00

Table 3. **Fertilizers and seed used by the sample households**

Inputs	Category	Number	Percent
Fertilizers	Organic	186	89.5
	Inorganic	21	10.5
Seed	Local	44	22
	Improved	156	78

Table 4. **Major crops produced by sampled farmers by production and area coverage**

Crop type	Area allocated (ha)		Production (Qt)	
	Mean	Percent	Mean	Percent
Coffee	2.29	28.76	17.87	19.60
Maize	1.96	24.62	25.35	27.80
Teff	1.36	17.10	11.12	12.19
Sorghum	1.25	15.70	18.23	20.00
Barley	1.10	13.82	18.62	20.41

Table 5. **Agricultural production constraints**

Major constraints	Number of farmers	Percent
Weed infestations	14	7
Crop diseases	56	28
Pests	35	17.5
Seed shortage	33	16.5
Animal shortage	19	9.5
Labour shortage	12	6
Climate	9	4.5
Others	22	11
Total	200	100.00

Table 6. **Summary of variables used to estimate the production function**

Variable	Mean	Std. Dev.	Min	Max
Output (qt)	17.87	5.27	9.00	41.00
Inorganic fertilizers (kg)	28.26	36.52	0.00	100.00
Seed (kg)	0.98	0.05	0.8	1
Labour (MD)	40.55	9.62	25.00	50.00
Land (ha)	2.29	2.04	0.5	10.00

Source: model output

APPENDIX

Table 7. Summary of efficiency model variables

Variables	Mean	Std. Deviation	Percentage of the mean with Dummy=1	Percentage of the mean with Dummy = 0
Age (years)	46.18	10.75	-	-
Education (years of schooling)	3.01	3.52		
Total cultivated land (ha)	4.56	3.12	-	-
Family size (MDs)	5.45	3.37	-	-
Land fragmentation (Number)	1.24	0.53	-	-
Distance of the farm (Km)	2.65	1.31	-	-
Livestock (TLU)	6.91	5.42	-	-
Total expenditure (Birr)	27391.73	12858.51		
Extension contact	11.32	10.07	-	-
Training	-	-	71.5	28.5
Technology adoption			78	22
Credit	-	-	65	35
Off/non-farm income	-	-	52	48
Sex of farm household head	-	-	92.50	7.50
Fertility	-	-	86.5	13.5

Table 8. **Estimates of the Cobb Douglas frontier production function**

Variables	**Coefficients**	**Std. Err.**	Elasticities	**Variables**
Ln(Inorganic fertilizers)	0.0152	0.0146	0.0152	Ln(Inorganic fertilizers)
Ln (Seed)	0.9071	0.5151	0.9071	Ln (Seed)
Ln(Land)	-0.0753	0.0465	-0.0753	Ln(Land)
Ln (Labour)	0.0004 ***	0.0503	0.0004	Ln (Labour)
Constant	2.819	0.1512		Constant

*** show significance at 1% probability level Source: model output

Table 9. **Summary statistics of efficiency measures**

Type of efficiency	Minimum	Maximum	Mean	Std. Deviation
TE	0.20	0.96	0.7171	0.1713
AE	0.10	0.30	0.1413	0.0641
EE	0.03	0.27	0.1012	0.0522

Source: model output

Table 10. **Generalized likelihood ratio tests of hypothesis for the parameters of SPF**

Null hypothesis	λ	Critical value (χ^2, 95%)	Decision
H_0: $\gamma = 0$	12.21	9.488	Rejected
H_0: $= \delta_0 = \delta_1 = \ldots = \delta_{15} = 0$	38.21	24.996	Rejected

Source: model output

APPENDIX

Table 11. **Tobit model estimates for different efficiency measure**

Variables	**TE**		**AE**		**EE**	
	Marginal Effect	Stad.Err.	Marginal Effect	Stad.Err.	Marginal Effect	Stad.Err.
Sex	0.0873	0.0631	-0.0586	0.0193	-0.0284	0.0166
Age	0.0001*	0.0011	0.0000*	0.0003	0.0001*	0.0003
Education	0.0017	0.0035	-0.0014	0.0011	-0.0009	0.0009
EXTCT	0.0011	0.0011	-0.0005	0.0004	-0.0002	0.0003
LANDFRAG	-0.0236	0.0280	0.0033	0.0085	-0.0002**	0.0073
PDistance	0.0204	0.0094	0.0006	0.0028	0.0027	0.0025
FAMSIZE(MD)	0.0001**	0.0034	0.0000***	0.0010	0.0002	0.0008
TOtarea	-0.0100	0.0041	0.0018	0.0012	-0.0001**	0.0011
TLU	0.0034	0.0027	-0.0010	0.0008	-0.0002	0.0007
FERT	0.0598	0.0611	-0.0348	0.0186	-0.0347	0.0161
Techno	-0.0873	0.0606	-0.0243	0.0184	-0.0292	0.0159
OFARM	0.0490	0.0415	-0.0958	0.0127	-0.0609	0.0109
Training	-0.0439	0.0636	0.0313	0.0193	0.0185	0.0167
Credit	0.0060*	0.0505	0.0887	0.0154	0.0614	0.0133
Tspending	-0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Constant	0.7455	0.0862	0.2278	0.0264	0.16702	0.02265

Where: *, ** and *** refers to 10%, 5% and 1% significance level, respectively.
Source: Model output