TECHNICAL EFFICIENCY OF SMALLHOLDER COFFEE PRODUCER IN MANA WEREDA JIMMA ZONE

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DECLARATION

I,AshebirSeifu,declare that this proposal thesis work entitled "Technical efficiency of smallholder coffee producers in ManaWoreda, JimmaZone,Ethiopia" is my own original work.I have carried out it independently with the guidance and suggestions of the research Proposal advisor.And it has not been presented in Jimma University or any other University and that all sources of materials used for the study have been duly acknowledged.

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ABREVIATIONS

AE	Allocative Efficiency
CC	Coefficient of Contigency
CSA	Central Statistical Authority
DEA	Data Envelopment Analysis
EE	Economic Efficiency
EEA	Ethiopian Economic Association
FGD	Focus Group Discussion
Ha	Hectare
Kg	Kilogram
LR	Likelihood Ratio
MLE	Maximum Likelihood Estimation
NBE	National Bank of Ethiopia
Qt	Quintal
RE	Revenue Efficiency
SPF	Stochastic Production Frontier
TE	Technical Efficiency
VIF	Variance Inflation Factor

Abstract

Coffee production in Ethiopia is a longstanding tradition that dates back dozens of centuries.Ethiopia is where the coffee Arabica plant originates.The Central Statistical Agency (CSA) reported that 26,743 tons of coffee were produced in JimmaZone,based on inspection records from the Ethiopian Coffee and Tea authority. This represents 23.2% of the Region's output and 11.8% of Ethiopia's total output. Even though coffee is the mainstay of the Ethiopian economy and several millions of people in the country, as well as familiar in the study area since the time of its discovery, its full productive capacity has not been exploited yet. Furthermore, researchers conducted on the Economic efficiency analysis of smallholder coffee producers also scarce in the study area. Accordingly, this study wasconducted to estimate the economic efficiency analysis of the coffee production of smallholder coffee farming 372 sampled farmer in the Jimma zone, based on the primary data by random sampling coffee farmers using cross-Sectional method through interview questioners. The data was analyzed using descriptive as well as econometric regression analysis. In econometric analysis Education and family size affects the technical inefficiency of coffee production significantly and positively at 5% and 1% level of significance. Also not to use chemical illustrates that it is significant (at 5 % probability level) and had a positive relationship with the probability of improving farmers income. The cobb-goudas' production model result shows the locative efficiency affected by log of farm area and log of labor participated in farming of household proxies by family size is about 30 percent of total production. The results of production efficiency was used the parametric stochastic production frontier (SPF), model and the result shows the inefficiencies in the production technique is about 10 percent of the unexplained part.Socioeconomic factors that affect the technical efficiency of smallholder coffee farming was SEX of house hold head. Age, education level, access to financial credit, land fertility, distance from farm land, distance to primary market area. All variables are significant at below 5 percent level of significance except level of education.The study recommends that all factor that affect both allocative and technical efficiency variables need attention in case improvement will be evitable. Further investigation on unexplained part recommended to be studied.

Keywords*:Coffee Farming, Economic Efficiency, Production,Small Holders*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

The second biggest commodity that was traded in the world is coffee (ICO 2018). It plays a vital role on the livelihoods of above 25 million small holder's farmers. These farmers produce 80 percent of the world's coffee production(USDA,2019/2020)**.**Global coffee production represented in 2016 an area of almost 11 million hectares(10,975,184) and a total production of 922,534 green coffee tons(FAO 2018).Despite the fact that coffee is grown in more than 70 countries,(Lowder etal.2016) over 73 per cent of the world's coffee is produced only by just five of them Brazil, Vietnam, Colombia, Indonesia, and Ethiopia. Brazil has long been by far the world's largest coffee producer, growing about 60.5 million bags in the year 2019/2020. Vietnam is next (31.3 million bags) followed by Colombia (14.4 million bags), Indonesia (10.7 million bags), and Ethiopia (7.345million bags) (USDA,2019/2020). At the recent time the main coffee importing and consuming markets in Europe, North America, and Asia are in the middle of the COVID-19 crisis. Governments have imposed measures, like social distancing and lockdowns, which have had a huge impact on coffees, micro-roasters, restaurants, and other out-of-home outlets. However, the current trend toward online shopping for at-home consumption is forcing retailers, roasters, and consumers to adapt to this new reality (ISAC,2019).

African is the cradle of coffee and is a producer of some of the best coffee in the world.(Thomas,2018/2019). African countries like Ethiopia and Uganda are significant coffee producers, but have faced constraints to increasing production due to lack of capital and extension service support(Gro Intelligence,2018). However, domestic demand, farmer support programs, and farmer training are increasing. If those countries can boost their market profiles and shore up their finances by targeting niche consumers in wealthier countries, they could be better prepared to profit at times when other producers have occasional lapses in production.

As the birthplace of coffee Arabica, Ethiopia is still a major producing country of high-value coffee. In Ethiopia, coffee is produced under four major production systems, i.e. forest coffee (8-10 percent), semi-forest coffee (30-35 percent), cottage or garden coffee (50-57 percent) and modern coffee plantations (5 percent). It has accounted, on average, for about 5 percent of gross domestic product (GDP), and 10 percent of total agricultural production in 2011.Ethiopia regained the No. 5 spot in the 2018/2019 year and is produced 7.3 million 60-kilogram bags. The country produced around 5 percent of world production and 39 percent of the total production of coffee in Sub-Saharan Africa (MoT, 2019/2020).

Measuring efficiency level of farmers benefit economies by determining the extent to which it is Possible to raise productivity by improving the neglected source of growth(efficiency) with the existing resource base and available technology. These have been various empirical studies conducted to measure technical efficiency in Ethiopia(Anbese 2020;Jules and Aeung2019;Hassen 2016;Berhan 2015)

In Ethiopia, the agricultural sector plays an important role in the economy and is an essential source of food, employment, and income. Improving production efficiency is one way of satisfying the growing domestic food demand (Endeshaw,2019). There is considerable room to increase domestic food supplies by improving management practices using existing inputs and technologies. Key factors for improving production efficiency in Ethiopia include factors that can be influenced by the market, the government, and farmers. Farm size, land quality, land fragmentation, age, education, family size, crop share, credit, extension service, and off-farm participation are the main factors affecting technical efficiency among smallholder Ethiopian farmers. The government can influence education and family size in the long run, and changes in crop shares, credit, extension service, off-farm participation, and technology use are quite rapid.(Anbese,2020).Therefore, policies and strategies aimed at improving education, extension, credit, and input supply systems will help raise the technical efficiency and productivity of farmers. (Anbese,2020).

According toMustafa et al., 2020. Studies on Economic Efficiency of Coffee Production,a trans log 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 result of the model showed that labouris the only input variable in the production that had a positive and significant effect on the level of coffee output. 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. 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. Finally, the findings prove that further productivity gains linked to the improvement of technical efficiency at the existing level of technology and inputs may still be realized in coffee production in Ethiopia

According to a research by (Dani et al., 2017), there are several factors which influence production of coffee in TemanggungDistrict,Indonesia such as land area, number of labor, number of coffee plants, use of fertilizer, and coffee plant age. Technical efficiency of the Arabica coffee cultivation in Panti Sub-district, Jember, was 71.4% meaning that there was still less than 30% of potential production which could still be acquired by applying the combination of labor force, inorganic and organic fertilizer applications.

Production inefficiency primarily harms the income of coffee farmers and other actors along the coffee supply chain and discourages the production of coffee; and secondly it also significantly decreases the country's foreign exchange earnings (which is an important asset the country extremely needs) obtained from coffee production and trading. Generally, in the case of Ethiopia, there are limited number of studies on economic efficiency analysis of smallholder coffee producer (Mustefa et al.,2017) which focused on technical efficiency of production. Even if technical efficiency being one component of economic efficiency, it may not provide plenty of information for decision makers and policy intervention at zonal and district level. Therefore, this study had analyzed the allocative and overall efficiencies of production and identifies factors causing inefficiencies of smallholder coffee producers. Particularly, in Manawereda, coffee is a major production item and it takes the lion share in terms of the income share , number of producers and area coverage relative to other major products in the wereda. However, its production was owned by small holder, a farmer which produces only to survive their hand to mouth livelihood. Therefore, it is crucial to increase their efficiency and volume of production to gate enough income and change their life. This suggests that it was very crucial to study and identify factors contributing to the economic inefficiency of smallholder coffee growers with a view to improve their economic efficiency. Therefore, the present study wasintended to examine the level and determinants of economic efficiency analysis of smallholder coffee producers in ManaWoreda, Jimma Zone, Ethiopia.

1.2. Statement of the problem

In Ethiopia, coffee is the most popular and widespread cash crop in several parts of the regional states. It provides cash income throughout the year and its transportability favors even the outlying communities. However, coffee production is inefficient and not as remunerative as it could be (Mustefa et al,.2017).

A major challenge confronting coffee farmers is on how much to increase production efficiency among smallholder coffee growers, both to meet growing demand for consumption and to offset yield losses due to production inefficiency. Moreover, production is characterized by limited use of fertilizers and pesticides with manual cultivation and drying processes (GAIN, 2017/18). According to the same report, production per hectare is low, with limited specialized government institution providing extension support for coffee production.

Smallholder coffee growers in south-western coffee growing areas of Ethiopia face various problems at production, processing, and marketing. The problems most commonly referred to include the high incidence of Coffee Berry Disease (CBD), with great impact making the production potential at risk; shortage of improved cultivars adapted to different localities; poor harvest and post-harvest practices reducing coffee quality; and weak linkages between research, extension services and producers (Taye, 2008). Moreover, challenges with quality control, incidence of smuggling and high transaction costs, and/or inadequate coordination between firms are highly threatening coffee transaction arrangements and the national GDP.

Many studies had been carried out with the view to inform future policy prescriptions, but majority of them was focused on issues related to coffee export and marketing performance (Zekarias et al., 2012; Boansi and Crentsil, 2013), price transmission (Worako et al., 2008), commercialization of agriculture in coffee growing areas (Gebreselassie and Ludie, 2008) and marketing and trading policies (ICO, 2010). However, in-depth literature on Ethiopia’s coffee sector is scarce, if not non-existent, except for a few consultancy reports for donor-funded projects.

Study conducted by Mustefa et al., 2017 which worked on Economic Efficiency of Coffee Production in Ilu Abbabor Zone, Oromia Region, Ethiopia indicated that 71.71%, 14.13% and 10.12% were the mean levels of TE, AE and EE, respectively. 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 study have a gap to consider the variable Perception of agricultural policy and Distance to the nearest market which have the significant effect on the efficiency of the farmers.

Enhancing the lion's share of foreign currency from coffee in Ethiopia, can be attained by improving the productive efficiency of coffee growers, that is, their ability to derive the greatest amount of output possible from a fixed quantity of inputs. In fact, the presence of shortfalls in efficiency means that output can be increased without requiring additional conventional inputs or new technologies. If this is the case, then empirical study on coffee growers' economic efficiencyanalysis and its determinants are vital in order to determine the magnitude of the gain that could be obtained with a given technology, inputs, institutional and marketing arrangements. Given the impetus of the coffee sector to the Ethiopian economy and all the efforts the government has put in place to reform the sector, there exists a strong case to assess Economic efficiency analysis of smallholder coffee growers in south-western Ethiopia, known with organic coffee production in the country. To this end, the study was strives to bridge the existing knowledge gap on identifying the determinants of economic inefficiency of coffee production and exerts possible solution to mitigate the existing inefficiency to be efficient both in production and turn over per hectare in the study area. Due the above possible problems the paper was rise the following question as an indicator which had a directive to give solution for the farmers and source of literature for policy makers.

1.3. Research Questions

The present study attempts to address the following key research questions:

- What is the level of Economic efficiency of smallholder coffee growers?
- Is there any room for improvement in the level of efficiency?
- What are the sources of Economic efficiency differentials among smallholder coffee growers in the study area?
- What are the main possible solutions to reduce the existing level of inefficiencies?

1.4. Objectives of the Study

1.4.1. General Objective

To find out the determinant factors on economic efficiencyon smallholder coffee growers in ManaWoredaJimma ZoneEthiopia.

1.4.2. Specific Objectives

The specific objectives of the study were:

- To measure the economic efficiency of smallholder coffee growers
- To identify the determinants of economic inefficiency of smallholder coffee growers

1.5. Significance of the Study

While knowing factors that determine the economic inefficiency of smallholder coffee growers has advantage to derive the greatest amount of output possible from a fixed quantity of input/without requiring additional conventional input or new technologies. So this research enables us knowing this socio-economic and institutional factors so as to improve efficiency of smallholder coffee producers, improve livelihood of the community and as well as quality and quantity.

The outcome of efficient coffee farmers has advantage by giving baseline information which used for farmers, policy makers and planers in design and implementation of efficient coffee farming management and for conducting research purposes for better coffee production and productivity. So the outcome of this research gives this all information.

1.6. Scope and Limitations of the Study

This study was conducted microeconomic analysis based on data collected using cross-sectional survey of coffee growers in Jimma zone Mana Woreda, Ethiopia. Actually the findings were pertinent mainly to the study areas; but also may be extended to other areas with similar socio-economic and agro-ecological characteristics. More importantly, further studies require large and rich dataset, such as time series or panel dataset, and more coffee growing sample woredas from other Zones would not be covered in the present study due to time and budget constraints. Moreover, since coffee is a perennial crop where harvesting takes place 4 or 5 years after the tree is planted, it has been difficult to get cost data until the harvest time.

1.7. Organization of the Research

The whole paper was organized in five chapters, chapter one includes introduction, statement of problem, research questions, objectives, significance of the study and the scope and limitation of the study, Chapter two presents review of literature on the concepts of efficiency in general and the various methodological issues concerning efficiency measurements and its determinants in particular.Chapter three presents the methodology used in the study.It includes description of the study area,sources of data and sampling design. Moreover, the econometric model and the variables definition are also briefly illustrated. Following this, chapter four focuses on econometric model results presented, narrated and discussed in comparison with other similar studies. Chapter five gives summary, conclusion and recommendation of the study.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Theoretical Literature

Many scholars use productivity and efficiency interchangeably and both are considered as the measure of performance of a given firm. However, these two interrelated terms are not precisely the same (Coelli*et al.*, 1998).Efficiency is the ability of a firm to produce the maximum level of output possible from a fixed amount of inputs. Productivity on other hand shows the ability of the farmer to produce a given output (it may not be the maximum possible output) at a given level of input. Hence, productivity does not show the relative performance of farmers in getting the maximum possible output given input level.

2.1.1. Concept ofEfficiency in Production

The area of efficiency analysis has become the central issue of performance analysis since the groundbreaking works of Farrell in1957. Accordingly, efficiency has two components. These are technical efficiency (TE) and allocative efficiency (AE). Technical efficiency is defined as the ability of a firm to produce a maximum level of output from a given level of inputs and technology. In other words, given the technology, TE is the ability of a household to produce on the production frontier. Any feasible points below the frontier line are all technically inefficient. However, technical efficiency accounts for only physical inputs and outputs and does not account for the price of inputs and outputs, which deals with allocative efficiency. Allocativeefficiency (AE) is the ability of a firm to produce a given level of output using cost-minimizing input ratios. The combination of these measures results in the level of economic efficiency (Coelli, 1995).

2.1.2. Approach to Efficiency Measurement

There is two approaches to measuring the efficiency of agricultural production. These are input-oriented and output-oriented measures.

2.1.2.1. Input-Oriented efficiency measures

The input-oriented measure deals with the question "by how much can input quantities be proportionally reduced without changing the output quantity produced". In other words, an input-oriented measure of efficiency means the minimum amount of input required to produce a given amount of output. An input-oriented measure of efficiency keeps the level of output constant.Input-oriented measure of efficiency keeps the level of output constant. Farrell (1957) in his work of efficiency explains the input-oriented measure of technical and allocative efficiency by taking firms that uses two inputs (X_1 and X_2) to produce single output Q under the assumption of constant return to scale. The assumption of constant return to scale allows the technology to be represented using the unit of isoquant. Farrell also discussed the extension of his method so as to accommodate more than two inputs, multiple outputs and non-constant return to scale.

Knowledge of the unit of isoquant of fully efficient firms represented by SS' in figure 1 below permits the measurement of technical efficiency. If a given firm uses quantity of inputs, defined by point P, to produce a unit of output Q, the technical inefficiency of that firm could be represented by the distance QP, which is the amount by which all inputs could be proportionally reduced without reduction in output. This is usually expressed in percentage terms by the ratio QP/OP, which represents percentage by which all inputs need to be reduced to achieve technically efficient production. The technical efficiency of a firm is most commonly measured by the ratio. TE= OQ/OP, which is equal to 1-QP/OP. It takes a value between zero and one and hence, provides an indicator of the degree of technical efficiency of the firm. A value of one implies that the firm is fully technically efficient and a value of zero implies that the firm is fully technically inefficient. These measures can be equivalently defined for the non-constant return to scale by adjusting the input level and assuming that isoquant represent the lower bound of the input set associated with the production of particular level of output. These efficiency measures assume that the production technology is known. In practice, this is not the case, and efficient isoquant must be estimated from the sample data. But identifying the production frontier is a complex problem.

In the presence of input price information, it would be possible to measure the economic efficiency (EE) of the firm under consideration. Let w represent the vector of input price and let x represent the observed vector of inputs used associated with point P. Let x' and x* represent the input vector associated with the technically efficient point Q and the cost minimizing input vector at Q', respectively. The cost efficiency of the firm is defined as the ratio of input cost associated with input vector, x and x* associated with point P and Q'. Thus, EE= w'x*/w'x=OR/OP. If input price ratio, represented by the slope of isocost line, AA' is also known, then allocative efficiency and technical efficiency measures can be calculated using isocost line. These are given by: AE= w'x*/w'x'= OR/OQ and TE=w'x'/w'x= OQ/OP. These equation follow from the observation that the distance RQ represent the reduction in production cost that would occur if production were to occur the allocatively and technically efficient point Q', instead of at the technically efficient, but allocatively inefficient, point Q.

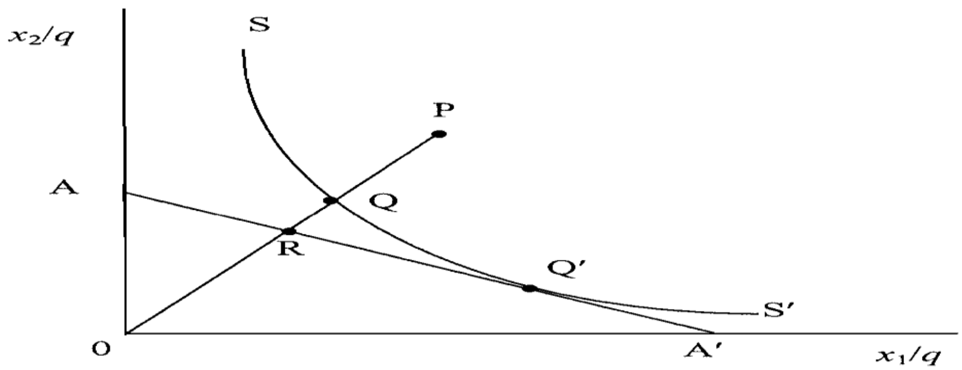


Figure 2.1:Input-oriented measure of technical,allocative and economic efficiency
Source: Coelli(1995)

2.1.2.2. Output-Oriented efficiency measures

The output-oriented measures of technical efficiency address the question: "By how much can output quantities be proportionally expanded without changing the input quantities used." This means the maximum attainable amount of output produced from a given level of vector inputs used.Output-oriented measure of efficiency keeps the level of input constant. According to Farrell (1957) in his work of efficiency explains the output-oriented measure of technical efficiency by considering the case where production involves two outputs (q_1 and q_2) and a single input (x) under the assumption of constant return to scale. In figure 2 below the curve ZZ' is the unit of production possibility and point A correspond to an inefficient firm. Inefficient firms operating at point A lies below the curve, because ZZ' represent the upper bound of the production possibilities. The distance AB represents technical inefficiency, which is the amount by which output could be increased without requiring extra input. Hence, a measure of output-oIn the presence of output price information, it would be possible to measure the revenue efficiency (RE) of the firm under consideration. Revenue efficiency can be defined for any observed output price vector p represented by the line DD'. If q, q' and q* represent the observed output vector of firm associated with point A, the technically efficient production vector associated with B and the revenue efficient vector associated with the point B’, respectively, then revenue efficiency (RE) of the firm is: RE= p’q/p’q* = OA/OC. If we have riented technical efficiency is given by: TE= OA/OB.price information we can draw the isorevenue line, DD’, and define the allocative and technical efficiency measures as follows: AE= p’q’/p’q* = OB/OC and TE= p’q/p’q’= OA/OB which has a revenue- increasing interpretation similar to cost- reducing interpretation of allocative inefficiency in the input-oriented case. Furthermore, we define overall revenue efficiency as the product of these two measures: RE= (OA/OC) = (OA/OB)*(OB/OC).

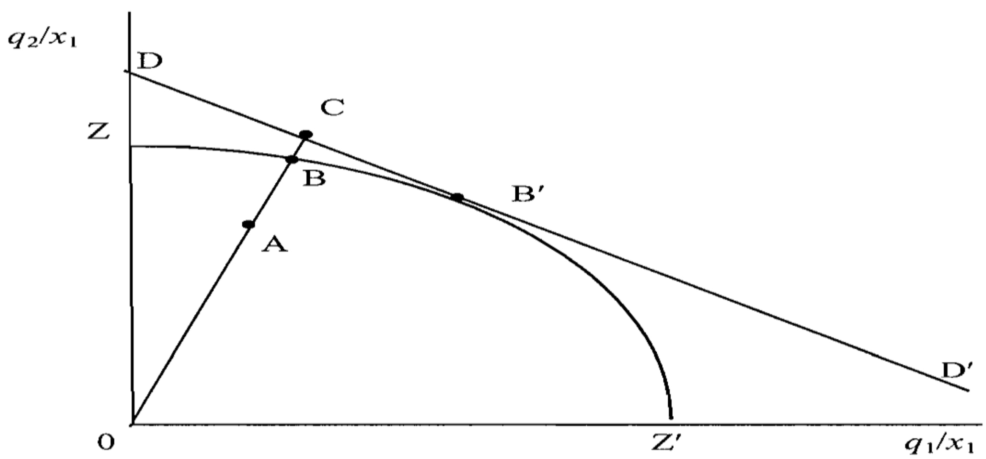


Figure 2.2:Output-oriented measure of technical,allocative and economic efficiency source et al.(1998)

2.2. Empirical Literatures

Many empirical literature showed studies of efficiency were devoted to analyzing what impact a given empirical model (specific frontier model) specification has on the efficiency measurements. Various issues about model specification were still debatable. The selection of a specific frontier model depends upon many considerations such as the type of data, cross-sectional or panel data, the underlying behavioral assumptions of firms, the relevance to consider and extent of noise in the data, and the objective of the study (Battese and Broca, 1996). Efficiency measurements are carried out using frontier methodologies which shift the average response functions to the maximum output or to the efficient firm. These frontier methodologies are broadly categorized as parametric and non-parametric frontier models.

2.2.1. Non parametric frontier model

One of the methods of measuring efficiency in agricultural production is the non-parametric approach of the data envelopment analysis (DEA). It is an evaluation method particularly adapted to comprise a set of multiple indicators into overall performance. It enables frontier estimation with the use of non-parametric programming models leading to a ranking of all unit observations based on efficiency scores. The focus is not on the estimation of an average technology production function used by all units analyzed, but to identify the best practicing units. The best-practice production frontier is constructed and all units of analysis were related to this frontier. Data envelopment analysis is based on the simple notion that an organization that employs less input than another to produce the same amount of output can be considered more efficient. The efficiency frontier is constructed of linear segments that join up those observations with the highest ratio of output to input. Also,the non-parametric frontier methodology may overstate inefficiencies and hence outliers may have a profound effect on the magnitude of inefficiency. The other disadvantage of DEA is that it is not possible to test the hypotheses regarding the existence of inefficiency and the structure of the production technology that waspossible in stochastic production frontier analysis.

2.2.2. Parametric Frontier Model

The parametric frontier model can further be classified into deterministic and stochastic frontier models. Typically, both models use econometric techniques to estimate the parameters of pre-specified functional forms. However, the deterministic model assumes that any deviation from the frontier is due to inefficiency, while the stochastic approach allows for statistical noises (such as measurement error, weather, industrial action, etc.) which are beyond the control of the decision-making unit.

Deterministic Frontier Model

The first deterministic frontier function was estimated by Aigner and Chu (1968) by assuming a function giving maximum possible output as a function of certain inputs. Accordingly, the estimation of parametric frontier production function using a Cobb-Douglas production function for a sample of N households was defined as follow:

$$\ln(Y_i) = F(X_i, \beta_i) - \mu_i i = 1, 2 \ldots N \qquad (1)$$

Where:

i −Denotes the number of sample households in the study

$\ln(Yi)$ − Denotes the natural log of the output of the ithhousehold;

X_i −Denotes a vector of input quantities used by the ithhousehold;

β_i −Denotes a vector of unknown parameters to be estimated;

$F(.)$ −Denotes an appropriate production function (Cobb-Douglas) and

μ_i −Denotes non-negative random variables which were assumed to account for inefficiency.

The main criticism of the deterministic frontier model is that it does not account for possible influence of measurement error and other noise upon the shape and positioning of the estimated frontier (Coelli*et al.*, 1998). All observed deviations from the estimated frontier are thus, assumed to be the result of inefficiency. Therefore, the method sums up all the effects of exogenous shocks together with measurement errors and inefficiency. The presence of high random errors on a data leads to exaggeration of the inefficiency estimates in deterministic model as compared to other models which takes random errors in to account.

Neff *et al*. (1993) in their comparative studies of frontier models found that deterministic frontier model generate higher inefficiency indices than stochastic frontier model. This is because the observed input and output quantities may not only deviate from some imaginary frontier through inefficient management (as in a deterministic interpretation) but also through noise.

Stochastic Frontier Model

In order to overcome the problem associated with a random error in the deterministic approach an alternative estimation method called the stochastic production frontier approach was independently developed by Aigner*et al*. (1977). Frontier production functions are important for the prediction of efficiencies of individual firms in an industry and their applications have involved both cross-sectional and panel data. The stochastic frontier model decomposes the error term into a two-sided random error that captures the random effects outside the control of the firm and a one-sided error that captures inefficiency. Stochastic frontiers assume that part of the deviations from the frontier is due to random events (reflecting measurement errors and statistical noise) and part is due to firm-specific inefficiency (Coelli*et al.*, 1998).

Assuming that producers are producing a single output using multiple inputs, the stochastic frontier approach provides the relative frontier against which production performance is evaluated (Kumbhakar and Lovell, 2000). Accordingly, the stochastic production frontier was specified by adding asymmetric error term (v_i) to the nonnegative error term(μ_i) of the equation 1 as:

$$\ln(Y_i) = F(X_i, \beta_i) + v_i - \mu_i \; i = 1,2,3 \ldots N \qquad (2)$$

In this equation $v_i's$ are assumed to be independent and identically distributed random errors following a normal distribution with zero mean and variance (σv^2). The random error v_i accounts for measurement error and other external factors such as climatic changes in the production process which is out of the control of the producer; whereas the μ_i account for the inefficiency of the firms.

Estimation of individual efficiency follows the specification of stochastic production frontier. Accordingly, the technical efficiency of i^{th}producer is estimated as the ratio of his actual output relative to the frontier output as in equation 3 below:

$$TE_i = \frac{Y_i}{exp(X_i\beta + v_i)} = exp(-\mu_i) = \frac{Y_i}{Y^*} \qquad (3)$$

Where:

Y_i −Represent the actual output obtained in the presence of the technical inefficiency effects;

Y^* −Represent frontier output under the condition of random shocks.

Its value lies between zero and one implying fully technically inefficient and efficient respectively.

Following Battese and Coelli (1995) the stochastic cost frontier function in equation (4) based on the specified production frontier in equation (2) was specified as:

$$\ln(C_i) = \beta_o + \sum_{j=1}^{K} \beta_j \, lnP_{ji} + v_i + u_i \qquad i = 1,2,3 \ldots N \qquad (4)$$

Where:

lnC_i −Denotes the (logarithm of the) cost of production of the ithfirm;

P_{ji} −Denotes a vector of inputs price and output of ithfirm;

β_j −Denotes a vector of the unknown parameter to be estimated;

v_i −Denotes random variables assumed to be independent and identically distributed random errors with zero mean and variance(σv^2).

u_i − Denotes non-negative random variables which were assumed to account for cost inefficiency and assumed to be independent and identically distributed random errors with zero mean and variance(σu^2).

Firm-specific allocative and economic efficiencies are computed from a dual cost function that was algebraically derived from the estimated parameters of the self-dual stochastic frontier production function (Kopp and Diewert, 1982). Accordingly, firm-specific economic efficiencies were computed as ratios of the weighted sums of economically efficient input quantities to the weighted sums of observed input quantities, the weights being the respective input price. Thus, economic efficiency indices for the ith firm were computed as:

$$EE_i = \frac{W_i{}'X_i{}^e}{W_i{}'X_i} \qquad (5)$$

Following Farrell (1957) allocative efficiency (AE) indices for the ith firm were computed as:

$$\mathrm{AE_i} = \frac{\mathrm{W_i{}'X_i{}^e}}{\mathrm{W_i{}'X_i{}^t}} \qquad (6)$$

Where:

$W_i{}'X_i{}^e$ −Denotes economically efficient costs of production;

$W_i{}'X_i{}^t$ −Denotes technically efficient input vectors;

The parameter of stochastic frontier model was preferably estimated by econometric procedure known as the Maximum Likelihood Estimation (MLE) or corrected ordinary least square

(COLS) approach. However, the former was asymptotically more efficient than the later (Coelli, 1998).

Parametric frontier methodology requires selection of specific functional form. Coelli*et al.* (1998) discussed three common functional forms namely Cobb-Douglas, Translog and Zellner-Revankar generalized production functions. The Cobb-Douglas functional form has been commonly used in the empirical estimation of frontier models. Its simplicity was the most appealing feature. This simplicity was, however, associated with a number of restrictive features like constant elasticity, constant return to scale for all firms and elasticity of substitution were equal to one. The trans log functional form imposes no restrictions up on returns to scale or substitution possibilities and the Zellner-Revankar form removes the return to scale restriction. But many studies indicate the Cobb-Douglas functional form is an appropriate specification over the trans log functional form due to the following reason: Simplicity, the possibility of decomposing efficiency estimates into technical and allocative efficiencies (since the function is self-dual) and problem of multicollinearity associated with translog (Battese*et al.*, 1996).

The other characteristic of stochastic frontier model associated with inefficiency effects was the type of distributional form foru_i. The specification of appropriate distributional form was the main criticism of the stochastic frontier model for it has generally no priori justification for its selection. There are many distribution forms for inefficiency effects like half-normal, truncated-normal and two-parameter gamma distribution. Half-normal distributional form is the most common and almost universally assumed in empirical studies of efficiency analysis (Aigner*et al.*, 1977)

After functional form was selected and distributional form was assumed, the next issue in SPF analysis was the specification of inefficiency effects model. It was specification of those factors that may contribute for the difference in efficiency among firms. There are two stage of estimating the parameter of inefficiency effect model. The first way was using two stages estimation after efficiency estimates are obtained for each decision-making in the first stage estimation. The other way of estimating was using a one-stage analysis with the production frontier. According to Kumbhakar*et al*. (1991) two stage estimations generate inconsistent estimator. To avoid this inconsistency, Reifschneider and Stevenson (1991) specified stochastic frontier models in which the inefficiency effects were defined to be explicit function of some firm-specific factors and all parameters were estimated in a single-stage maximum likelihood procedure. Many empirical studies showed that a range of firm- specific characteristics, institutional and environmental factors cause inefficiencies. The significance of these factors can be analyzed using the following inefficiency effect model (Battese and Coelli, 1995):

$$\mu i = \delta izi \tag{7}$$

Where:

μ_i −Denotes the inefficiency of the i[th] firm and is assumed to be a function of farm specific socio-economic and farm management practices.

z_i −Stands for vector of firm specific variables which affect the inefficiency of the i^{th} firm;

δ −Denotes a vector of parameters to be estimated;

Aigner*et al.* (1977) proposed the log likelihood function for the model on the equation (7) by assuming half-normal distribution for u_i and normal distribution for (v_i) and using lamda (λ) parameterization to express the likelihood function, where, λ is the ratio of the standard errors of the non-symmetric to symmetric error terms $(\lambda = \frac{\sigma_u}{\sigma_v})$. However, due to the reason that λ could be any non-negative value while γ ranges from zero to one the latter better measures the distance between the frontier output and observed output and basically separates the effects of noises from inefficiency (Battese and Corra, 1977). Accordingly, the maximum likelihood estimates of the parameters of the frontier model were estimated from the log-likelihood function expressed in terms of gamma (γ) parameterization as follows:

$$\ln(L) = -\frac{N}{2}[\ln[\frac{\pi}{2}] + \ln\sigma^2] + \sum_{i=1}^{N} \ln[1 - \varphi[\frac{\varepsilon i\sqrt{\gamma}}{\sigma^2}\sqrt{\frac{\gamma}{1-\gamma}}]] - \frac{1}{2\sigma^2}\sum_{i=1}^{N} \varepsilon i^2 \tag{8}$$

Where:

$L =$ Represent likelihood function

$\varepsilon i = lnY - X_i\beta$ −Represent composed error term;

$N -$ Represent the number of observations;

$\Phi(.)$ −Represent the standard normal distribution;

$\sigma^2, \gamma -$ Represent the variance of parameters of the model and

$$\gamma = {\sigma^2}_u \Big/ {\sigma^2}_v + {\sigma^2}_u$$

Gamma (γ) parameter has a value between zero and one. A value of zero indicates deviations from the frontier are entirely due to noise, while a value of one would indicate that all deviations are due to inefficiency. Minimization of the function on equation (8) with respect to the parameters$(\beta, \sigma^2\gamma)$ and solving simultaneously the first partial derivatives of the function by equating to zero produces the efficient maximum likelihood estimates of the parameters.

2.2.3. Empirical Studies on Efficiency in Ethiopia

Many efficiency analyses have been conducted by different researchers to identify the sources of inefficiencies and their policy implications to improve future development endeavors through enhancing the prevailing efficiencies. (Jules and Seung;2019) conducted a research on technical efficiency and its potential determinants among small-scale coffee producers in Rwanda based on simple sampling method 320 coffee producer in coko,muhondo,Ruli and Minazi districts of Rwanda.They used Cobb-Douglas SPF analysis approach to estimate technical efficiency and identify the determinants of efficient among coffee producers. The mean level of TE among coffee farmers in the study area was estimated at 82 percent. From a technical standpoint, this implies that there is a potential to increase coffee production by about 18 percent with the current levels of inputs and farm technologies available in the country through the reduction of technical inefficiency. The results further revealed that education, extension services, access to credit, land consolidation, improved variety of coffee trees, and cropping system significantly improved coffee producers' TE.

Hailemaraim (2015) conducted a study on technical efficiency in teff production based on cross-sectional data obtained from a random sample of 123 teff-producing farmers in Bereh District, Oromia National Regional State. He used a Cobb-Douglas stochastic frontier production analysis approach with the inefficiency effect model simultaneously to estimate technical efficiency and identify the determinants of efficiency variations among teff producer farmers. The maximum likelihood parameter estimates showed that teff output was positively and significantly influenced by area, fertilizer, labor, and number of oxen. The value of gamma(γ) 68% implies that the variation in teff output among the sample respondents was attributed to technical inefficiency effects.

Musa (2013) conducted a study on the economic efficiency of smallholder farmers in maize production. He used the Cobb-Douglas production function fitted using stochastic production frontier approach to estimate technical, allocative, and economic efficiency levels and the Tobit model to identify factors affecting efficiency levels of the sample farmers. The estimated results showed that the mean technical, allocative, and economic efficiencies were 84.87%, 37.47%, and 31.62% respectively which indicates the significant inefficiency in maize production in the study area.The discrepancy ratio (γ), which measures the relative deviation of output from the frontier level due to inefficiency, implied that about 79.06% of the variation in maize production was attributed to inefficiency effects. Among factors hypothesized to determine the level of efficiencies, education was found to significantly determine allocative and economic efficiencies of farmers positively while the frequency of extension contact had a positive relationship with technical efficiency and was negatively related to both allocative and economic efficiencies. The result indicated that there is room to increase the efficiency of maize producers in the study area.

Sisay*et al*. (2015) conducted a study on technical, allocative and economic efficiency among smallholder maize farmers in Southwestern Ethiopia. He estimates, technical, allocative, and economic efficiency using a parametric stochastic frontier production function (Cobb-Douglas). The result shows that the mean technical, allocative and economic efficiency score was found to be 62.3%, 57.1%, and 39%, respectively, indicating a substantial level of inefficiency in maize production. Inefficiency effects are modeled in a second stage applying a two-limit Tobit regression model. The result shows that important factors that affect efficiency were several family sizes, level of education, extension service, cooperative membership, farm size, livestock holding, and use of mobile.

Solomon (2014) used the SPF model together with the inefficiency parameters to identify factors affecting level of technical efficiency of major crop. The result show that age of the household head measured in years was found to be the determinant of technical inefficiency negatively and significantly. The value of gamma(γ) 88.5% implies that the variation in teff output among the sample respondents was attributed to technical inefficiency effects. Land was a significant variable that explains the variation in teffoutput among plots. Themodel output depicted that the mean level of TE for teff was found to be 63.56%. This result indicates that there is a room to enhance productivity by 36.44% through improving the efficiency of production given same level of input and current technology.

2.3. Conceptual Framework

The interaction of various factors that would have various degree of impact on the level of technical, allocative and economic efficiency of coffee production. These factors directly or indirectly affect the performance of agricultural production and are believed to have an impact on the inefficiency of farmers. Institutional factors such as market infrastructure, credit, and access to inputs will have a significant effect on the inefficiency of coffee production. Therefore, policies, programs, and institutional arrangements which target access to credit, market infrastructure, and access to education among others are important factors that can substantially affect inefficiency. The differences in efficiency between farmers will also be explained by environmental characteristics such as soil fertility, altitude, climate, weather, rainfall, and temperature, among others. These factors will have a positive or negative effect on inefficiency.

Household characteristics like the education level of the household, family size, and livestock ownership among others will also have a significant effect on the inefficiency of coffee production. Thus, factors related to farmer characteristics will be included in the analysis believing that they will have effects on the inefficiency of the farmer.

Efficiency variations between farms can also be explained by the farm characteristics like distance of farm from home and soil fertility status. Thus, farm-related variables are being considered in the analysis as they will have effects on the inefficiency of coffee production.

The final element of the framework is the feedback effect of the interaction of various external (institutional and environmental factors) and internal (farmer and farm characteristics) variables for further reforms. It indicates whether the interventions or changed practices have impacts in the society.

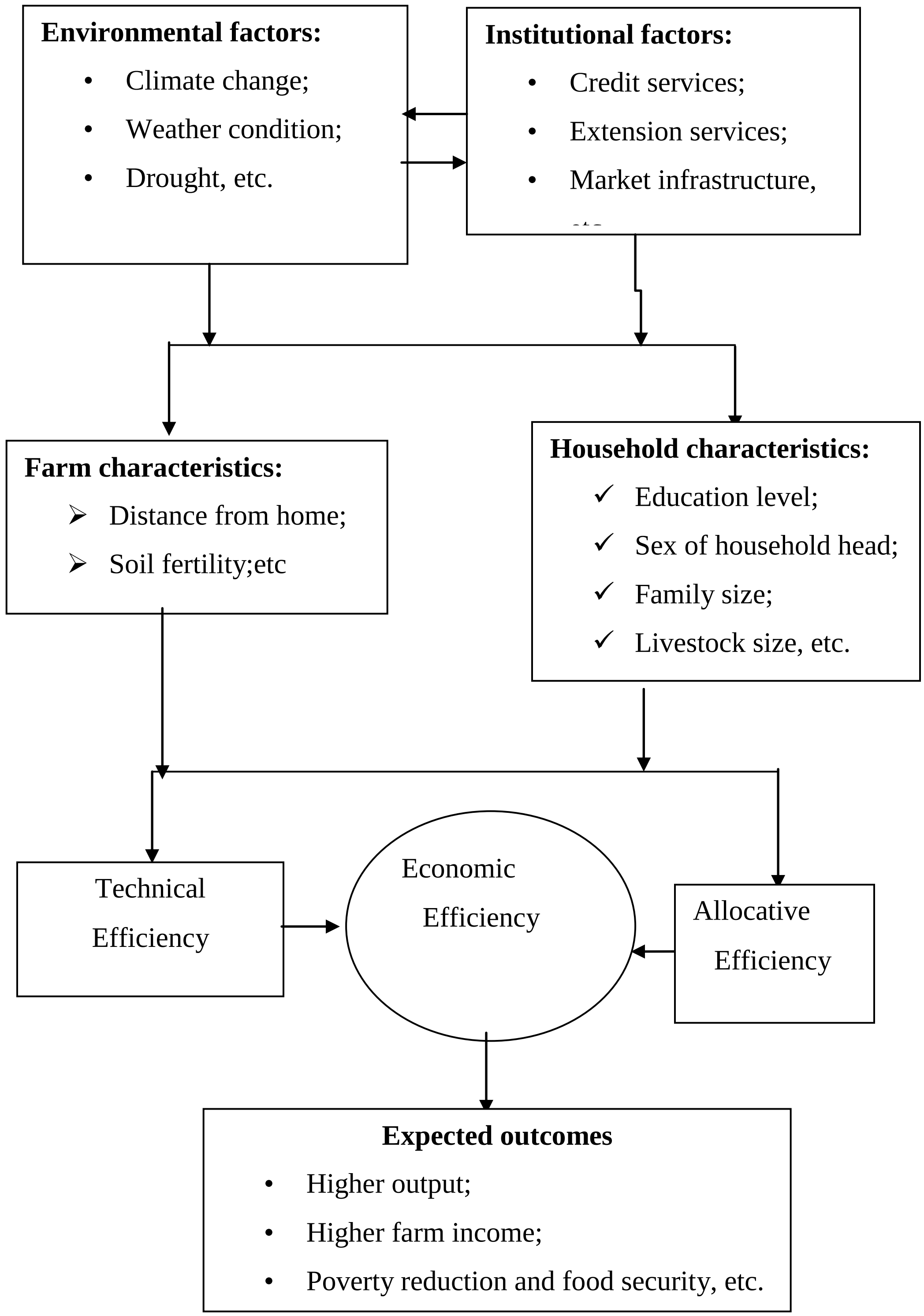


Figure 2.3 Conceptual framework of efficiency analysis
Source own sketch

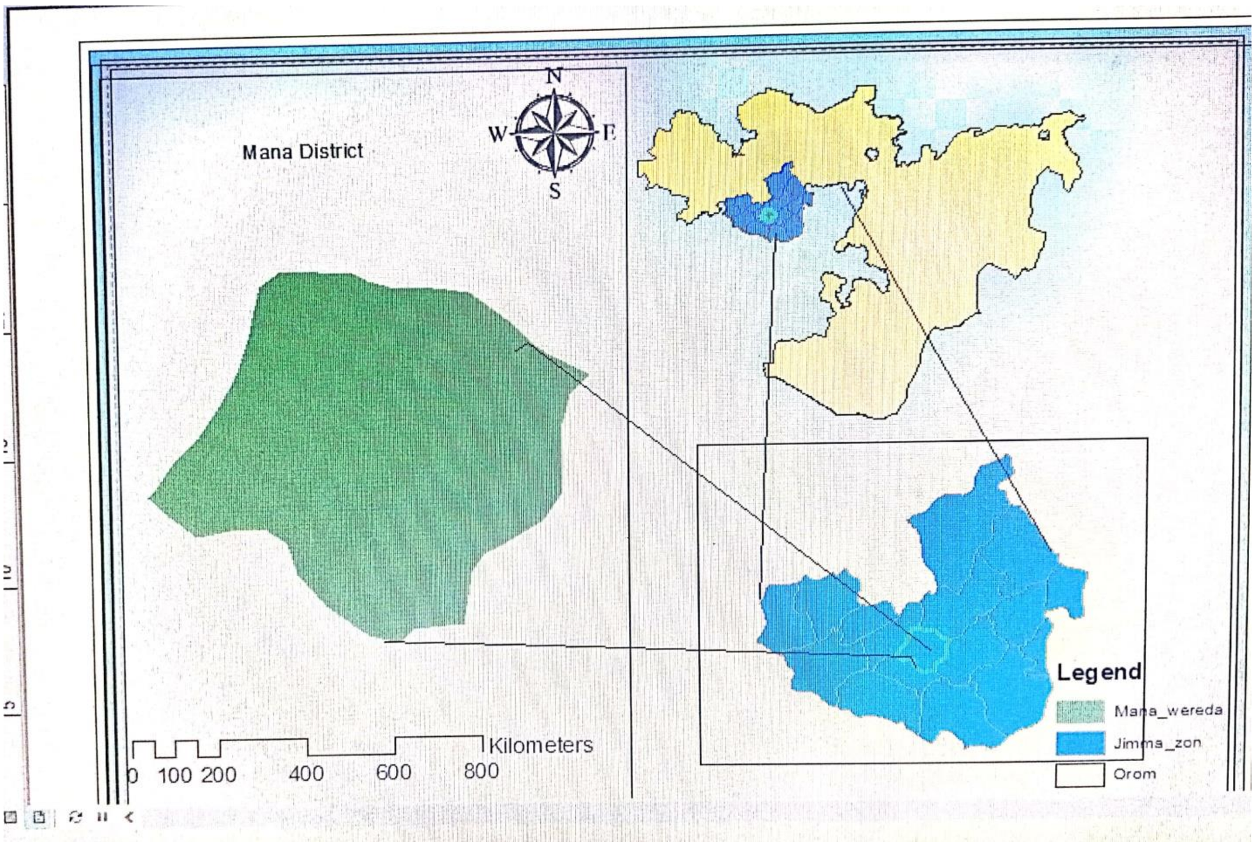
CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Jimma Zone is located in the Oromia National Regional State, Southwest Ethiopia. Jimma town is the capital and administrative center of the Zone and is located at a distance of 350 km away from the capital of Ethiopia Addis Ababa. The study area is situated between 1689 and 3018 m.a.s.l (meter above sea level) and receives an average rainfall between 1200 and 2400 mm per annum. The maximum and minimum annual temperature of the area is 28.8 and 11.8oC, respectively (CSA, 2005).Jimma Zone has plenty of year-round evergreen wetlands that support biodiversity, livestock, and socioeconomic activities. Based on the 2007 Census conducted by the CSA, the Jimma zone has a total population of 2,486,155, (1,250,527 men and 1,235,628 females).Jimma has a population density of 159.69.While 137,668 or 11.31 % are urban inhabitants. Among these 80.9% and 19.1% live in rural and urban area respectively. It is composed of a total of 21 woredas. It holds a total area of 15,568.58 square kilometers.

Mana is one of the woredas in the Oromiaregion of Ethiopia.Part of the Jimmazone,Mana is bordered on the south by SekaChekorsa,on the west by Gomma,on the north by Limmu Kossa,and on the east by kersa. The 2007 national census reported a household number is 42,199 among this 22,349 are farmers. A total population for this woreda is 146,675,of whom 74,698 were men and 71,977 was women. Mana woreda have 24kebele. The geographical condition of the weredais situated between 935 and 2274 meter above sea level. The landscape of Mana includes mountains, high forests, and a plain divided by valleys.Coffee is an important cash crop for this woreda;Over 5,000 hectares are planted with this crop.(Census,2007) Reports show that farmers in this woreda sold 99,850 quintals of washed and unwashed coffee beans, earning 27.3 million birr.(Manaworeda coffee and tea authority report,2006 E.C)



3.2. Sampling Technique and Sample Size Determination

In this study, both purposive and probability sampling techniques will be employed to draw a representative sample. Three-stage sampling techniques will be used to select sample households. In the first stage, the Woreda will be purposively selected based on the agro-ecology and accessibility. In the second stage, from the selected wereda; six coffee-producing kebeles will be purposively selected who are located in different altitude and coffee production yield of 2019/2020 year. In the third stage, probability proportional to household heads living in the kebele and producing coffee will be employed to select sample farmers. Accordingly, 372households will be selected for the survey. The sample size will be determined by using the formula given by Yemane (1967) as follow:

The sample size of farmers was determined by applying Yamane's (1967) formula with confidence interval of 95% and variability of 0.05.)

$$n = \frac{N}{1 + N(e^2)} \quad (9)$$

where n=the sample size, N=number of coffee producer households in Mana Wereda in 2019/2020 production season (which was **5338**), e=margin of error (which was 5%) then n=372. Yamane's formula was used because of its homogenous type of population in the study area.I select six kebele by using stratified sampling method by grouping the kebele in to three altitudinal setup i.e. lowland, middle and highland (Kassaye, Joliey,Lucduchateau and psacal,2016)

Where:

n −Denotes sample size;

N −Denotes total number of coffee producers in the districts and

e −Denotes the desired level of precision (taking 5%);

Table 3.1: Total number of households and sample households in the study area

Name of kebeles	Male headed	Female-headed	Total	Proportion	Sample size
I/Guddaa	928	99	1027	0.19	71
G/Bosoqa	816	71	887	0.17	63
D/Biqila	786	43	829	0.15	56
S/Bontu	828	88	916	0.17	64
B/Kossaa	836	59	895	0.17	63
B/Kaarraa	742	42	784	0.15	55
Total	**4936**	**402**	**5338**	**1**	**372**

Source:Own survey (2020)

3.3. Types and Source of Data

The study will use both primary and secondary data. Primary data will be collected from sampled household based on the actual farming practices existed in the study area. Accordingly, data on coffee production activities; the amount of input used per hectare and the corresponding output attained; the prevailing market price for each input and output; resources (land, labor, and capital) available on the farm for production purpose; a major source of income and problems encountered in coffee production, in particular, will be collected from the sampled households. Secondary data will be collected from the woreda agricultural office, Annual reports of NBE and CSA, journals, websites, published thesis, and dissertation.

3.4. Method of Data Collection

The following data collection tools were employed to gather relevant and accurate data.

3.4.1. Field Observation

Field observation was conducted from the time of proposal preparation and continued through the whole process of data gathering to assure the validity of the acquired data. The main purpose was to understand the local communities' farming practices and major problems of coffee production.

3.4.2. Interview

The interview was conducted from sample households of four kebeles of the wereda. This helps me to get a better response rate then distribute questionnaires, and helped me to judge the none verbal behavior of the respondent. The point of this was because most of our sample targets cannot read and write.

3.4.3. Selected group discussion

The group discussion was conducted on the purposively selected group of people from the farmers, kebele administrator, Coffee collector and Agricultural extension worker.

3.5. Method of Data Analysis

In this study, both descriptive and econometric methods were executed to analyze data. Descriptive statistics like mean, percentage, frequency, and standard deviation had been used to analyze the socio-economic characteristics and efficiency levels of the sampled farmers. Cob-Douglas stochastic production frontier was also employed to estimate the efficiency level of sampled farmers.

3.5.1. Descriptive Analysis

Descriptive statistics techniques had been used to describe demographic, socio-economic, and institutional characteristics of smallholder coffee producers. Input uses and outputs of production processes among sampled farmers were also presented using descriptive statistics.

3.5.2. Econometric Analysis

Most empirical studies on efficiency in Ethiopia were analyzed using Cobb-Douglas stochastic production frontier methodology (Jema, 2008; Solomon, 2014; Musa, 2013; Hailemaraim, 2015 and Sisay*et al.*, 2015, etc.). The main reason was stochastic approach allows for statistical noise such as measurement error and weather which are beyond the control of the decision-making unit. Essa*et al.* (2012) and Endrias*et al.* (2013) was used the DEA approach to measure efficiency level and source of variation among smallholder farmers. The stochastic frontier approach has been preferably applied in many agricultural economic researches (Coelli, 1995). This is because of the deterministic parametric methods assumption that all the deviations from the frontier are caused by inefficiency. Risks in agriculture like weather, pests, diseases, etc cause the inherent variability of agricultural production. Besides, the fact that record keeping was not a priority in many small family-operated farms also results in measurement errors. Therefore, the study was used Cobb-Douglas stochastic production frontier. Following Aigner*et al*. (1977) the specified Cobb-Douglas SPF model were also defined as follows:

$$\ln(Y_i) = F(X_i, \beta_i) + v_i - \mu_i \; i = 1,2,3 \ldots n \qquad (10)$$

Where:

$i -$ Denotes the number of sample households

$\ln(\mathrm{Yi}) -$ Denotes the natural log of the (scalar) output of the i^{th}household;

$X_i -$ Represent a vector of input quantities used by the i^{th} household

$\beta_i -$Denotes a vector of unknown parameters to be estimated

v_i- is a symmetric component and permits a random variation in output due to factors such as weather, omitted variables, and other exogenous shocks. It is assumed to be independently and identically distributed $N\sim (0, {\sigma^2}_v)$and

u_i-intended to capture inefficiency effects in the production of coffee measured as the ratio of observed output to maximum feasible output of the i^{th} plot. It was assumed to be independently and identically distributed as half-normal, $u \sim N\ (u, {\sigma^2}_u)$.

After the specification of SFP, the next stage was the estimation of TE for individual firms. Using the above estimated Cobb-Douglas production function in equation (10), the estimation of

TE for individual firms is predicted by obtaining the ratio of the observed production values to the corresponding estimated frontier values. The study were also computed TE for the ith firms as:

$$TE = \frac{lnY_i = \beta_o + \sum_{j=1}^{5} \beta_j lnX_{ji} + v_i - u_i}{\ln Y_i = \beta_o + \sum_{j=1}^{5} \beta_j lnX_{ji} + v_i} = \frac{Y_i}{Y_i^*} \quad (11)$$

The value lies between zero and one implying fully technically inefficient and efficient respectively. Following Battese and Coelli (1995) the stochastic cost frontier function was specified which forms the basis of computing EE and AE of coffee production. The dual cost frontier was specified as:

$$\ln(C_i) = \beta_o + \sum_{j=1}^{3} \beta_j \, lnP_{ji} + v_i + u_i \quad (12)$$

Where:

lnC_i −Denotes the (logarithm of the) cost of production of the ithfirm;

P_{ji} − Denotes a vector of inputs price and output of ithfirm;

β_o, β_j −Denotes a vector of the unknown parameter to be estimated;

v_i −Denotes random variables assumed to be independent and identically distributed random errors with zero mean and variance(σv^2) and

u_i −Denotes non-negative random variables which are assumed to account for cost inefficiency and assumed to be independent and identically distributed random errors with zero mean and variance(σu^2).

To analyze the determinants of inefficiency, the inefficiency model was employed. In the inefficiency model, the dependent variable is the inefficiency variable (u_i) and the explanatory variables are the factors that are hypothesized to affect inefficiency(Z_i). A positive sign of a coefficient of inefficiency model impliedthat the variable considered had an increasing effect on inefficiency. The relationship implies that variables that increase inefficiency was decreased efficiency. The inefficiency model was specified as follow:

$$u_i = \delta_o + \sum_{i=1}^{13} \delta_i Z_i \qquad (13)$$

Where:

ui - is the inefficiency of the ith firm and is assumed to be a function of farm-specific socio-economic and farm management practices;

δ_o-Intercept term of inefficiency model;

$\delta 1, \ldots \delta 13$ - are the coefficient of parameter estimates of the inefficiency variables and

z_i −Stand for vectors of firm's specific variables which affect the inefficiency of the i^{th}firm.

Following Greene (2003) the hypothesis test had been conducted using the log-likelihood ratio (LR) statistics, λ, which were defined in equation (14):

$$LR(\lambda) = -2ln[L(H_o)] - ln[L(H_1)] \qquad (14)$$

Where:

$L(H_0)$ −Denotes the likelihood function value under the null (H_0)

$L(H_1)$ −Denotes the likelihood function value under the alternative hypothesis(H_1)

3.6. Definition,Measurement and Hypothesis of study variables

3.6.1. Production function

Output: The quantity of coffee output obtained by the sampled households during the 2019/2020 production year measured in quintals was used as the dependent variable.

Inputs: It is explanatory variables of production functions and defined as follows:

1. Household family size used to proxy Labor force participation in coffee farm (LB): It is the total amount labor for deforest to dig,harvesting,transporting, and other agronomic practicesmeasured in man-equivalent. The various categories of labor such as child labor, adult men and women, was recorded separately and converted into man-equivalent using a standard conversion factor.

2. Area (ARA): It is a continuous variable and defined as the size of land in hectare (ha) used for coffee production by sampled farmers. The land may belong to the farmer; it may be obtained by means of hiring, leasing or through share-cropping arrangements

3.6.2. Inefficiency Model

These are socio-economic and institutional variables used to explain the variation in technical efficiency among coffee producers in the study area. In this case,the dependent variable is the technical inefficiency variable (u_i) and the explanatory variables are the factors that are hypothesized to affect technical inefficiency (Z_i). Based on previous literature and socio-economic conditions of the study area, the following factors were expected to determine technical inefficiency differences among sampled households.

1. Age of the household head: It is a continuous variable measured in several years used as a proxy measure to indicate the general farming experience of the sample household. The implication is that as the age of the farmer increases, the farmer becomes more skilled in the method of production and optimal resource allocation. However, after a certain age limit as farmers get older their technical inefficiency increases. Therefore, it is hypothesized that middle-age households had less inefficient in coffee production than others.

2. Sex of the household head: it is a dummy variable that takes a value of 1 if the household head is male and 0, otherwise. These are related to women's lack of control over economic resources and the nature of their economic activity. Therefore, it is hypothesized that male-headed households were less inefficient than others.The result is consistent with Isahet.al.(2013)

3. Educational level of the household head: It is a continuous variable measured in years of schooling of the household head and is used as a proxy variable for the managerial ability of input.Those farmers who are advanced attheschool level have a better opportunity for agricultural productivity (Solomon, 2014). Therefore, it is hypothesized that more educated households head do have less inefficient than others.

4. Family size: It is a continuous variable and defined as the total number of people living together with a household during the survey period measured in adult equivalent (AE). The family size is hypothesized to affect the technical inefficiency level of the farmers negatively. This is because those households having a large number of family sizes have a large number of family labor which is the main input in coffee production. As a result, a household that havea large family size could carry out the required agronomic practices during production periods.

This is because a large number of family members conducted different agronomic practice on time. Therefore, it is hypothesized that family size would have negatively affect inefficiency.

5. Livestock holding: It is a continuous variable and defined as the total number of livestock the household owns in terms of Tropical Livestock Unit (TLU). This variable enters the inefficiency model as a proxy variable for the wealth of the farmers. The cash from livestock sale can improvecoffee production through purchase different inputs on time and they also produce manure that will be used to maintain soil fertility. In the case of the study area, households having a large number of livestock are less inefficient than others. This is reflected in their ability to buy or hire inputs on time. Therefore, it was hypothesized that livestock size negatively affect inefficiency.

6. Farm size: It is a continuous variable thatrepresents the total coffee area in hectares. As the farm size of a farmer increases the managing ability them decreased given the current level of technology. Therefore, it is hypothesized that farm size was positively affect the inefficiency of coffee production.

7. Credit: It is a dummy variable which takes a value 1 when household uses cash credit for agricultural purpose and 0, otherwise. Farmers who use cash credit for agricultural purposes overcome their financial constraints to buy different inputs (Musa, 2013; Sorsie*et a*l., 2015). Therefore, it is hypothesized that household which uses credit for the agricultural purpose was less inefficient than others.

9. Farm fertility: It is a dummy variable thattake a value of 1 when the plot is fertile and 0, if not. It is hypothesized that a fertile plotnegatively affectedthe inefficiency of coffeeproduction. This is because fertile plots are more productive than less fertile plots. This hypothesis is supported by (Fekadu, 2004; Hailemaraim, 2015). If there are many plots managing ability of the farmers' decreases. It was positively affect the inefficiency of coffee production.

10. Frequency of extension contact: This variable serves as a proxy measure for access to extension services since all the extension user households may not get the services every time they need them. It is a continuous variable measured by the number of visits made by development agents concerning about coffee production during the cropping year. It is hypothesized that a low frequency of contact with the development agent was negatively related to inefficiency. This is because, they are better access to information on new technology, recommended agronomic practices, and market information that would be productively used on their farm. This hypothesis is supported by (Musa, 2013; Hailemaraim, 2015).

11. Proximity of home to farm area distance: It is a continuous variable defined as the distance of the coffee plot from the homestead measured in walking hour. It is hypothesized that the longer the distance of the plot from the home had the higher the inefficiency. This is because plots that are far away from the homestead received less management attention fromthe farmer. This hypothesis is supported by (Mohammed, 1999; Kinde, 2005).

12. Distance to nearest market: It is a continuous variable and defined as the distance of farmers from the nearest market measured walking hour. When farmers are located far from the market, there would be limited access to input and market information. Moreover, the longer the distance to the market leads to higher transportation cost that reduces the benefits that accrue to the farmer. Therefore, it is hypothesized that the longer the distance from the nearest market, positively affect the inefficiency of coffee production. This hypothesis is supported by (Musa, 2013).

3.6.3. Multi-collinearity test

One of the serious problems with the identification of variables to be included in the model is the existence of multi-collinearity. Multi-collinearity refers to a situation where it becomes difficult to disentangle the separate effects of independent variables on the dependent variable because of strong relationships among them (Maddalla, 1977). The existence of this situation was tested using the methods of variance inflation factor(VIF) for continuous variables and contingency coefficients (CC) for dummy variables. As a rule of thumb, if the VIF exceeds 10 (happened if R_i^2 exceeds 0.90), and CC exceeds 0.75 there wereindications of serious multicollinearity relationship between variables (Gujarati, 1995). Under this situation, we removed one of the high collinear variables or we find a better proxy for those variables. Accordingly, the variance inflation factor is defined as

$$\text{VIF}\ (X_i) = \frac{1}{1 - R_i^2} \qquad (15)$$

Where:

R^2-is multiple correlation coefficients between $X_i$and other explanatory variables.

VIF- is variance inflating factors

For each selected continuous explanatory variable, X_i was regressed on all other continuous explanatory variables and the coefficient of determination (R_i^{2}) constructed for each. The higher value of the coefficient of determination (R_i^{2}) and the higher value of VIF (X_i) caused higher collinearity in the variables (X_i).

Contingency coefficient analysis carried out to check for the strength of the relationship among discrete variables. The value ranges between zero and one, with zero indicating no association between the variables and values close to one indicating a high degree of association between the variables. Contingency coefficients computed for dummy variables from chi-square (χ^2) value to detect the problem of multicollinearity (the degree of association between dummy variables). Thus, contingency coefficient is defined as:

$$CC = \sqrt{\frac{\chi^2}{n + \chi^2}} \qquad (16)$$

Where:

$CC -$ Contingency coefficient,

$n -$Sample size,

$\chi^2 -$Chi-square value

This measure of association is based on chi-square. It is asymmetric measure thatindicates the strength and significance of the relation between the row and column variables of a cross-tabulation.

3.7. Summary of the study variables

Table 1;Summary of study variables and their expected sign

Variable name	Variable Description	Measurement	Expected sign
Input Variables			
LB	The total labor force used for different production activities during the production period	Man equivalent	+
FRT	The total amount of Urea and DAP used for coffee production during the production period	Kilogram	+
ARA	The total land allotted for coffee production duringthe production period	Hectare	+
Inefficiency Variables			
AGE	Age of household head (middle age household head)	Years	_
SEX	Sex of household head (if male household head)	Dummy	_
EDUl	Education level of household head (if household head is more educated)	Years of schooling	_
HHFS	Total family size of the household	AE	_
TLVC	Total number of livestock in number	TLU	_
CFARE	Total farm land size	Hectare	+
ACCT	Access to financial credit for coffee farm expenditure	Dummy	_
LNDFRT	The relative fertility status of household farm land (takes the value 1, if it is fertile and 0 other wise)	Dummy	_
TRCFM	Frequency of extension contact made during production period (if higher frequency of contact is conducted)	Number	_
DSFM	The distance of the coffee farm from the household home (if distance is far from household home)	Walking hour	+
DTNM	Distance to nearest market (if distance is far from the nearest market)	Walking hour	+

CHAPTER FOUR

4. RESULT AND DISCUSSION

This chapter deals with the major outcomes of the study. It was divided into two main sections. The first section deals with descriptive analysis/demographic and socio-economic/ of the sample households and the second section deals with the econometrics analysis of the research findings.

Demographic and Socio-Economic Characteristics of the Sample Households

It was important to find out from the respondents that their sex, training levels, access to credit, and use of fertilizerof sample households are the aspects of determining demographic and socio economic characteristics of sampled households. In this research, all the above variables were assessed and the result is displayed in table three below.

The result showed, out of the total respondents, 50(13.47%) of the respondents' age are between 15 to 25yeras, 55(14.82%) of the respondent are between 26 to 39, 230(61.99%) of the respondents' age are between 40 - 65years, and 36 or 9.70%. of the respondents are above 65 years. Most of the respondents' age is in the range of 40 to 65years, such an age group is categorized as an effective workforce productive age which is known to create significant economic benefit within the household on coffee production and production cost reduction to contribute to 61.99% of respondents out of the total. This shows that more of the respondent from both treated and control group are at an adult stage which has an opportunity to create better income-generating through provision of quality coffee for the house hold for a premium price.

This is in lined with Seifuet. al.,(2020), an age range of 40 to 65 years are categorized as an effective workforce, have an ample experience and productive which create significant economic benefit within the household.

4.1. Descriptive Analysis

4.1.1. Demographic analysis

Variable	Description	Number of respondent	% respondent
Sex	male	287	77.3585
	female	84	22.6415
Access to credit	yes	268	72.2372
	no	103	27.7628
Use fertilizer	yes	133	35.8491
	no	238	64.1509
Attend training	yes	117	31.5364
	no	234	63.0728
	15 - 25	50	13.4771
	26 - 39	55	14.8248
	40 - 65	230	61.9946
Age	65+	36	9.7035

Sex of respondents, as indicated in the above table, out of the total respondents, 287 or (77.36%) of the respondents are male; whereas 84 or (22.64%) of the respondents are females. This indicates that most of the respondent in the study area is both from control and the treatments are dominantly males because male are more decisive in land owner-ship.

Use of fertilizer for coffee production about 238 or (64.15%) of the respondent Saied they do not use inorganic fertilizer because the return could not cover the cost but about 133 or (35.85 %) of the respondent uses fertilizer for their coffee production. Though, training is the main component for value addition and better production of coffee about 234 or (63.07%) of the respondent Saied they do not attained any training on coffee production but about only 117 or (31.5364 %) of the respondentattained the training in the study area.

4.1.2. Socio-Economic Characteristics

In the study area aroundout of the total respondents, 287 or (77.36%) of the respondents are male and 84 or (22.64%) of the respondents are females with min and max of 500 and 7500 with the age having of min and max of 23 and 81 years respectively, cost of fertilizer used for coffee production is with a mean and max of 5000 and 80,000 birr in the last three to five production years. In the case of family and daily labour time they spend a min and max of 48 and 504 hours per month on coffee farm management, and costs with a min and max of 1000 and 30000 birr in a given production year/per annum

Table 2: Socio-economic Descriptive

Variable	Obs	Mean	Min	Max	Std. Dev.
y	371	2038.464	500	7500	1089.644
frmsiz	371	30066.71	5000	80000	13377.21
lbhr	371	176.4744	48	504	82.31746
cost	371	10558.37	1000	30000	4973.567
age	371	48.96765	23	81	12.13545

4.2. ECONOMETRIC RESULTS

4.2.1. Estimation of Technical Efficiency

The maximum likelihood estimate of the parameters of the stochastic production was estimated. Before proceeding to look at the parameter estimates of the assembly frontier and therefore the factors that affect the inefficiency of coffee sample smallholder farmers, there's a necessity to hold out some tests for variables included under the estimation of stochastic production frontier and examine the existence of inefficiency effects together with coffee producers. Before estimation of technical efficiency and analysis of its determinants, variance inflation factor (VIF) for the continual variables and contingency coefficient (CC) for the discrete variables were have a look at to test the matter of great multi-co linearity. Based on equation 15, production inputs used were found to be a mean of 1.14 in average because the survey result showed that was a production input vif less than ten is appropriate. This value the appropriate range for the Cobb-Douglas production function estimation, see Table 4 below

Table 4: VIF of the estimation

Variable	VIF	1/VIF
edul	1.45	0.689217
age	1.39	0.721005
lbhr	1.17	0.854764
frmsiz	1.16	0.858864
cost	1.11	0.899286
lvsch	1.11	0.9044
impsed	1.08	0.926762
tring	1.07	0.93192
sex	1.07	0.932495
chemipt	1.04	0.959407
dsfm	1.04	0.962433
dsfhm	1.03	0.971403
Mean VIF	1.14	

Regarding the explicit variables the variables that were alleged to be associated with technical inefficiency level were also tested for multi-co linearity problem and results have shown that there was no multi-co linearity problem among variables. (Appendix 4)

4.2.2. Hypothesis testing and model robustness

Before keep on to check the parameter estimates of the assembly frontier and factors that affect the efficiency of the smallholder farmers, the validity of the model used for the analysis was examined.

The Cobb-Douglas and also the Trans-log functional forms were the most commonly used stochastic frontier functions within the analysis of technical efficiency in production. As a result, the following step was to test whether the assembly technology of the sample smallholder farmer is more represented by the Cobb-Douglas production function or the Trans-log production function. To decide on the suitable specification, both Cobb-Douglas and Trans-log functional forms were investigated (Appendix Table 6).

The hypothesis was checked using the generalized Likelihood Ratio (LR) statistics, which can be computed from the log likelihood values acquired from estimation of Cobb-Douglas and Trans-log functional specifications. In summary, the subsequent tests were administered for testing the functional forms, inefficiency results and determinants of coefficients for coffee farmers within the study areas:

(1) Frontier model specification for the information is Cobb-Douglas production function.

That is H0: COBB-DAGLASS PRODACTION MODEL ($\beta 7$ ……… $\beta 35=0$) is sufficient representation of the assembly function.

H11: Trans-log production function is sufficient representation of the assembly function.

Here B7 ……… $\beta 35$ represents Trans-log production function

(2). Distribution assumption (H0: $\mu=0$)

(3). there's no inefficiency effect that's ($H0=\gamma=0$)

(4). the coefficients of determinants of inefficiency model equals zero that's

($H0=\delta 0=\delta 2 \ldots\ldots=\delta 11=0$)

(5) Return to scale (H0: $\Sigma\beta i=1$)

The formulation and results of various hypotheses (model selection, inefficiency effect) were presented in Table 5. All the hypotheses were checked by using generalized likelihood ratio (LR). The first hypothesis associated with the suitability of the Cobb-Douglas functional form in preference to trans-log model. The computed LR statistic was significant at 5% significance level (LR statistic 2.329< 2.342 in absolute value). The null hypothesis was accepted by indicating that the Cobb-Douglas functional form is in physiological state representation of the info. This indicated that the coefficients of the interaction terms and therefore the square specifications of the input variables under the Trans-log specifications weren't different from zero. This means that the Cobb-Douglas functional form sufficiently represents the information into account.

Table 5: Summary of statistics of stochastic production function variables

Variable	Obs	Mean	Std.Dev	Min	Max
Age	371	48.96765	12.13545	23	81
EDUL	371	3.3477	1.5632	1	5
HHFS	371	5.8867	2.378	1	13
TCPHH	371	1394.879	437.7469	500	2500
TLVK	371	6.1428	5.1363	0	23
CFARE	371	2.7654	0.8801	1	5
DSFM	371	2.1644	1.1.0436	1	4
DFM	371	2.4609	1.1834	1	4

Source: computed on field survey data 2022

The second hypothesis check was conducted for about the distributional assumption of the one sided error term. Given Cobb-Douglas stochastic frontier production function best wells the data, the hypothesis whether the technical efficiency levels were better estimated employing a half normal (μ=0) or a truncated normal distributional assumption of Ui (μ>0). ln{L(Ho)} and ln{L(H1)} are the values of the log-likelihood function under the null (Ho) and alternative (H1) hypotheses. The restrictions form the idea of the null hypothesis, with the unrestricted model being the alternative hypothesis. As will be seen from Table 4 above, the results indicated that the half normal distribution wasn't appropriate for the sample smallholder farmers within the study area as the calculated LR value of -5.32was greater than the critical $\chi 2$ value of -2.342in definite quantity at 5% significance level. The third hypothesis was checked for the truth of the inefficiency component of the full error term of the stochastic production function. In other side, it absolutely was concluded whether the average production function (without considering the non-negative random error term) best fits the information. The difference between the common response function and stochastic production frontier is that the later decomposes the entire error into one sided inefficiency parameter and random normal error. If the one sided error term is adequate zero, the stochastic production function model is that the same to the typical response function indicating that there's no efficiency difference among farmers. This may be checked by comparing the Log-Likelihood values of the OLS with SPF (MLE). Hence, the third hypothesis stated that γ=0, was not accepted at 5% level of significance confirming that inefficiencies existed and were indeed stochastic (LR statistic -0.062< -2.342 in absolute value) (Table 4). The coefficient for the parameter γ could be interpreted in such how that about 95% of the variability in coffee output within the study area was due to the effect of random noise , while the remaining about 5% percent variation in output was thanks to technical inefficiency effect. This means that there was a scope for improving output of coffee by first identifying those institutional, socioeconomic and farm specific factors causing this variation. The fourth hypothesis which situation of the technical inefficiency effects weren't associated with the variables per the inefficiency effect model. To test this hypothesis likewise, LR (the inefficiency effect) was calculated using the worth of the Log-Likelihood function under the stochastic production function model (a model without independent variables of inefficiency effects: H0) and therefore the full frontier model (a model with explanatory variables that were supposed to verify inefficiency of each: H1). It absolutely accepted at 5% level of significance (LR statistic -0.53<-2.342 in absolute value). Thus the observed inefficiency among the smallholder farmers in Jimma zone manna woreda may be attributed to the variables laid out in the model which see a major role in explaining the observed inefficiency.

The fifth hypothesis test was performed to returns to scale. It can divide the dependent variable output and every one independent variable by coffee plot size to urge constant return model specification. The results of the estimation made under both model specifications, under constant returns to scale and variable returns to scale, shows that the log-likelihood function is equal 2.57and -0.06, respectively. Thus, the log likelihood-ratio test is calculated to be -6.82and when this value is compared to the critical value of -2.342, the null hypothesis that the assembly system is characterized by constant return to scale wasn't accepted (Table 4). The estimation result presented in table 5 shows that the return to scale is equal to 0.92. During this case the return to scale is decreasing returns to scale. Thus, production structure, offered these inputs, is characterized by decreasing returns to scale. As a result, a 1% increases all told the indicated production inputs, output increases by 0.92%. Therefore, an increase altogether production inputs by 1% will increase coffee yield by less than 1%. It can be escaped from stage II of production surface by using their existing resources and technology efficiently within the production process. Therefore, there's still subsists opportunities for improving on their existing level of technical efficiency and that they can achieving maximum coffee output from their given quantity of inputs.

4.2.3. Parameter estimates of the SPF model

As showed within the data analysis of the methodological part, the desired Cobb-Douglas functional type of the stochastic frontier model with half-normal distributional assumption of the error terms is reflect to estimate the model or parameters of the model. The parameters were estimated concurrently with those involved within the model for the inefficiency effects. Table 6 presents the results of both the OLS and ML estimates additionally as inefficiency model result. In total twenty parameters were estimated within the stochastic production frontier model including seven within the cobb-daglass production model production frontier model, and eleven explanatory variables were hypothesized to influence the technical efficiency scores while the

remaining two being the parameters related to the distribution of μi and vi. Out of the twenty parameters estimated, two parameter were omitted for multi colinearity one parameter from COBB-DAGLASS PRODACTION MODEL production model and also one from technical efficiency scores and the rest others eleven were statistically significant. From twelve significant parameters, eight were significant at 1% level; 1 were significant at 5% level and three were 10 % significant level Furthermore, the worth of log likelihood function for both OLS estimations and also the stochastic production function was computed. The utmost Likelihood estimates of the parameter of SPF functions together with the inefficiency effects model were presented in

Table 6: Cobb-Douglas production function

Source	SS	df	MS
Model	25369776.5	3	8456592.18
Residual	45530493	367	124061.289
Total	70900269.5	370	191622.35

Number of obs	= 371
F(3, 367)	= 68.16
Prob > F	= 0.0000
R-squared	= 0.3578
Adj R-squared	= 0.3526
Root MSE	= 352.22

logTCPHH	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TLVK	23.02113	3.964229	5.81	0.000	15.22568	30.81659
logCFARE	200.9105	21.32199	9.42	0.000	158.9819	242.8391
logHHFS	28.15585	8.500213	3.31	0.001	11.44062	44.87109
_cons	532.0979	70.64258	7.53	0.000	393.1829	671.0129

4.2.4. Input elasticity and returns to scale

Determination of elasticity is crucial for the estimation of responsiveness of output to inputs. Half of the inputs on the stochastic frontier are statistically significant and have the expected signs. As showed in Table 6, the results of the Cobb-Douglas Stochastic Production Frontier indicated that the estimated coefficients for land(coffee area), generally conform expected positive signs except labor,had a negative sign. The results of the Cobb-Douglas Stochastic Production Frontier indicated that coffee plot, the amount of inputs was found to be important variables in increasing the productivity of coffee. Additionally, coffee plot(area),were significant at 1%. Besides, labor and herbicide showed unexpected result. As indicated in Table 6, the parametric coefficients or partial elasticity of great inputvariables were 0.58 for area, 0.07. These values explain the relative importance of everything about coffee production. Otherwise, a 1%increase within the use of land(coffee area) will result 0.58% increase within the efficiency level of coffee output, respectively. Summation of the partial elasticity of production with relevancy every input for a homogeneous function (all resources varied within the same proportion) is 0.92. This represents the returns to scale coefficient of total output elasticity. If all factors are varied by the identical proportion, the function coefficient showed the share by which output are increased. During this case, the assembly functions are often accustomed estimate the extent of returns to scale. If the sum of all partial elasticity is adequate to one, over one and less than one, then the function has constant, increasing and decreasing returns to scale exists respectively. For that reason, the results showed that the variables per the model had inelastic effect on the output of coffee production. The coefficient parameters summation ofthe partial elasticity 0.92 showed that coffee production within the study area was operated atdecreasing returns to scale. Persistent increase altogether the desired production inputs was lead to about 0.92 to extend in output. Therefore, a rise all told production inputs by 1%, increased coffee yield by less than 1%. Additionally, the study showed that coffee yieldhad the very best responsiveness urea, followed by area and seed allocated to coffee.

4.2.5. Variability of output from the frontier because of technical efficiency differentials

It is shown in Table 6 above that both σ^2 and γ were statistically significant, respectively andshowing the survival of great variation from the frontier function and also the importanceof the technical inefficiency effects in studying the coffee production system within the Zone.

The total difference of output from the potential might not necessarily be caused totally by theefficiency differentials between the sample households. Visible of this, it's necessary todetermine the variability of the output in coffee production within the study area pointed to everyerror components.

The Maximum Likelihood estimation of the frontier model was wont to see the worth forthe parameter (γ), which is that the ratio of the variance of the inefficiency component to the fullerror term ($\gamma=\sigma 2 u / (\sigma2v + \sigma2u) = \sigma2u / \sigma2s$. The γ value showed the relative variability of the one sided error term to the full error-term. One to the farmer's inefficiency problem, which wasunder his/her manage, and also the other one was to the random variation/or typical noise component, which was beyond the management of the farmer. In other words, the degree of variability between observed and frontier output that's influenced by the technical inefficiency was measured. As a result, the overall variation in output from the most might not have necessarily caused efficiency gaps among the sample smallholder farmers. Hence, the error/noise term had also contributed in varying the output level. During this case, it had been essential in determining the relative contribution of both usual random noises and therefore the inefficiency component in total variability. The closer the ratio to 1, the extra the output variability is influenced by technical inefficiency than the standard random variability. The technical efficiency (TE) analysis revealed that technical efficiency score of sample smallholder farmers varied from 27% to 96%, with the mean efficiency level being 68.7%. This variation was also verified by the worth of gamma (γ) that was 0.95. The gamma value of 0.95 suggested that 95% variation in output was due to the differences in disturbance term of smallholder farmers while the remaining 5% was as results of the effect of the technical efficiencies

4.2.6. Value of farm level technical efficiency score

The indices of TE showed that if the average smallholder farmer of the sample could achieved the TE level of its most efficient answerpart, then average smallholder farmers couldincrease their output by 29% approximately [that is, 1- (68.7%/96.6%)] (Table 9). In the same way themost technically inefficient smallholder farmer could increase the production by 71%approximately [that is, 1- (27.7/96.6)] if he could increase the level of TE to his most efficient answerpart. Since the mean TE was 68.7%, it can be figure out that 31.3% of the output was lost due to the inefficiency in coffee producing system or in the inefficiency between the sampledsmallholder farmers or both combined. In the same way on average, output can be increased by at least 31.3% while utilizing obtainable resources and technology given the inefficiency factorswere fully addressed. It also showed that smallholder farmers in the study area, on average,can gain higher output growth at least by 29% through the progress in the technicalefficiency. Furthermore, from the total sample smallholder farmers, around one third of sample smallholderfarmers scored above the mean TE score while almost around two third of sample respondentproduces less than the mean TE score of smallholder farmers in their surrounding area. As a result, the extensive variation in technical efficiency estimates is an indication that smallholder farmers were still using their resources inefficiently in the production process and there wasstill exists opportunities for progressing on their current level of technical efficiency. These results intend that a few smallholder farmers was not utilized their production resources efficiently,showed that they do not attained maximum output from their given quantity of inputs.

4.2.7. Technical efficiency and Input use

Clustering the levels of individual technical efficiency scores into certain classes can givemore picture about the distribution of individual efficiency scores. Clustering of sample respondent based on their efficiency score was based on the relative performance of each sample smallholder farmers to the mean efficiency level.

Input use and yield varied across the two assumed efficiency group were summarized basedon the technical efficiency score. Overall efficiency score was approximately 68% with standard deviation of 15%. The input utilization across various levels of technical efficiency score was also analyzed. The group possessing average TE used 13.18 oxen days and 44.51 MD per hectarein pre harvest farming operations. Additionally, they used seed 16.42 kg/ha and less efficient group used 16.43 kg/ha. It implied that less efficient group of smallholder farmers used the identical quantity of seed as compared to the foremost efficient smallholder farmers (Table 10).

In contrast, the applying of inorganic fertilizers for average and fewer efficient smallholder farmers were different. Additionally, the less efficient group used low level of management as reflected through less human labor days utilized in production. Thus, the clear reason for low inefficiency appears to use less labor in crop production and fewer oxen power allocated under types of seed. Though 87.74% of the sample smallholder farmers grouped under more efficient but was found to use but recommended level of fertilizer.

4.2.8. Estimated actual and potential level of coffee output

The understanding of the individual smallholder farmer efficiency level and their correspondingactual output permits to see what quantity yield is lost thanks to efficiency problems in the existing production practice. The difference between the particular level and also the frontier level of output was computed by estimating the individual and also the mean level of frontier output. likewise, it was possible to search out the potential level of production that might are produced by the smallholder farmer had there been efficient use of the obtainable resources. From the connection of technical efficiency in an exceedingly given period of your time because the ratio of the actual output to the potential output applying (Equation 19) below the potential achievable μ level of coffee yield per ha of every individual farmer was obtained as follows:

$$TEi = Yi/(Y^*)=(f(X ; \beta)\exp(v-\mu))/(f(X ; \beta)\exp(v)) = \exp(-\mu)$$

Then, solving for Y* the potential yield of every sample smallholder farmer is represented as:

Y* = Yi/TEi = f(X ; β)exp(v) -------------------------------------(Equation 19)

Where TEi = Technical efficiency of the i sample smallholder farmer in coffee production

Y*i=The potential output of the i sample smallholder farmer in coffee production, and

Yi =The actual/observed output of the i sample smallholder farmer in coffee production

Using the values of the particular output attained and therefore the calculated technical efficiency indices, the potential output was estimated for each sample smallholder farmers. The mean levels of the actual and potential output during the assembly year were 32.5qt/ha and 45.22qt/ha, (Table 11). As a result, it indicates that there's a space to lift the assembly level on the average by 12.72qt per ha with the present level of input use. Table 11 illustrated that under the prevailing practices there was a scope to extend coffee yield following the simplest practiced smallholder farmers within the area.

Table 7 Comparison of estimated actual yield and potential coffee yield

Efficiency category	**Potential yield per hectare**		**Actual yield per hectare**	
	Mean	Number of smallholder	**Mean**	Number of smallholder
0.25-0.50	36.46	60	16	25
0.51-0.75	39.33	150	24.22	100
0.76-0.95	58.38	90	49.7467	75
Above 0.95	20.04	4	19.25	4
Averagely efficient	38.39	171	31.07	179
Less efficient	36.46	180	16	25
Over all	45.22	371	32.5	371

Source: Computed from Field Survey Data, 2022

Potential yield was also calculated for every smallholder farmer and therefore the results were presented by range of technical efficiency group. In general, for the less efficient smallholder farmers the recorded average actual yield was16 qt/ha. Their corresponding average efficient group potential yield was 38.39qt/ha. On the opposite hand, the online magnitude of yield improvement through efficient utilization of existing resource for fewer and average efficient smallholder farmers was approximately 20.46 and 7.32qt/ha. At zonal level, working towards improving the efficiency of the smallholder farmers could bring additional yield of 2236.81 qt of coffee given 175.85ha of total acreage assigned for coffee production within the study period. These findings may invite attention of the policy makers and Zonal experts to enhance the efficiency of the smallholder farmers through adoption of right strategy to efficiently utilizethe existing resource to enhance the food security of the Zonal.

4.3. Determinants of Technical efficiency

The inefficiency input within the study was grouped under three categories. These were the socio economic and demographic factors, resource related factors, and institutional factor. Factors was education, age and family size the socio economic and demographic, where factors such as farm size,slope of land ,livestock holding ,off-farm income activities, improved seed variety, coffee plot fragmentation and ownership of land, were resource related factors and also the credit access as an institutional factors. The variable of the model was inefficiency and therefore the negative signs implied that a rise within the explanatory variable would decrease the corresponding level of inefficiency (i.e. improvement of efficiency), and also the positive sign is interpreted inversely. It is essential to notice that these coefficients mustn't be directly interpreted rather it only indicated the direction of the results that the variables had on inefficiency and hence marginal effects using the formula recommended by Coelli and Battese, (2005) would be calculated later. Table 6 above explained that the coefficients of explanatory variables within the technical inefficiency model results estimates. Among the explanatory variables entered within the analysis, two variables namely slop and land ownership have showed expected signs the opposite five variables namely education , age, farm size , fragment and improved seed have appeared with unexpected signs, and all were statistically significant and the remaining explanatory variables were expected signs but insignificant. Furthermore, the results of the seven inefficiency variables conform to the priori expectations, within their signs and significance level additionally in determining inefficiency /efficiency of coffee production in the study area.

Before discussing the numerous determinants of inefficiency in coffee production it was important to determine how efficiency and inefficiency were interrelated. The results are often presented in terms of efficiency or in terms of inefficiency. The above results presented in terms of inefficiency and hence the negative sign showed the rise within the value of the variable attached to the coefficient means the variable negatively contributes to inefficiency level or conversely it contributes positively to efficiency levels. Thus any negative coefficient happens to cut back inefficiency which suggests its positive effect in increased or improved the efficiency of the firm contrariwise. In view of that, the negative and significant coefficients of slope and land ownership indicated that improved these factors contribute to reduce technical inefficiency (Table 6). Whereas, the positive and significant variables of education, age, farmsize, improved seed and fragmentation affected the technical inefficiency positively, which increase within the magnitude of these factors aggravated the technical inefficiency levels. The inferences of serious variables on the technical efficiency of the smallholder farmers within the study area were discussed below this.

Education: Education was vital to extend the managerial capacity of the smallholder farmer's in higher cognitive process. The results indicated that a smallholder farmer with more years of formal and informal schooling wasmore efficient than their counterparts (Table 6). As expected, education affects the technical inefficiency of coffee production significantly and positively at 5% level of significance. The positive sign implies that smallholder farmers more educated tends to be less efficient in agricultural production than the less educated ones.

Age: Used as a proxy measure to point the overall farming experience, of the sample smallholder farmers. The variable was hypothesized as the age of the smallholder farmer increases, the smallholder farmer becomes more skillful within the method of production and optimal resource allocation. The positively sign significant at 10% this showed the tiny holder farmer as age increase and increase the ability to operate farming is decrease efficiency of farming activity within the study area.

Farm size: This refers to the full area of soil (own, shared or rented in) that was smallholder farmers managed during 2020/21 production season. It was expected to see the efficiency differential of smallholder farmers within the study area. It was important to judge whether relatively large smallholder farmers was more efficient or not than small ones. Because the farm size increased, the manageability may decrease. On the opposite hand, because the farm size increases, the technical efficiency of the smallholder farmer would be increased.

The result the survey showed positive sign at 10 this important , It indicated that little holder farmer who have more farm size operated less efficient because the inefficiency explanatory which farm size sign positive means operating of farm system made by small holder were technically less efficient.

4.4. Marginal Effects of inefficiency variables

The marginal effects of explanatory variables from FROTIER analysis were computed. The derived values for the many explanatory variables showed that the results of a unit change in those variables. The estimated parameters on the inefficiency model offered in Table 11 only showed the direction of the consequences that the variables had on inefficiency levels (where a negative parameter estimate indicates that the variable decreases technical inefficiency). In contrast, the marginal effect presented on Table 11 below indicates the consequence of inefficiency variables on technical efficiency level. As PerCoelli and Battese, (2005), quantification of the marginal effects of inefficiency variables on technical efficiency was done by partialdifferentiation of the technical efficiency predictor with relevancy each variable within theinefficiency function.

Table 7: Marginal effect of efficiency variables among sample household heads

residual	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AGE	.0071949	.0020409	3.53	0.000	.0031815	.0112082
sex	.1588271	.0508134	3.13	0.002	.0589015	.2587526
trcfm	.0614702	.0481749	1.28	0.203	-.0332667	.1562071
lndfrt	.1081536	.0448679	2.41	0.016	.01992	.1963871
acct	.1188082	.053699	2.21	0.028	.0132081	.2244083
DSFM	.0502291	.0206204	2.44	0.015	.0096787	.0907794
DFM	.0369714	.0179263	2.06	0.040	.0017189	.072224
_cons	1.916026	.1490086	12.86	0.000	1.622997	2.209054

Source: Computed from Field Survey Data, 2022

The above table (Table: 7) indicates the marginal effect of the efficiency measuring variables (this table is interpreted differently, a positive sign indicate a rise in TE). Therefore, so as to extend the yield, they probably must improve the standard of coffee seeds instead of the amount of seed. The marginal change (gain in TE) for an extra year of faculty(education) is 12.6%. This indicated that for considered smallholder farmers a rise in the year of faculty, on the average was increased the technical efficiency by 12.6 %. The marginal effect old 0.004 this means the age of the small holder increase in farm experience technical efficiency increase by0.4% on top of people who had no experience. The marginal effect of farm size 0.065 this indicated that the farm size small holder farmer increased the technical efficiency of small holder increased by 6.5% over who do not increase theirs farm land. In contrast the marginal effect (-0.178) of slope for technical efficiency showed that, a rise in slope, on average his technical efficiency was decreased by 17.8%. The marginal effect for fragmentation is 0.207 indicated that the tiny holder coffee plot parcel increase technical efficiency of afarmer increases by 20.7 % over who had just one plot. Finally the owner ship of land status can be interpreted as the smallholder farmer share crop farm land managing is increase, his private farm land managing technical efficiency decreased by 22.2%, but who does not have managing farm land of the smallholder farmers.

Table 8: Determinants that improve coffee farmers' income in mana woreda

y	exp(Coef.)	Std. Err.	t	P>|t|	[95% Conf.	Interval]
frmsiz	1.031027	.0041209	7.64	0.000	1.022955	1.039164
lbhr	9.18992	5.983376	3.41	0.001	2.554061	33.0668
cost	1.023778	.0107557	2.24	0.026	1.002842	1.04515
impsed	2.40e+21	1.86e+23	0.64	0.524	3.09e-45	1.87e+87
chemipt	2.3e+127	2.3e+129	2.90	0.004	1.14e+41	4.5e+213
sex	4.63e+70	5.60e+72	1.35	0.179	2.32e-33	9.2e+173
age	102.6783	493.7454	0.96	0.336	.0080252	1313724
edul	1.05e-09	2.35e-08	-0.92	0.357	7.54e-29	1.46e+10
lvsch	.4868074	5.120022	-0.07	0.945	5.06e-10	4.68e+08
tring	1.91e-93	1.96e-91	-2.08	0.039	3.1e-181	.0000118
dsfhm	2.37e-28	1.14e-26	-1.32	0.188	1.70e-69	3.32e+13
dsfm	3.27e+12	1.39e+14	0.68	0.500	1.15e-24	9.26e+48
_cons	2.0e+109	6.3e+111	0.79	0.433	4.2e-165	.

4.5. Determinants to improve farmers' income from coffee production

Family size: In the model, the family size had hypothesized to have a positive influence on cost minimization in the form of family labor. It is significant at a 1% significance level and had a positive association with cost minimization.

This study contradicts with (Seifu, *et. al* 2020) The result also showed the dependency ratio of the Jimma area is about 0.89; which is above to National average i.e. 0.81 (World Bank, 2010).

Thus family labor endowments have posetively affected participation in coffee production, given the labor-intensive nature during coffee peak time.

Labour working hour: In the model, the labour hour had hypothesized to have a positive influence on cost minimization in the form of working small amount of payed hour per annum. It is significant at a 5% significance level and had a positive association with cost minimization and increase margin.

This study contradicts with (Seifu, *et. al* 2020) The result also showed using family labour and less payable labour hour have positively affected in coffee production through cost minimization, given the labor-intensive nature during coffee peak time.

Cost of production: hypothesized to have a positive association with on not to use chemical fertilizer, using family labour and less working hour and the model output illustrates that it is significant (at 5 % probability level) and had a positive relationship with the probability of improving farmers income (Table 8).

The result was in line with (Abebaw and Haile 2013; Francesconi and Heerink 2011). indicated that farm income of a given farmer house hold is improved indirectly by minimizing of production costs. For instance, farmers having of a better income from their farm product have a positive effect on decision of community development and have access credit from different micro finances and cooperatives.

Chemical Fertilizer: hypothesized to have a positive association with on not to use chemical and the model output illustrates that it is significant (at 5 % probability level) and had a positive relationship with the probability of improving farmers income (Table 8).

The result was in line with (Abebaw and Haile 2013; Francesconi and Heerink 2011). indicated that farm income of a given farmer house hold is improved indirectly by minimizing of production costs, like purchasing chemical fertilizers.

Training : In the model, having training had hypothesized to have a positive influence on improving coffee production in the form of high volume and Quality coffee production, cost minimization and increase profit margin. It is significant at a 10% significance level and had a positive association with cost minimization.

A trained household head could innovate and adopt timely technology and has a better understanding of the cash crops that can help them to had a better income than those not trained one (Fekadu, 2018; Amaza*et al*., 2016). Therefore, training was expected to have a positive influence on improving an income and profit margin (Divine M. 2014).

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusions

The central aim of this study was to research technical efficiency of smallholder farmer coffee production system in Jimma zone manna woreda. This was realized by measuring the efficiency of smallholder farmers and identifying the factors of technical efficiency those effects of technical efficiency of coffee production. The study used a stochastic frontier model and make use of the cross sectional data of 2020/21 production year covering randomly sampled 372 smallholder farmers in four wereda and selected kebelesof EA(enumeration area) . The sample smallholder farmers were drawn in three stage sampling technique. The study area has crop-livestock agriculture system regarding livestock production, dominated by cattle is additionally as equally important component of the farming system as that of crop production. based on major crop production especially coffee is that the main and therefore the most produced crop within the area produced by smallholeder farmer, the second stage from those area CSA used the survey for AGSS year to year in order that using csa sample technique to pick out sample units and EA within the final from randomlyselected EA, select smallholder farmer purposely who produced coffee for the production year of 2020/21 are selected for the study.

Production of coffee by smallholder farmers in Jimma zone manna woredaplays a key role in alleviating poverty, since coffee is the staple food within the Zone. The presence of inefficiency and therefore the combine explanatory power of the considered inefficiency effect variables were formally checked. Consequently, Parameters of the stochastic frontier function (from which efficiency scores have to be measured) and inefficiency effects model were account thus, estimated by the maximum likelihood methods in an exceedingly single stage estimation procedure. Additionally, the assembly structure was characterized by decreasingreturns to scale since summation of the inputs coefficient is 0.92. The implication of such aresult is that a proportional increase all told the factors of production results in a lessproportional increase in output. The results obtained from the stochastic frontier estimation indicated that inefficiency was present in coffee production between smallholder famers. Sufficient verification of positive relationship among coffee productivity and better use of intermediate inputs like NPS, Urea and coffee plot(area) utilization were practiced. The results of efficiency analysis indicated that smallholder farmers could progress their efficiency by operating closer to production frontier. Hence, there existed considerable range to expand output and also productivity by decreasing the average yield gap among the foremost efficient and fewer efficient farm smallholder farmers.

At Zonal level, working towards progressing the efficiency of the smallholder farmers could bring additional gross output of 2236.81 quintal of coffee given 175.85 ha of total farm areaallocated for coffee production. This amount of output and efficiency within the utilization of production input can be attained significantly by giving more attention to the technical efficiency. Some of the areas which demand more attention were availability of NPS, Urea and adoption of recommended seed practices in coffee cultivation. More over technical efficiency increased with the decreased slope and crop sharing farm land ownership status and education, age, farm size,improved seed and fragmentation decreased efficiency. Thus, it absolutely was needed in a very priority basis to invest on improving quality of public education and explore on quality based improved seeds. The mean technical efficiency level of sample households was about 68.7% with the minimum and maximum of 27.7% and 96.6%, respectively. this means that there's a clear stage to improve coffee output from the obtainable level if appropriate reallocation of basic inputs measures is given due attention. The worth of the discrepancy ratio, γ, calculated from the Maximum Likelihood estimation of the frontier was 0.95 with the quality error of 1.099724. The coefficient of 95% of the variability in output for coffee producer sample smallholder farmer was attributed to technical random noise effect, while the remaining about 5% variation in output is thanks to the effect of inefficiency. On the entire, a very important conclusion stemming from this study is that, there exists a considerable room to cut back the extent of technical inefficiency of coffee production within the Jimma zone manna woreda. Therefore, mixed development endeavors which will improve the prevailing level of input use and policy measures towards decreasing the prevailing level of inefficiency will have Paramount importance in improving the food security of the study area.

5.2. Recommendations

Based on the above results, the subsequent essential recommendations were given: The study validated that there was a sign of a good potential for coffee productivity progress in utilizing the obtainable experiences of few happier smallholder farmers and Demonstration of improved coffee technologies. The positive and statistical significance of major traditional inputs like coffee plot/area, seed variety,Urea show the importance of conformist inputs in smallholder farmers Implying more access and use of those inputs could guide to higher coffee production and productivity within the study area. Improving the productivity of those factors of production is necessary.

It equips smallholder farmers with the required agricultural farming knowledge thereby facilitating information dissemination regarding modern agricultural technology, input utilization, technical knowhow and environmental preservation that shifts their production frontier outward. Therefore, formal and informal quality education in agriculture must be provided kidsfor college and farmers to boost their technical efficiencies in coffee production. consequently, the government have designed capacity building programs should be placed and performed so as to capacitate the smallholder farmers development project through vigorous grass-root level extension work, farmers' active participation, on-farm demonstration and trials and proper guidance of the farmers should be increased within the study area.

Chapter Six

6. References

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7. Appendices

Apendex1 questionnaire

Jimma University

College of Business and Economics

Department of Economics

Dear respondents,

This is a questionnaire that intended to assess the Economic efficiency analysis of smallholder coffee producers in ManaWereda, JimmaZone,South West Ethiopia. The information you provide is totally sought for academic purpose and shall be kept strictly confidential. Please feel free to share your comments and experiences regarding factors affect your economic inefficiency coffee production.

Thank you in advance for your cooperation.

Name of Respondents--------------------------------Kebele--------------------------------

I. *Background Information*

1. Sex of the household head

   01= Male 02= Female

2. Marital status:

   01= Single 02= Married 03= Divorced 04= Widowed

3. Age of the household head---------------years old.

4. Educational back ground (Literacy) of the household head

   01=Illiterate 02=Literate(Specify level in years of formal education--------------)

5. What is house hold Size? ______________

6. What is the total number of family who are belonging in the working age? _______

7. How long have you lived in this community?

   01=Less than 5 years 02=5 to 10 years 03=more than 10 years

II. Land ownership and utilization

1.What is your main source of income?--

2.Is there a provision of credit service? 01=yes 02=no

3.Ifyes,do you use the credit provision? 01=yes 02=no

4.If your response is no,What is your reseon?--
----

5. Is there a family member that participate on off farm income activity? 01=yes 02=no

6.Have you hired labor for your coffee farm in the 2019/2020 production season?

01=yes 02=no

7.What is the total livestock holding of the household owns interms of Tropical Livestock Unit(TLU) ? ______

8.On what land the household produce coffee?

01=Own 02=Rented 03=Other

9. What is the the total coffee area of the household in hectares?

01=Less than one hectare

02=1 to 3 hectare

03=4 to 5 hectare

04=6 to 10 hectare

05=over 10 hectare

10.What is the kind of the landscape of your farm area?

01=Lowlands 02=Middle lands 03=Highlands

11. How long have you been a farmer?

01=Less than 5 years 02=6-10years 03=11-20 years 04=over 20 years

12. Is your farm land fertile?

01= Yes 02= No

13.If your answer is no for question no.12 Do you use fertilizer for production of coffee in 2019/2020 year? 01= Yes 02= No

14.Whom do you harvest your coffee farm with?

01=Family 02=Labour 03=Both

15.If your ansear for question no.14 is 02.How much is the total cost of labour it incurs per hectar during the production period?

16.Do you have problem in supply and marketing of artificial fertilizer? 01= Yes 02= No

17.Ifyes,what are the major problems of supply and marketing of artificial fertilizer?

01=Not supplied timely 02=There is shortage of fertilizer supply 03=The price is high 04=The market is far from home 05=Other

18.Is the agricultural developmental agent visit your coffee farm land? 01= Yes 02= No

18.1 . If yes,On what interval the agricultural Development agent visit your coffee farm land?

01= Weekly 02=Monthly 03=Quarterly 04=Not at all

18.2 If no,what is thereseon?--

18.3 Did you get any practical training on coffee production over the last three years?

01= Yes 02= No

18.4 If yes types of training---------------------------------duration--------------------------

19. How far is the coffee plot from home?

01=Near to house 02=Little far 03=Too far from house

20. How much is the distance of the nearest market from your home?

01=Near to house 02= Little far 03= Too far from house

21.Do you have problem with regards to Coffee marketing? 01=Yes 02=No

21.1 If yes,What are the major problem?--

21.2 In your opinion,What would be the solution for this problem?--

22. What is the frequency of weeding?

01= continuously 02= Quarterly 03=Once a year

Name of Enumerator---Date-------------------------

Kebele-------------------------------------

Gaaffannoo

YuniversitiiJimmaatti

KolleejjiiBiizinesii fi Iconomiksii

MuummeeEconomicsii

KabajamtootaDeebistootakeenyaa

Gaaffileearmaangadiikanqophahanqorannoobu'aqabeessummaadiinagdeeoomishtootabunaaAanaaMaannaa,GodinaJimmaa ,KibbaLixaItoophiyaati.Odeeffannoonisinkennitanguutummaanguutuuttidhimmaqorannoofqofakanoolu fi iccitiinisaakaneegameedha.Kanaafyaadakeessan fi muuxannoooomishabunaairrattiqabdanofqabuutokkomaleeakkanuuqooddanisingaafanna.

Deeggarsanaagootanuufdurseenisingalateeffadha.

Maqaanamadeebiikennuu------------------------------------Ganda-----------------------

I. Odeeffannoodhuunfaa

1.SaalaAbbaawarraa

01=Dhiira 02=Dubara

2.Haalagaa'ilaa

01=Hinfuune 02=Kanfuudhe 03=Kanhikee 04=Kanirraadu'e

3.Umuriiabbaawarraa/Haadhawarraa --------------------waggaa

4.Haalabarnootaaabbaawarraa

01=Kanhinbaranne 02=Kanbarate(sadarkaabarumsaisaakutaanibsi---------------)

5.Baayyinnimaatiimeeqa?---------------

6.Baayyinnimaatiigulantaahumnahojjatu(Hojiifqophiitahe) keessajirumeeqa?

7.Hawaasahammawaliinjiraataartuwaliinwaggaameeqawaliinjiraatte?

01=Waggaashaniigadi 02=shaniihangakudhanii 03=waggaakudhaniiol

II. Haalaqabiyyee fi ittifayyadamalafaa

1.Maddigaliikeeinniijoomaali?---

2.Naannooatijiraattuttidhiyeessiinliqiijiraa? 01=Eeyyee 02=Lakki

3.Gaaffiiarmaanoliifeeyyeeyoojette,dhiyeessiiliqiittihinfayyadamtaa?

01=Eeyyee 02=Lakki

4.Gaaffiiarmaanoliifdeebiinkeelakkiyoota'esababnikeemaali?--------------------------------------

5.Miseensamaatiikeekeessaahojiiqonnaatiinalagaliikanargatujiraa?

01=Eeyyee 02=Lakki

6.Hojiioomishaqonnaabara 2019/2020 'f hojjataaqaxaratteehojjachiifatteettaa?

01=Eeyyee 02=Lakki

7.Baayyinnihoriimanaaqabdumeeqa?-------------------------------

8.Lafaeenyuurrattibunaoomishaajirta?

01=kandhuunfakoo 02=Kirreeffadhee 03=Kan biro

9.Ballinnibunakeeheektaaraanmeeqa?

01=Hektaara tokkoogadi

02=Hektaara 1 hanga 3

03=Hektaara 4 hanga 5

04=Hektaara 6 hanga 10

05=Hektaara 10 oli

10.Haalliteessuma(olka'iinsa) qonnalafakeetiimaali?

01=Gadiaanaa 02=Giddugaleessa 03=Olka'aa

11.Ergaqonnaanbulaataatewaggaameeqa?

01=Waggaashaniigadi 02=Waggaa 6 hanga 10

03=waggaa 11 hanga20 04=waggaa 20 oli

12.Laftiqonnakeetiigabbataadha?

01=Eeyyee 02=Miti

13.Gaaffiiarmaanoliifdeebiinkeemitita'eoomishabara 2019/2020

dhiyeessiixaa'oofayyadamteettaa?01=Eeyyee 02=Miti

14.Sassaabbiioomishabunaaeenyuwaliinraawwatta?

01=Maatiiwaliin 02=Hojjataahumnaan 03=Lamaanuu

15.Gaaffiiarmaanoliifdeebiinkeehojjataahumnaatiinkanjedhuyoota'ebaasiinhumnaabaraoomi shakanaahektaaraanmeeqa?--------------------

16.Dhiyeessii fi gurgurtaaxaa'oonamtolcheenwalqabateerakkoonsiqunnamejiraa?

01=Eeyyee 02=Miti

17.Gaaffiiarmaanoliifdeebiinkeeeeyyeeyoota'erakkoongamakanaansiqunnamemaali?

01=Yeroobarbaadamettihinjdhiyaatu 02=Hanqinadhiyeessii calla

guddistutujira03=Gatiinisaaolka'aadha 04=Laftigabaafageenyaqaba 05=Kan biro

18.Ogeessihojjataamisoomaalafaqonnaakeenidaawwataa? 01=Eeyyee 02=Miti

18.1 Gaaffiiarmaanoliifdeebiinkeeeeyyeeyoota'eyeroohagamiikeessattidoowwata?

01=Torbeetti al tokko 02=Ji'attialtokko 03=Kurmaanaattialtokko

04=doowwataniihinbeekan

18.2 Gaaffiiarmaanoliifdeebiinkeemitiyoota'esababniisaamaali?-----------------------------------

18.3 Waggotasadandarbeoomishabunaanwalqabateeleenjiinfudhattejiraa?

01=Eeyyee 02=Miti

18.4 Gaaffiiarmaanoliifdeebiinkeeeeyyeeyoota'egosaleenjichaaibsi------------------------------

turmaatayerooleenjii---------------------------

19.Laftqonnakeemanajireenyakeeirraahagamfagaata?

01=Dhiyoo 02=Xinnoofageenyaqaba 03=Manajireenyakooirraabaayyeefagaata

20.Gabaabunaatiinwalqabateerakkoongabaasiqunnamejiraa? 01=Eeyyee 02=Miti

21.1Gaaffii armaanoliifdeebiinkeeeeyyeeyoota'erakkoonijoota'emaali?--------------------------

21.2 Akkailaalchakeettirakkooarmaanoliitticaqasteeffurmaannimaalta'uuqabajetta?------------

22.Yeroohagamiikeessattibunakeejalaaaramaamaqsita?

01=Ittifuufiinsaan 02=Ji'asadisaditti 03=Waggaattialtokko