ST.MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

INISTITUTE OF AGRICULTURE AND DEVELOPMENT STUDIES

ANALYSIS OF TECHNICAL EFFICIENCY OF GREEN MUNG BEANS IN JILLE DHUMMUGA WEREDA AMHARA NATIONAL REGIONAL STATE OROMIA ZONE, ETHIOPIA

BY

MOHAMMED HASEN

MAY /2019

Addis Ababa, Ethiopia

ST.MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

ANALYSIS OF TECHNICAL EFFICIENCY OF GREEN MUNG BEANS IN AMHARA REGIONAL STATE OROMIA ZONE JILLE DHUMMUGA WEREDA, ETHIOPIA

BY

MOHAMMED HASEN AREBIYYE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS

ADDIS ABABA, ETHIOPIA

MAY, 2019

ST.MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

I hereby certify that I have read and evaluated this thesis entitled Analysis Technical Efficiency of Green Mungbaen in Amhara Regional State Oromia Zone Jille Dhummuga wereda, Ethiopia prepared under my guidance by Mohammed Hasen. I recommend that it has been submitted as fulfilling the thesis requirement

____________________________ ______________ __________________

Name of major advisor Signature Date

As members of the Board of Examiners of the MSc Thesis Open Defense Examination, I certify that I have read and evaluated the thesis prepared by Mohammed Hasen and examined the candidate. I recommend that the thesis be accepted as fulfilling the thesis requirement for the Degree of Master of Science in Agricultural Economics.

1.______________________________________ _______________ _____________

Name of Chairman Signature Date

2. ______________________________________ _______________ ______________

Name of Internal Examiner Signature Date

3._______________________________________ ______________ ______________

Name of External Examiner Signature Date

Final approval and acceptance of the Thesis is contingent up on the submission of its final copy to the council of Graduate studies (CGS) through the candidates department or school graduate committee (DGC or SGC).

DEDICATION

I dedicated this Thesis manuscript to my beloved mother for the dedication she made in the success of my life.

STATEMENT OF AUTHOR

First all, I announce that this thesis is the result of my own work and that all sources of materials used for this thesis have been duly recognized. This thesis has been submitted in partial fulfilment of the requirements for M.Sc. degree at St. Mary University and is deposited at the University Library to be made available to borrowers under rules of the Library. I seriously declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the department or the Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Muhammed Hasen Arebiyye …………………

Signature:

Place: St. Mary University, Addis Ababa

Date of Submission: …………………

ACKNOWLEDGEMENTS

First of all, I would like to thank the Almighty God Allah for being with me in all aspects of my life.

In next, I would like to thanks heartily to my advisor Wendimagegn Chekol (PH.D.) for his patience to advise me on different external challenges faced me, in addition to, valuable advice, insight and guidance to the completion of the research work. I have also an appreciation for his hard working starting from proposal development to the final accomplishment of the study.

I would like also to express my sincere gratitude to Artuma Furse wereda administration for the impartial financial support to pursue my post graduate study. I would like to extend my heartfelt gratitude to my friends Ato Arebu Ali, Ato Husein Ibrahim, Ato Ahmed Ibrahim, Ato Alemu Assefa, Ato Jemal Indiris, Ato Ahmed Muhe, Ato Ahmed Hasen, Ato Jemal Umer and Ato Kebir Hasen for encouraging and facilitating necessary requirement for my study. Truly speaking they have made an enormous contribution for the success of my work

Finally, my special gratitude go to my beloved families, specially my mother Zahra Ahmedu for her priciest du’a for my success, my wife Fozia Seid, my son’s Fowzan and Salman for their patience during my study work mainly done at the expense of the time they deserved to have with me.

TABLE OF CONTENT

List oF Figure

List of Tables

ACRONYMS

ACSI	Amhara Credit and Saving Institute
AE	Allocation Efficiency
AGP	Agricultural growth Program
ANRS	Amhara National Regional state
AVRDC	Asian Vegetable Research Center
CSA	Central Statistical Agency
ECX	Ethiopian Commodity Exchange
ECEA	Ethiopian Commodity Exchange Authority
E.C	Ethiopian Calendar
EE	Economic Efficiency
EPA	Ethiopian Plan Agency
FTC	Farmer Training Centre
GDP	Growth and Domestic production
GRDC	Grains Research and Development Center
GTP	Growth and Transformational plan
HH	House Hold
JWAO	Jille Dhumuga wereda Agriculture Office
SFPF	Stochastic Frontier Production Function
MoA	Minister of Agriculture
TLU	Tropical Livestock Unit
TE	Technical Efficiency
TFP	Total Factor of Productivity

ANALYSIS OF TECHNICAL EFFICIENCY OF GREEN MUNG BEANS IN ANRS JILLE DHUMMUGA WEREDA OROMIA ZONE, ETHIOPIA

ABSTRACT

Dry land areas are experiencing low agricultural yields due to severe water shortages weather variability and salinity, leading to food scarcity. Green mungbean is gaining attention as a short-season crop that can tolerate dry land conditions, and fix atmospheric nitrogen and decreasing soil nutrient depletion. Increasing productivity and efficiency of green mungbean production in particular could be an important role towards achieving food security. This study was conducted to assess the technical efficiency and factors affecting efficiency of green mungbean production in Jille Dhummuga district of Oromia Zone Amhara regional state, Ethiopia. Both primary and secondary data sources were used in this study. The primary data relating to farm production, input usage, and socioeconomic and institutional factors were collected during 2017/18 cropping year through a structured questionnaire from randomly selected 170 green mungbean farmers. The stochastic frontier and translog functional form with a one-step approach were employed to assess efficiency and factors affecting efficiency in mungbean production. The mean technical efficiencies were found to be 84.9% for mungbean production. This implies that it is possible to increase green mung bean yield up to 15.1%. The production efficiency of this green mungbean farming was determined by gender, age, education, farm size, farm experience, livestock population, family size variability and climate change. Policy implications drawn from this study include support initiatives like improving access of improved seed quality, productive agronomic practise gender-sensitive agricultural intervention; improvement, encouraging group approach extension service, scaling out of best practices and promotion to the multi-dimensional importance of green mungbean.

Key words: - Green mungbean, economic efficiency, Technical efficiency, Stochastic Frontier model, Jille dhummuga

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

In Ethiopia, agriculture is the main option for stimulating growth, overcoming poverty, enhancing food security and improving distribution of income among the poor households. The Agricultural sector in Ethiopia contributes about 42% to the total gross domestic product (GDP), provides 85% of employment opportunities, constitutes more than 80% of the nation's total exports, and provides most of the foreign exchange earnings to the economy (EPA, 2012). It also plays an important role in providing raw materials for domestic industries.

In Ethiopia, effective economic development strategy depends critically on promoting productivity and output growth in the agricultural sector, particularly among smallholder producers. This can be achieved not only by generating and introducing high yielding varieties of crops but also by considering production efficiencies in relation to scarce resources. The concept of efficiency is concerned with the relative performance of the processes used in transforming a given inputs into outputs. In any production of output, there are three types of efficiencies (technical, allocation and economic efficiencies).

Technical efficiency shows the ability of firms to employ the 'best practice' in an industry, so that no more than the necessary amount of a given sets of inputs is used in producing the best level of output. Allocation efficiency refers to the ability to combine inputs and outputs in optimal proportions in light of prevailing prices. Economic efficiency is the product of technical and allocation efficiencies (Bifarin et al., 2010).

Green mung bean is one of the most important food legume crops in South, East and Southeast Asia, where 90% of global production currently takes place. Mungbean is a relatively drought-tolerant and low-input crop that can provide green manure as well as livestock feed and thus is favoured by smallholder farmers, the Mungbean Management Guide, 2nd edition, A.M.A (2010).

Teodor. R, et, al(2014) describe that the potential yield of green mung beans in experimental center of northern east of Romania was presented that yield ranged from 1.42 t/ha for PA5 genotype to 2.59 at PA3 genotype of green mungbaen. This shows that research centres were releasing a variety of green mungbean through adoption of technology with high potential of yield per hectare.

Jayne Gentry, (2010) noted that the potential yield of green mung bean of Australia, in case of fallow the yield was in range of 0.75 – 2 ton/hectare and in case of irrigation the yield increase to arrange of 1.33 – 2.75 ton/hectare. Mung bean management guide 2nd edition Department of Employment, Economic Development and Innovation of Australia. In similar Jayne Gentry, (2010) describe that Crystal and Salin II genotype of green mung bean were released by the National Mungbean Improvement program under license of the Australian Mungbean Association in 2008 with consistent performance in all region of Australian for 5 years have an average of 20% higher yield than the other.

According to M.A. Haque, et,al 2014, the average yield of mung bean production in same selected area of Bangladesh was found to be 1196 kg per hectare, where the yield was highest at Jessore (1211kg /ha) followed by Kushtia (1189 kg /ha) and Barisal (1187 kg /ha) of Bangladesh region.

Despite the importance of green mung beans as a food and export crops, the efforts made to generate and distribute improved production technologies for green mung beans was insignificant, its productivity remains far from its potential. According to Habte U, (2018), the maximum grain yield of green Mungbean was 786.8kg/ha which was harvested from Borada research canter of west hararge of Ethiopia. Mohammed .A,et,al (2015), noted that 150,000 to 200,000 quintals of Mung bean, known in Amharic as „Masho‟, is produced per year in Ethiopia. Minister of Agriculture reported that the productivity of green mung bean expected to decrease from 12.35kum/hec 10.05 kun/hec.

Dry land areas are experiencing low agricultural yields due to severe water shortages and salinity, leading to food scarcity. Mungbean(Vegan radiate) is gaining attention as a short-season crop that can tolerate dry land conditions, and fix atmospheric nitrogen, decreasing soil nutrient depletion. Pataczek, L, et, al (2018). Ethiopia is one of the countries of east Africa severing from drought because of climate change with high prevalence of food security. In spite of multi-dimensional importance of green mungbean, very little attention has been paid to its productivity improvement in the country. Moreover, the yield gap in relative to the Asian countries suggests that there is a potential for increasing production and productivity of smallholder green mung bean farmers.

Ethiopia gifted various agro ecological zones and diversified natural resources, which has been known as the home land and domestication of several crop plants. Pulse crops are important components of crop production in Ethiopia's smallholder's agriculture, providing an economic advantage to small farm holdings as an alternative source of income and food security. Moreover, some of them have also played an important role in the export sector generating foreign currency for the country. The major pulses grown in Ethiopia are: Horse beans, chickpeas, haricot beans, lentils, dry peas, vetches and mung bean.(Mohammed A,et al, 2017)

The green mungbean (Vigna radiata) has been grown in India since ancient times. It is still widely grown in Southeast Asia, Africa, South America and Australia. It was apparently grown in the United States as early as 1835 as the Chickasaw pea, Ministry of Agriculture, Forestry and Fishery of RSA (2010). The first commercial green mung bean varieties grown in Australia in the late 1960s and 1970s were varieties introduced (GRDC 2011). Mung bean is a recent introduction in Ethiopian pulse production grown in limited area in smaller quantity. It has green or yellow skin and sweet in flavor. It is drought resistant crop compared to other pulse crops. However, its consumption is not widespread like the other pulses in the country. Reliable information is lacking on the potential and actual production levels of mung bean at the national scale in Ethiopia.(Mohammed A, et al, 2017)

However, little of this legume's potential has been explored. This review aims to underline the economic importance of mung bean as an agricultural crop by reviewing relevant literature on the potential contribution of mung bean to economic efficiency, food security and a balanced diet as well as the effect of mung bean cultivation on farm income and environmental impact in case of Oromo Zone.

1.2 Statement of the Problem

Agricultural output can be increased either through introduction of modern technologies or by improving the efficiency of inputs such as labour and management at the existing technology. In other words, productivity can be increased through dissemination of improved technologies such as fertilizer and high yielding varieties and/or by improving the productive capacity of say the manager (the farmer). These two are not exclusive because the introduction of modern technology could not bring the expected shift of production frontier, if the existing level of efficiency is low. This implies the need for the integration of modern technologies with improved level of efficiency (Fekadu, 2004). Theoretically, introducing modern technology can increase agricultural output. However, in areas where there is inefficiency, trying to introduce new technologies may not have the expected impact and "there is danger of trying to rediscover the wheel", if existing knowledge is not efficiently utilized (Tarkmani and Hardakar, 1996).

Recently different studies were conducting on the low land and dry land areas on drought tolerant cereals and pulses crop. It is getting importance to use these droughts tolerant varieties at the optimum level which can be determined by efficiency searches. The Ethiopian Statistical Agency report of 2017/18 indicated that the mungbean productivity level was 12.35 and 12.47quintals per hectare at national level and in Amahara region respectively. Which have wide difference with the finding of Teodor. R, et, al (2014) in northern east of Romania having yield ranged from 1.42 t/ha to 2.59 t/hec for PA3 genotype and Jayne Gentry, (2010) describe the potential of yield mungbean in Australia was arranged from 1.33 – 2.75 ton/hec of green mungbaen. .This shows as production and productivity of the crop remain in a question in relating to the potential of the crop in Ethiopia in general and in study area, in particular.

Increasing productivity within the agricultural sector particularly among smallholder producers requires a good knowledge of the current efficiency or inefficiency inherent in the sector as well as factors responsible for this level of efficiency or inefficiency. Based on the technical efficiency of green mungbean in the contexts of ecology of the country, the effort of direct policy makers and development practitioner's on the strategic conceptual and empirical analysis in the context of the efficiency of green mung bean productivity is insignificant. Moreover, the findings of few previous studies are not consistent with the gap, and there is no previous study on the technical efficiency of the smallholder framers in the study area in particular.

Therefore, this study is an attempt towards assessing the technical efficiency of the farmers in the study area and aims to bridge the prevailing information gap on the contextual factors contributing to efficiency differentials in the production of green mungbean. Because, the assumption that farmers produce the same level of output, given the same level of inputs and technology appears to be unrealistic. To that end, this study tried to answer the following research questions: what is the technical efficiency of green mung bean farmers? What are the factors affecting farmer's technical efficiency in the study area?

1.3. Objective of the Study

1.3.1. General Objective

The general objective of the study is to assess the technical efficiency of green mung bean in relating to factors affecting technical efficiency and to direct the remedial solution in case of Oromo zone Jillee Dhummuga district

1.3.2. Specific Objective

- To measure the technical efficiency of mungbean farmers in case of oromo zone Jille Dhummuga district
- To identify factors affecting technical efficiency of mungbean farmers in case of oromo zone Jille dhummuga district
- To indicate remedial solution for the inefficiency determinants

1.4. Research Hypothesis

1. $H_0:\beta_i = 0$ Coefficient of the second-order variables in the traslog model are zero (Cobb-Douglas)

   $H_1: \beta_i \neq 0$, Coefficients of the second-order variables in the translog model are different from zero.
2. $H_0: \gamma = \delta_i = 0$, Inefficiency effects are absent from the model (all farms are fully efficient)

   $H_1: \gamma > 0, \delta_i \neq 0$, Inefficiency effects are present in the model (all farms are not fully efficient)
3. $H_0: \delta_i = 0$, There are no farm specific factors on technical inefficiency

   $H_1: \delta_i \neq 0$, There are farm specific factors on technical inefficiency

1.5. Significance of the Study

This paper is elaborating the technical efficiency of green mungbeans production and indicates the remedial solution for the basic challenges in the production of the crop. So this paper is significant for policy makers to take measure and to prepared intervention policy on the problem area. In addition to the above the result of this study is important for government and nongovernment institutions those participated on reducing social problems to concentrate on the problem area.

1.6. Scope and Limitation of the Study

The study is geographically focused on the economic importance of Mung bean production in oromo zone while the limitation on understanding is very wide and most of the problems were leading to malnutrition in drought area of the country and loses of foreign currency. In similar the studies topic analysis of economic efficiency of mung beanie is so wide so on this study the writer more focused on the economic importance of mung bean production. Therefore the study has same conceptual and analysis limitation.

The study has certain methodological limitations. Since the study is descriptive type of study were the writer uses observation as a study design may causes certain limitation. The data source of this study is mostly related studies, reports of concerned bodies and field observation most of the data was secondary data. So there might be certain shortage on the data source. In addition to the above there might be limitation on level of analysis of the data. So the researcher specifies that the results should be accepted on the condition of those limitations.

1.7. Organization of the Study

Chapter one deals with the background of the study, statement of the problem, objectives, hypothesis, significance, scope and limitation of the study. Chapter two review literature [theoretical and empirical] was related to the research topic. Methodology issues were presented in Chapter three.

CHAPTER TWO

2. REVIEW OF LITERATURE

2.1. Theoretical Concepts Technical Efficiency

In production theory the main choices centred on what to produce (i.e., enterprise choice or combination of products), how much to produce (the levels of output) and how to produce (the combination of inputs to use) (Kenneth et al., 1999). Although firm is not analogous to farm, the process and problems of farm production with the application of economic theory is dealt with in the field of agricultural production (David, 2012). In the theory of farm production, the farm household instead of the individual farmer is the decision-making unit. The conventional theory of the firm assumes that firms in different sectors of the economy are homogeneous and are guided by the sole motive of profit maximization (Kenneth et al., 1999; David, 2012). It generally treats the firms, which are responsible for production, and households, which consume the products, as separate entities. Firms are supposed to purchase all their inputs and sell all their products with the aim of maximizing profits, while households supply labour and other resources for hire and use the proceeds to purchase the goods and services they desire (David, 2012).

Consequently, there is a basic difference between a firm assumed in the conventional production theory and a farm firm, particularly a smallholder farm dealt with in the theory of agricultural production. A farm household is both a producer and a consumer of the produce. For peasant farm households, as they are often called, the primary goals are other than profit maximization (David, 2012; William and Ronald, 2005).

Certainly, in the agricultural sectors of developed and developing countries there are farms producing cash crops for the domestic or foreign market, that may fall within the conventional definition of a firm (Udry, 1979). Besides, the farm household unit is both a family and an enterprise that simultaneously engaged itself in both production and consumption activities (Bardhan and Udry, 1999). This dual economic nature of the farm household has its own implications for the economic analysis that can be made. The hypothesis that farm households are efficient is attributed to the farm household motivation of profit maximization, farmers in developing countries are 'poor but efficient' (Schultz, 1964).

The strict definition of economic efficiency also requires a competitive market, since neither the individual production unit nor the sector can attain efficiency if different producers face different prices or if some economic agents can influence the prices and returns of other agents (Ellis, 1993). While this would seem to rule out the discussion of efficiency in the context of farm household, it does not mean that strong elements of economic calculations can't exist in the context of the multiple goals and constraints of the farm household (Xu. X. and Jeffrey.S.R. 1998). Most of the agricultural policy and planning in developing countries are based on this maxim. This suggests that there are virtually no aspects of farm household that are not touched efficiency considerations. Profit maximization behaviour conditional on constraints and markets confronted by farmers may exist though efficiency is not observed. Hence, the concept of efficiency can well be applied in the context of farm household production activities.

The neoclassical theory of production is based on the notion of efficiency, i.e., firms are efficient and whatever inefficiency comes in the process of production is due to external shocks or statistical noise which is entirely beyond their control. This idea is emphasized in the textbook definition of a production function, which gives the maximum possible output for given quantities of inputs. One problem with the concept of maximum is that nobody can recognize it simply by observing the actual level of output unless the observed output is assumed to be the maximum. Such an assumption is not realistic since different producers do produce different levels of output even if they use the same level of every observed input. One way of explaining the difference in observed outputs among producers is through differences in productive efficiency (Coelli et al., 2005).

Efficiency is a very important factor of productivity growth, especially in developing agricultural economies where resources are meagre and opportunities for developing and adopting better technologies are dwindling Greene W.H. (2003) and Bifarin et al., (2010). Such economies can benefit greatly by determining the extent to which it is possible to raise productivity or increase efficiency, at the existing resource base or technology. For efficient production, non-physical inputs, such as experience, information and supervision, might influence the ability of a producer to use the available technology efficiently. Each type of inefficiency is costly to a firm or production unit (e.g., a farm household), in the sense that, inefficiency causes a reduction in profit below the maximum value attainable.

2.1.1. Concepts of productivity and efficiency

Often, many scholars used productivity and efficiency interchangeably and consider both as the measure of performance of a given firm. However, these two interrelated terms are not precisely the same (Coelli et al., 2005). In simple terms, productivity is the quantity of a given output of a firm (e.g. a farmer) per unit of input. Though the concepts are related, in general, productivity can be thought of as being a broader concept than efficiency. Both concepts can be related to a production function which the primitive (in the single output case) is representing the transformation of inputs to output. From a conceptual viewpoint, productivity and efficiency measurement can be classified into the frontier and non-frontier approaches and from an implementation viewpoint, into parametric and non-parametric. Now let us consider the simple case of one output, one fixed factor of production – capital and one variable factor of production – labour. A measure of partial productivity could be labour productivity, which is output per unit of labour input, or, the average product of labour. An increase in the average product of labour would represent an increase in productivity. However, as discussed below; this could come from a variety of sources.

2.1.2. Concepts of stochastic production function

To understand the stochastic and deterministic nature of production function, it is very important to present the stochastic production function proposed by Aigner et al. (1977); Meeusen and Broeck (1977) as follows:

$$Q_i \ = exp(\beta_o + \ \beta_1 \ln x_i \ = \exp(x_i'\beta) \text{ -- } (2.1)$$

$$Qi = exp(\beta_o + \ \beta_1 \ln x_i + v_i - u_i \ = \ \ \exp(x_i'\beta + \ v_i - \ u_i) \text{ -------------------- } (2.2)$$

Where Equations 2.1 and 2.2 represent deterministic and stochastic frontier respectively. The second equation is by adding a systematic error to account for a statistical noise (arises from omission of relevant variables and measurement error, and approximation errors associated with the choice of functional form. The stochastic frontier production function is simply because the output values are bounded from above by the stochastic (i.e. random) variable; v_i (can be positive or negative (Figure 1).

Figure 1 represents the important features of stochastic frontier model. To be convenient, it is better to restrict attention to firms (farms) that produce the output, $\mathbf{Q_i}$ using only one input, $\mathbf{X_i}$ and plot the values of inputs along the horizontal axis and outputs (vertically) of two firms A and B. Here the deterministic component of the frontier model was drawn to reflect the existence of diminishing returns to scale (Figure 1). These two firms could have either a frontier (Q_A^* and Q_B^*) and observed outputs (Q_A and Q_B).

$$Q_A^* = \exp(\beta_o + \beta_1 \ln X_A + V_A) \text{ -- } (2.3)$$

$$Q_B^* = \exp(\beta_o + \beta_1 \ln X_B + V_B) \text{ -- } (2.4)$$

$$Q_A = \exp(\beta_o + \beta_1 \ln X_B + V_B - U_B) \text{ -- } (2.5)$$

$$Q_A = \exp(\beta_o + \beta_1 \ln X_A + V_A - U_A) \text{ -- } (2.6)$$

Where, Equations 2.3 and 2.4, and Figure 1 represent frontier (potential) outputs while equations 2.5 and 2.6 represent observed outputs of Firms A and B, respectively. Firm A uses the input level X_A to produce Q_A, while firm B uses X_B to produce Q_B. If there were no inefficiency effects, frontier outputs would be $\boldsymbol{Q_A^*}$ and $\boldsymbol{Q_B^*}$ for firms A and B respectively. The frontier output for A lies above the deterministic (Qi) part, because the noise effect is positive ($V_A >0$), while for firm B lies below Qi (because the noise effect is negative). Figure 1 also shows that observed output of firm A lies below Qi of the frontier because the sum of the noise and inefficiency effects is negative (i.e.,$V_A - U_A <0$). Frontier outputs tend to evenly distributed above and below the deterministic part of the frontier. However, observed outputs tend to be lie below Q_i of the frontier. Thus, much of stochastic frontier analysis if directed towards the prediction of inefficiency effects (Coelli et al., 2005).

The Stochastic Production Frontier

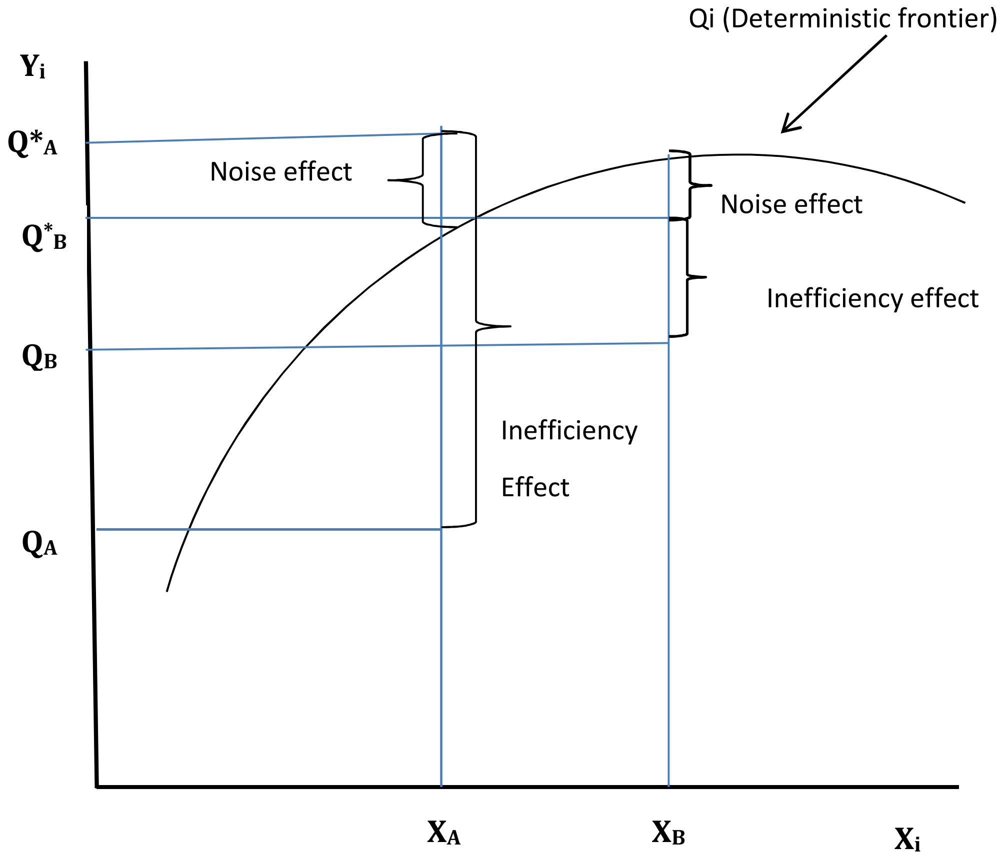

Fig1. The Stochastic Production Frontier Source: Adopted from Coelli et al., (2005

2.1.3. Concepts of production efficiency

Production efficiency has two major components (technical and Allocative). The purely technical or physical component refers to the ability to avoid waste by producing as much output as input usage allows or by using as little input as output production allows. Thus the analysis of technical efficiency can have an output increasing orientation or input conserving orientation. The allocative or price component refers to the ability to combine inputs and outputs in optimal proportions in the light of prevailing prices (Lovell, 1993). In other words, allocative efficiency (AE) is the ability of a firm to produce a given level of output using cost minimizing input ratios and finally the product of technical efficiency and allocative efficiency gives economic efficiency.

Coelli et al. (2005) illustrated these three measures of efficiency using Figure 2, which involves two inputs (X_1 and X_2) to produce a single output (Y) under the assumption of constant returns to scale. According to this known scholar, economic efficiency is distinct from the other two even though it is the product of technical and allocative efficiency. A firm that is economically efficient should by definition be both technically and allocatively efficient. However, this is not always the case. It is possible for a firm to have either technical or allocative efficiency without having economic efficiency. The reason may be that the firm, in this case, is unable to make efficient decisions as far as the use of inputs is concerned. In some cases, a firm might fail to equate marginal input cost to marginal value of product. If technical and allocative efficiency occur together they are both a necessary and a sufficient condition for economic efficiency. This assumes that the farmer has made right decision to minimize costs and maximize profits implying operating on the profit frontier.

Measurement of economic efficiency requires an understanding of the decision making behaviour of the producer. A rational producer, producing a single output from a number of inputs, $X = x_1, x_2 \ldots x_n$ that purchased at given input prices, $w = w_1, w_2 \ldots w_n$ and operating on a production frontier will be deemed to be efficient. But if the producer is using a combination of inputs in such a way that it fails to maximize output or can use less inputs to attain the same output, then the producer is not economically efficient. A given combination of input and output is therefore economically efficient if it is both technically and allocatively efficient; that is, when the related input ratio is on both the isoquant and the expansion path.

From Figure 2, SS' is an isoquant, representing technically efficient combinations of inputs, x_1 and x_2, used in producing output Q. SS' is also known as the best practice production frontier. AA' is an isocost line, which shows all combinations of inputs x_1 and x_2 such that input costs sum to the same total cost of production. However, any firm intending to maximize profits has to produce at Q', which is a point of tangency and representing a least cost combination of x_1 and x_2 in production of Q. At point Q' the producer is economically efficient. Coelli et al. (2005)

Knowledge of the unit isoquant of fully efficient firms represented by SS', in Figure 2 permits the measurement of efficiency. If a given firm uses quantities of inputs defined by the point P to produce a unit of output, the technical efficiency of that firm could be represented by the distance QP, which is the amount by which all resources could be proportionally reduced without a reduction in output. This is usually expressed in percentage terms by the ratio of QP/OP, which represents the percentage by which all inputs need to be reduced to achieve technically efficient production. From Figure 2, the technical efficiency is most commonly measured by the ratio:

$$TE = {}^{OQ}/_{OP} = 1- {}^{QP}/_{OP} \text{ --- (2.7)}$$

If the input price ratio, represented by the isocost line, AA', is also known, allocative efficiency (AE) of a firm operating at point P could be measured as the ratio:

$$AE = {}^{OR}/_{OQ} \text{ --- (2.8)}$$

The distance RQ represents the reduction in production costs that would occur if production were to occur at the allocation and technical efficient point Q', instead of at the technically efficient but allocation inefficient, point Q. The total economic efficiency (EE) is defined to be the ratio

$$EE = {}^{OR}/_{OP} \text{ --- (2.9)}$$

The product of the technical efficiency and allocative efficiency provides the measurement of overall economic efficiency. That is,

$$EE = TE * AE = \left({}^{OQ}/_{OP}\right) * \left({}^{OR}/_{OQ}\right) = {}^{OR}/_{OP} \text{ ------------------------- (2.10)}$$

Input oriented Technical efficiency model

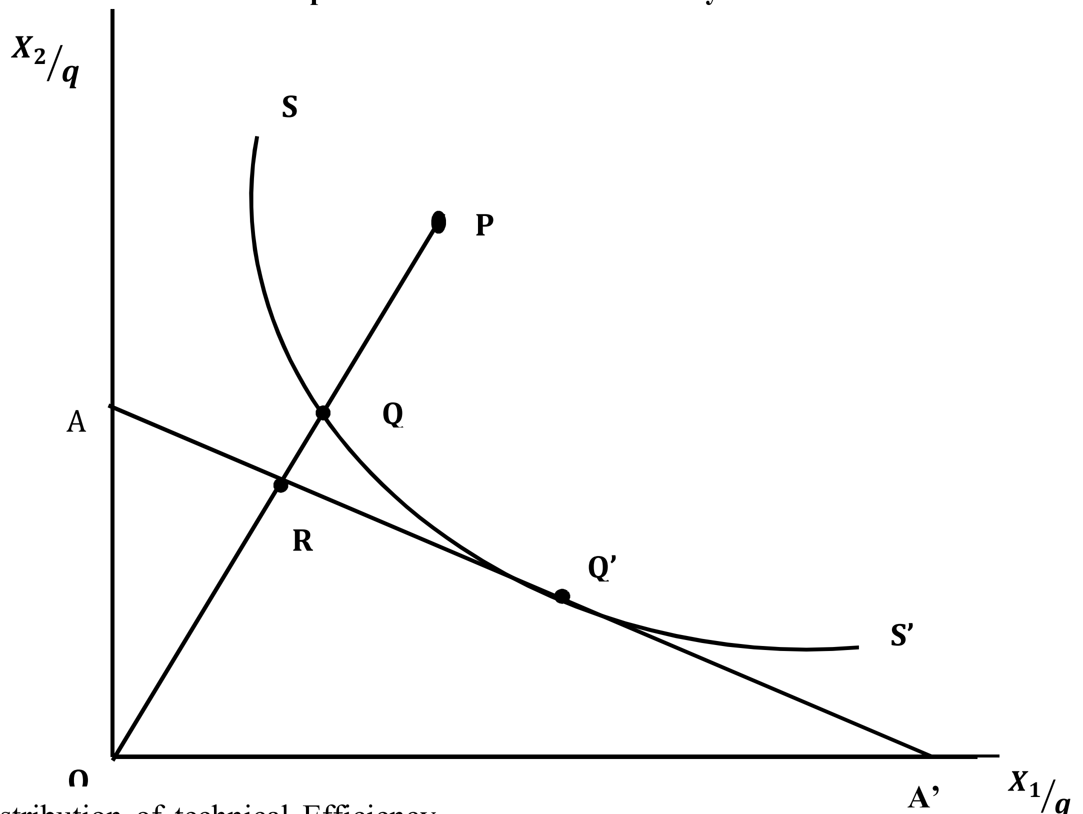

Fig2. Distribution of technical Efficiency

Source: Coelli et al., (2005)

2.1.4. Techniques of efficiency measurements

According to Coelli et al. (2005), there are various approaches to efficiency analysis. These include (1) least squares econometric production models, (2) total factor productivity (TFP) indices, (3) data envelopment analysis (DEA) and (4) stochastic production frontiers (SPF). The first two approaches are applied to aggregate time-series data and provide measures of technical change and/or TFP. Both of these approaches assume that all firms are technically efficient. However, approaches 3 and 4 are most often applied to data on a sample of firms (cross-sectional data) and provide measures of relative efficiency among firms (ex. farmers) and do not assume that all firms are technically efficient. There is an alternative way of grouping the above approaches, 1 and 4 involve the econometric estimation of parametric functions, while 2 and 3 involve non parametric functions.

Therefore, these two final groups may be termed as "parametric" and 'non-parametric" methods respectively (ibid). These techniques are generally grouped according to their assumptions about the functional form of production (or cost) frontiers. However, there are no explicit criteria to pick the most relevant approach for constructing the production frontier. Tortosa-Ausina, (2002) pointed out that the choice of a technique for empirical analysis is fairly arbitrary.

Consequently, the following discussion will focus on DEA and SPF methods in general, on SPF in particular. Since these two (DEA and SPF) methods have been used to estimate frontiers and involve mathematical programming and econometric methods respectively.

2.1.5. Stochastic Frontier Model

This method was developed in response to the criticisms raised against the deterministic parametric model. The deterministic frontier production model was criticized because it assumed that all the deviations from the frontier are results of technical inefficiency. However, a firm could perform sub-optimally because of factors outside its influence apart from the inefficiency factors (i.e., factors under its control). And, the deterministic frontier production function failed to satisfactorily isolate the effects of these two groups of factors that affect technical efficiency of a firm.

The stochastic frontier production function was autonomously introduced by Aigner et al. (1977) and Meeusen and Broeck (1977) cited by Coelli et al. (2005). The basic advancement of the model is that it segregates technical inefficiency effects from the random noise. That is, the model contains a composed disturbance term having two error elements. One error element explains the effect of random (uncontrollable) factors such as weather, measurement error, etc and the other error element is associated with systematic factors which are believed to be the sources of technical inefficiency.

The stochastic frontier production model is defined as,

$Y_i = f(X_i : \beta_0) + v_i - u_i$, i = 1, 2, . . . N --(2.11)

$Y_i = f(X_i; \beta_o)\exp(\varepsilon_i)$, where i = 1,2,3,…,n --(2.12)

$\varepsilon_i = v_i - v_i$ -- (2.13)

Here, Y_i represent the observed output level of the i^{th} firm; $f(X_i; \beta_i)$is convenient frontier production function (e.g. Cobb-Douglas or translog); X_i denotes the actual vector of input used by the i^{th} firm; β stands for the vector of unknown parameters to be estimated; and n represents the number of sample firms. ε_I is a composed disturbance term made up of two elements (v_i and u_i). v_i is a random error that accounts for the stochastic effects beyond the firm/farmer's control (e.g. weather, natural disaster, and luck), measurement errors as well as other statistical noise. According to Aigner et al. (1977) cited by Coelli et al. (2005), the symmetric component (v_i) is assumed to be independently and identically distributed as, $N(0,\delta_v^2)$. On the other hand, u_i captures the technical inefficiency of the firm. $u_i s$ are non-negative truncated half normal random variables with zero mean and constant variance, δ_u^2.

From the above definition of technical efficiency, the technical efficiency of an individual firm is measured as,

$$TE_i = {Y_i}/{f(X_i; \beta_o)\exp(v_i)} \quad \text{-- (2.14)}$$

$$TE_i = {f(X_i; \beta_o)\exp(\varepsilon_{i=} u_i - v_i)}/{f(X_i; \beta_o)\exp(v_i)} \quad \text{-------------------------- (2.15)}$$

$TE_i = \exp(-u_i)$ --(2.16)

Where TE_i , the ratio of actual output to potential (frontier) output is technical efficiency of the i^{th} firm; Y_i represents the output of firm; $f(X_i; \beta_o)\exp(v_i)$ is the stochastic frontier output; $v_i \sim N(0, \delta_v^2)$; and $u_i \sim N(0, \delta_u^2)$.

2.2. Review of Empirical Studies on Green Mungbean

2.2.1. Review of Ethiopian agricultural Policy

The Agricultural Growth Program (AGP) is a major component of the growth and transformation plan (GTP) in the country level and its objective is to increase productivity and market access for key crop and livestock products with good potential for agricultural growth EPA, (2012). It aims to achieve a greater balance between targeted supports to the poorest rural households in food insecure.

The growth and transformation plan (GTP) of Ethiopia consists of firstly, agricultural Production and Commercialization to strengthen the capacity of farmer organizations and their service providers to scale up best practices and adopt improved technologies in production and processing, and to strengthen marketing and processing of selected commodities through engagement with private sector stakeholders; secondly Small-scale Rural Infrastructure Development and Management to support construction, rehabilitation and/or improvement, management of small-scale rural infrastructure to improve productivity and further develop and increase the efficiency of key value chains through improved access to markets, The second growth and transformation plan GTP II (2015-2020)

According to Ethiopian Agricultural policy and Investment Framework (2010-20200) Ethiopia's agricultural strategy is focusing on placing major effort to support the intensification of farm products both for domestic and export markets by small and large farms through technology development and dissemination, commercialization and linking with markets. It is assumed that productivity of smallholder farmers can be increased in short period of time by utilizing smallholders' labour, land and agricultural technologies.

In Ethiopia, effective economic development strategy depends critically on promoting productivity and output growth in the agricultural sector, particularly among smallholder producers. This can be achieved not only by generating and introducing high yielding varieties of crops but also by considering production efficiencies in relation to scarce resources. The concept of efficiency is concerned with the relative performance of the processes used in transforming a given inputs into outputs. In any production of output, there are three types of efficiencies (technical, allocation and economic efficiencies) Fekadu Geleta and Bezabih Imana (2008).

According to Mohammed, A., et.al (2015) the theoretical and practical experiences teach us having efficient domestic agricultural commodity marketing system plays a decisive role in accelerating the growth and development of the agriculture sector. Ethiopia is sufficiently endowed with different natural and man-made resources that contributes a lot for continues development especially in the agricultural sector. It has also verities of climatic zones suitable for the production of a variety of exportable commodities to acquire foreign currency to support its sustainable development in sectors of the economy.

The country tries to modernize agricultural marketing; ECX and ECEA (Ethiopia Commodity Exchange Authority) are playing their pivotal roles to expand the types and quantities of traded commodities like coffee haricot bean, sesame and currently try to register some other commodities through ECX (2017-1018). These include emerging commodities like Mung Bean Haricot beans, and Sesame, to mention a few. Ethiopia Commodity Exchange (ECX) announces the entrance of a new commodity, Green Mung Bean, in to its trade floor. Green Mung bean is the sixth product that ECX is trading. Coffee, sesame, white pea beans, maize and wheat have been traded in ECX so far ECX (2017-1018).

2.2.2. Global review of green mungbean

The Green mung bean (Vigna radiata) has been grown in India since ancient times. It is still widely grown in Southeast Asia, Africa, South America and Australia. It was apparently grown in the United States as early as 1835 as the Chickasaw pea. Often called green gram or golden gram in international publications, it is also cultivated in several countries of Asia, Africa, and South America.(Thippeswamy T.G, et, al (2015)

Green mung bean is one of the most important food legume crops in South, East and Southeast Asia, where 90% of global production currently takes place. Mungbean is a relatively drought-tolerant and low-input crop that can provide green manure as well as livestock feed and thus is favoured by smallholder farmers The World Vegetable Center (2010).

Teodor. R, et, al (2014) describe that the potential yield of green mung beans in northern east of Romania was presented that yield ranged from 1.42 t/ha for PA5 genotype to 2.59 t/hec at PA3 genotype of green mungbaen. This shows that research centres were releasing a variety of green mungbean through adoption of technology with high potential of yield per hectare.

Jayne Gentry, (2010) noted that the potential yield of green mung bean in case of Australia, in case of fallow the yield was in range of 0.75 – 2 t/hec and in case of irrigation the yield increase to arrange of 1.33 – 2.75 t/hec. Mung bean management guide 2nd edition. In similar Jayne Gentry, (2010) describe that Crystal and Salin II genotype of green mung bean were released by the National Mungbean Improvement program under license of the Australian Mungbean Association in 2008 with consistent performance in all region of Australian for 5 years have an average of 20% higher yield than the other.

According to M.A. Haque, et,al 2014, the average yield of mungbean production in same selected area of Bangladesh was found to be 1196 kg per hectare, where the yield was highest at Jessore (1211kg /ha) followed by Kushtia (1189 kg /ha) and Barisal (1187 kg /ha) of Bangladesh region.

Dry land areas are experiencing low agricultural yields due to severe water shortages and salinity, leading to food scarcity. Mungbean (Vignaradiata) is gaining attention as a short-season crop that can tolerate dryland conditions, and fix atmospheric nitrogen, decreasing soil nutrient depletion. It is a source of high-quality protein for human consumption and can serve as a multipurpose crop, if harvest residues are used as fodder or green manure.Pataczek, L.,et,al(2018). Ethiopia is one of the countries of east Africa severing from drought because of climate change with high prevalence of food security. In spite of multi-dimensional importance of green mungbean, very little attention has been paid to its productivity improvement in the country. Moreover, the yield gap in relative to the Asian countries suggests that there is a potential for increasing production and productivity of smallholder green mung bean farmers.

The periods of food insecurity ranged from less than one month in India to more than six months in Ethiopia. This indicates that climate change has become a major challenge for food security. The pressure on natural resources is likely to rise and make both people and ecosystems more vulnerable, particularly where agriculture plays a major role in the country's economy. (Pataczek, L.,et,al(2018)

The main international objective of mung bean cultivation is to develop new varieties of the species, some with short vegetation periods (55and 65 days), with mass maturation phases (for a single harvest) with high and stable yield (2.5t ha-1), with reduced sensitivity to photoperiod and temperature, and with resistance / tolerance to biotic and abiotic stress. Teodor. R, et, al(2014)

Mungbean [Vigna radiata] is such a minor crop that dryland smallholder farmers can use to break the downward spiral, and increase the profitability and sustainability of their farms. It is a nutritious warm season legume crop. The grains are rich in protein, minerals, and vitamins. Mungbean is widely grown in Asia, but also in parts of Africa and Australia. Nowadays, almost 90% of the mungbean production is found in Asia, where India, China, Pakistan and Thailand are among the most important producers. Integration of mungbean in cropping systems, particularly in Central and South Asia, may increase the sustainability of dryland production systems. Diversification of local production systems through inclusion of mungbean as a catch crop provides additional income to farmers and has potential to improve soil fertility.(Pataczek, L.,et,al(2018)

The mungbean species particularly valuable to soil fertility due to its ability to improve soil quality through cultivation by using symbiotic nitrogen fixation and a factor particularly important for farmers with limited resources. Input requirements for mung bean cultivation are low, making the species extremely valuable in the current economic crisis. The mung bean is the most important grain legume in Thailand and the Philippines, and it ranks second in importance in Sri Lanka, and third in India, Burma, Bangladesh, and Indonesia (Pataczek, L.,et,al(2018)

2.2.3. Nutritional Importance of Green mungbean

Many health organizations worldwide have recommended increased intake of plant-based foods to improve the prevention of chronic diseases and to improve overall human health. As a result, a variety of plant-based functional foods have been introduced into health care programmers. One such crop that has exhibited health benefits is mungbean [Vigna radiata]. Due to its high nutritional value, especially in seeds, mung bean has served as an important food/feed source for humans and animals.(Zhu Yi-Shen et al.2018)

According to Pataczek. L., et,al (2018), Mungbean is an important grain legume in South, East and Southeast Asia, which produce up to three million metric tons of seed consumed directly or processed into high value noodles. Mungbean provides significant amounts of protein, carbohydrates and a range of micronutrients to human diets. They contain the essential amino acid lysine, which is lacking in cereals. These beneficial dietary properties of mungbean can be also correlated to an improved state of health of women in several Asian countries between 1984 and 2006, when mungbean consumption increased. It is widely cultivated for human consumption. M.J. Robert Nout, et, al (2014)

2.2.4. Economic Efficiency of Green Mungbean

The first commercial mung bean varieties grown in Australia in the late 1960s and 1970s were different varieties introduced (GRDC 2011), currently the world production area of mungbean is about six million hectares per year, out of which 90% is in Asia. The productivity of mungbean is still low, but the demand might increase in future due to its high dietary quality. According to (GRDC 2011) about 95% of mungbeans produced in Australia are exported. Mungbeans are mainly marketed as a vegetable rather than as bulk grain so their appearance is very important. A small proportion of mungbean seed produced is used in Australia for sprouting.

According to Pataczek, L.,et,al(2018), In the past five years, the total import of mungbean into Europe was between 21 Mt and 27 Mt. In 2017 the main origins of these imports were Myanmar and China where Australia is the largest developed country supplying mungbean. The United Kingdom imports the highest quantity of mungbean in Europe, probably due to a large Indian and Pakistani population that use mungbean in their traditional recipes.

Mungbean production can not only increase a farmer's income through the sale of beans, but also through the reduction of farm inputs after cultivation. When grown between wheat and rice in India, it left 33 - 37 kg nitrogen (N) $ha^{-1}$for the succeeding crop Pataczek, L., et,al(2018). Doughton and McKenzie observed increasing sorghum yields by 70% after mungbean cultivation. This corresponds to aNitrogen application of 68 $kg \cdot ha^{-1}$.

According to the Australian mungbeans industry strategic plane of 2015- 2019, Australia is the largest developed country in production and supply of mungbean. Nearly all (95%) of the Australian mungbean crop is bagged, containerized and exported were 44.1% of the exported Australian mungbeans to African market. All stages of crop production and processing have to comply with strict hygiene practices to ensure the crop meets the highest standards for food safety and hygiene (Mungbaen managment guide line 2010.)

The average total value of the mungbean industry has risen considerably from $42.6 million (2004/5 - 2008/9) to $74.5 million (2009/10 – 2012/3) between publication of the Strategic Plan and the previous Plan Australian mungbeans industry strategic plane of (2015- 2019)

Many of the countries that compete with Australia in the international mungbean market use traditional farming methods and hand-harvest their mungbeans. Although labor-intensive, hand-harvesting results in a grain product with exceptional seed quality. Australian mungbeans are sold against hand-harvested product; so to compete effectively, the Australian industry has developed varieties and management practices that enable the production of high-quality mungbeans under mechanized production systems.(Mungbaen management guide line 2010.)

According to ECX 2014, mung bean is being cultivated as a recently introduced crop in Ethiopia. As Habte 2018 reported, in Ethiopia mung bean is mostly grown by smallholder farmers under drier marginal environmental condition and the production capacity is lower than other pulse crops. For resource poor farmers in Ethiopia, mung bean is mainly used as food, but growing it for income generation can also be important.

Shahidur. R et al 2010 describes the Export market has been substantial growth in recent years, the current export market is underdeveloped. The less developed, fragmented exporters operating at smaller scale in the market results in inconsistent export flows and thus causes inconsistent demand for exports. The major causes of limited export development are

i. inadequate market intelligence
ii. inability to leverage scale efficiencies due to smaller size and
iii. non-conducive the business environment due to missing credit and insurance
iv. Inconsistent policy interventions.

2.2.5. Soil Health and Environmental Impact

As a legume that fixes its own nitrogen, mungbeans do not need nitrogen fertilizer. However, seed should be inoculated with the appropriate Rhizobium species. Potassium and phosphorous needs have not been studied for mungbean in Missouri. Using the amounts recommended from soil tests for soybeans would be appropriate. Soil pH should be close to neutral. Robert L. Myers (2003)

Teodor. R, et, al(2014) describe, In recent years, society as a whole has begun paying increasing attention to the health of the environment. This shift demonstrates a growing interest in finding sustainable solutions that would reduce the negative effects of human activity upon the environment, particularly those caused by agriculture. Over the course of the last few years, the use and development of adapted genotypes with minimum impact (genotypes requiring only low doses of fertilizers and pesticides) that are also resistant to drought, salinity, and pathogens has become increasingly important.

Currently, sustainable intensification of agriculture has become a key issue, as soil degradation increased worldwide over the past decades. In Central and South Asia, mung bean may play an important role in sustainable intensification of agriculture due to its potential for environmental health, Parihar, C.M et al (2017) argued that adoption of conservation tillage practices with improved nutrient management could be a viable option for achieving higher biomass productivity, water and energy-use efficiency and profitability in maize-wheat cropping systems, particularly when mungbean is introduced to rotations enhance crop productivity, profitability and nutrient uptake of kharif maize in the north-western region of India and under similar agro-climatic conditions Yadav, M.R. et al 2016.

2.3. Review of Ethiopian Pulse production

Resulting to the current agricultural commercialization strategy, grain legumes have recently emerged as the third strategic agricultural export commodity next to coffee and sesame in generating foreign exchange earnings for economic growth in Ethiopia ECX (2018).

Pulses are among the major crops in Ethiopia, according to CSA (2017/18 or 2010 E.C) 29,785,881 quintal of pulses was produced in 2017/18 product year. Green mung bean is the highly marketable pulses in the country. In the 2017/18 year of product 514,227 quintal of green mung beans was produced were the market share of the total production of green mung beans is 69.94% of the total production. On the other hand the share of green mung beans production of Amahara region was 78.37% or 403,015 quintal of the total production of the country. From the total mung beans production in Amhara regional state 77.95% of the product was produced for the market mostly for export market.

Mung bean is mostly produced in Amhara regional state particularly in some areas of North Shewa, Oromo Zone and South Wollo as well as in some woreda‟s of Benishangul Gumuz regional state and southern zone of Tigray regional state. Despite increases in the potential export market, Mung bean production at the country level is no considerable improvement in quantity as well as quality of production to provide it for the central market with the help of Ethiopia commodity exchange (ECX). Therefore, in this study attempts will be made to assess the technical efficiency of green Mung bean production CSA (2017/18 or 2010 E.C)

Total Area and Production of Grain Crops for peasant holdings, 2017/18 (2010 E.C.), Meher

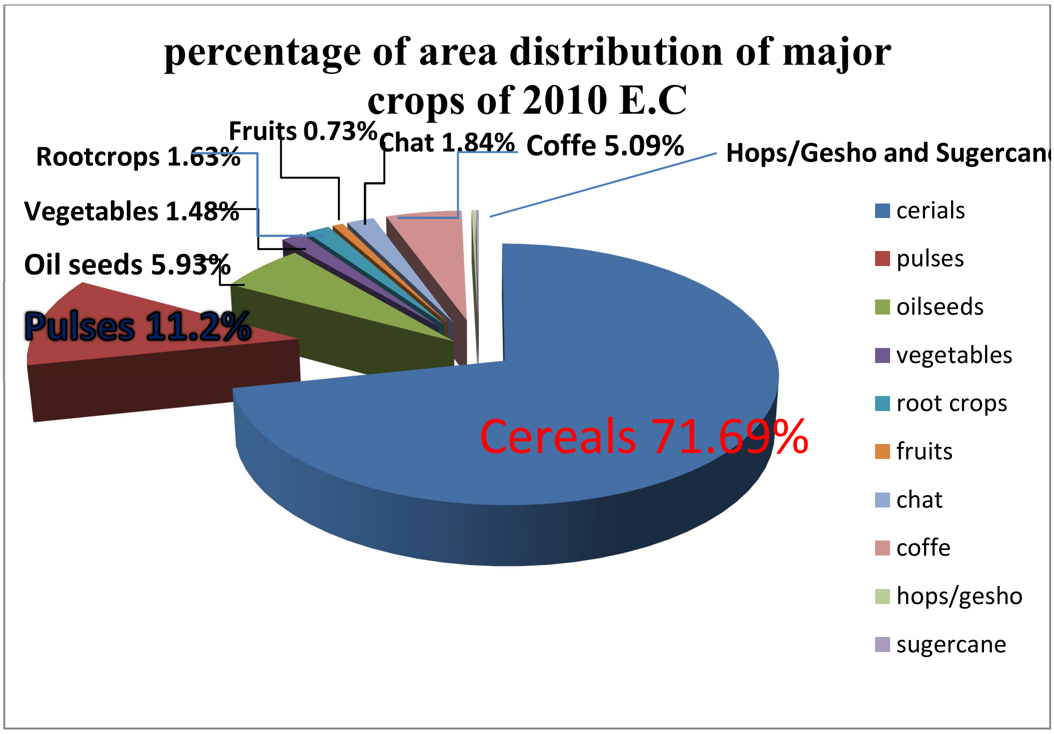

Fig 3. Total Area and Production of Grain Crops for peasant holdings, 2017/18 (2010 E.C.), Meher

2.4. Review of Ethiopian Mungbaen production

Ethiopia endowed various agro ecological zones and diversified natural resources, which has been known as the home land and domestication of several crop plants. Pulse crops are important components of crop production in Ethiopia's stallholder’s agriculture, providing an economic advantage to small farm holdings as an alternative source of income, and food security. Moreover, some of them have also played an important role in the export sector generating foreign currency for the country. The major varieties of pulses grown in Ethiopia are: Horse beans, chickpeas, haricot beans, lentils, dry peas, vetches and mung bean.Mohammed. A et at 2017

Mung bean is a recent introduction in Ethiopian pulse production grown in limited area in smaller quantity. It has green or yellow skin and sweet in flavor. It is drought resistant crop compared to other pulse crops. However, its consumption is not widespread like the other pulses in the country. Reliable information is lacking on the potential and actual production levels of mung bean at the national scale in Ethiopia Mohammed. A et at 2017

The farmers grow various crops for own consumption and/ or economic benefits. Pulses are among the various crops produced in all the regions of the country next to cereals. Pulses are grown in different volumes across the country as indicated in CSA 2017/18 sample survey the total area covered by pulses was 12.61% of the total production area of the country, in similar to this, the production of pulses also covers 9.73% of the total production of the major crops.

Despite the importance of green mung beans as a food and export crops, the efforts made to generate and distribute improved production technologies for green mung beans was insignificant, its productivity remains far from its potential. According to Habte U, (2018), the maximum grain yield of green Mungbean was 786.8kg/ha which was harvested from Borada research centre of west hararge of Ethiopia. Mohammed .A,et,al (2015), noted that 150,000 to 200,000 quintals of Mung bean, known in Amharic as „Masho", is produced per year in Ethiopia. Minister of Agriculture reported that the productivity of green mung bean expected to decrease from 12.35quital per hectare to 10.05 quintal per hectare.

Efficiency Factors

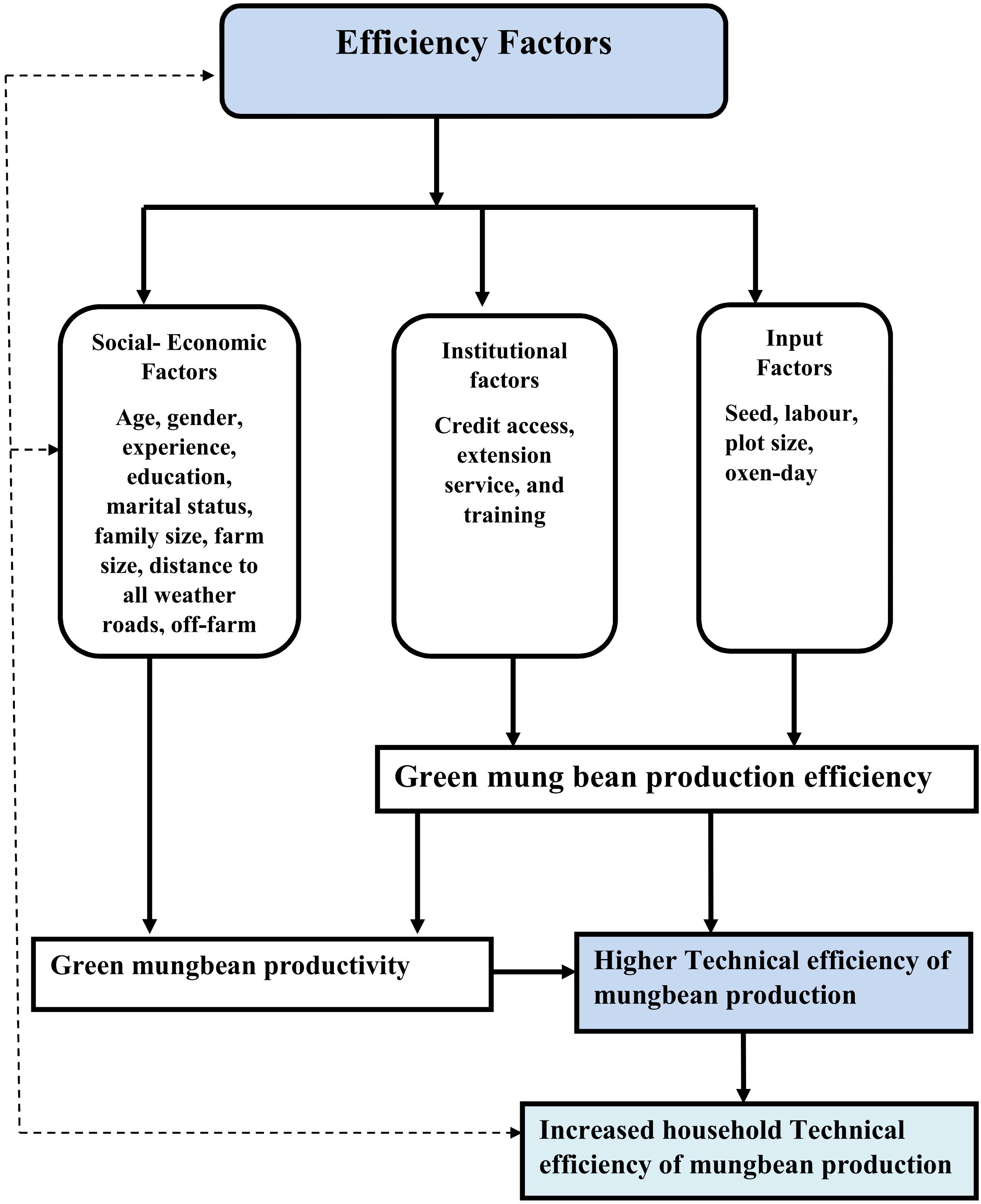

Fig. 4. Conceptual framework of efficiency factors
Source: Hika W. (2016)

CHAPTER THREE:
METHODOLOGY OF THE STUDY

3.1. Description of the Study Area

The study was conducted in Amhara regional State Oromia Zone Jille Dhummuga wereda. Jille dhummuga district is one of the seven administrative wereda of the Oromia Zone. The district shares border in the east with Afar Regional state weredas, in the south and west with Qowwet and Eefratana gidim weredas of North Showa zone of Amhara Regional state and in the north with Artuma Furse wereda of Oreomia zone. Senbete is the wereda town of the study district, is located at 260 Km North East of Addis Ababa on the main road of Addis Ababa to Dessie.

The area is characterized by summer season rainfall known (meher) which covers months from the last week of june to September with few and temporal Belg season rain. The Meher season rainfall accounts more than 80% of the annual rainfall when more than 95 % crop production is taking place (JWAO, 1017).

The study area is characterized by farming and Sami pastoralized with mixed crop-livestock farming systems. Since Jillee Dhumuga Wereda is low land area with low annual rain fall and long dry months. Drought resistant varieties of agricultural crops with short period production are the only choice in the district. Different varieties of sorghum, maize, Teff, green Mung beans were among the major staple crops in the area.

According to BoFED report of Development indicator of 2011/12 the population density of the oromiya zone is 121.17 peoples per square km with the total land area of 4,192.1 square km. in similar to this, Jille Dhummuga wereda has total land area of 882.57 square km and population density of 95.07 peoples per square km

The livestock sector is a key component of the agricultural system in the study area. Livestock production consists of cattle, camel, sheep, goats, Bees and poultry. They provide draft power for land preparation, planting and threshing; manure which is essential for soil fertility maintenance, family diet, transportation, and used as storage of money for hard times.

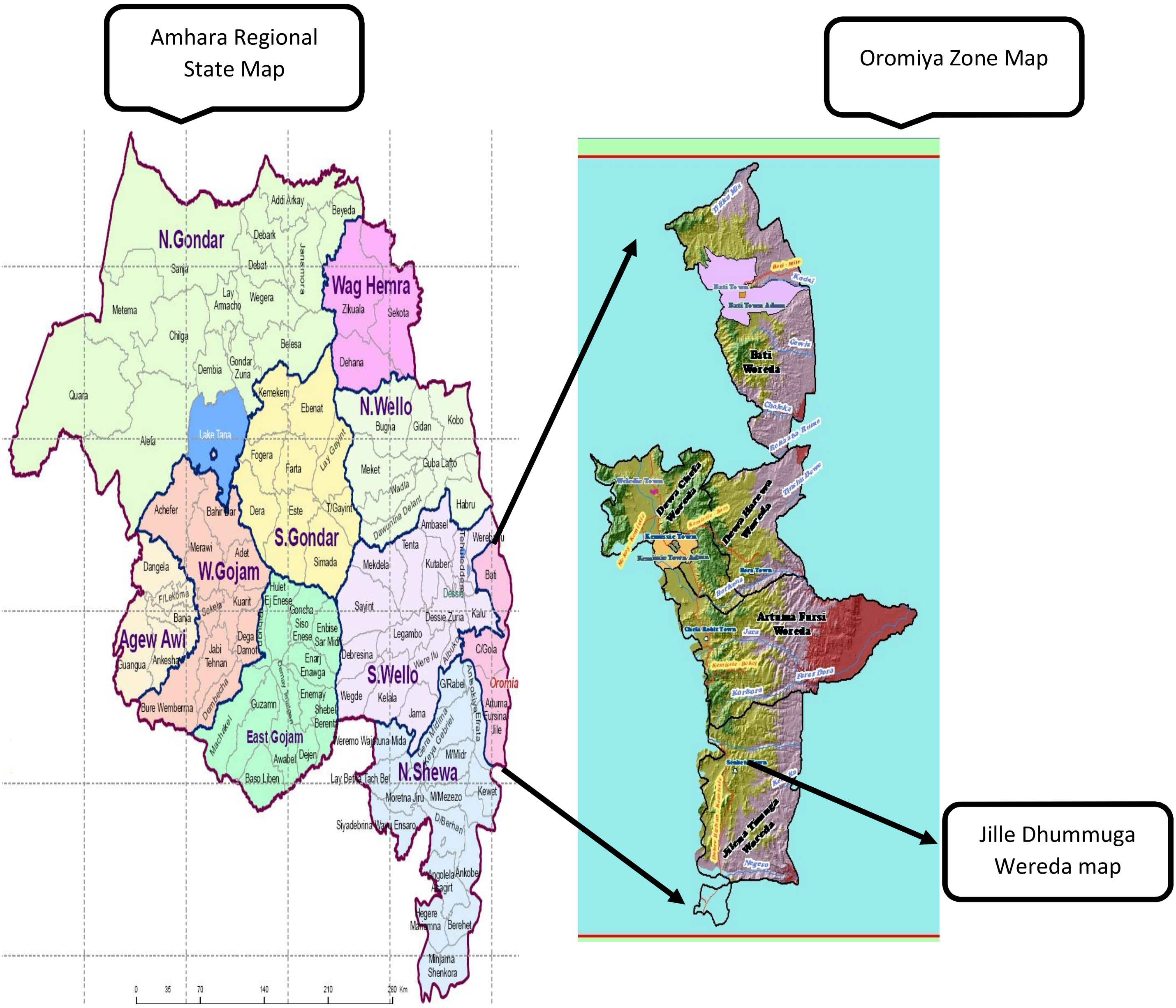

Fig 5 :- Map of Oromia Zone

Jille Dhummuga is one of the weredas of oromiya zone mostly exposed to drought in relative to the other weredas. Majority of peoples of the weredas were familiar with drought tolerant and short period crops because of the environmental challenges. In related to this nature influence Jille Dhummuga wereda is the largest green mungbean grower in the area. Most of the weredas farmers are familiar with green mungbean farming that is the reason why area is selected for the study on the green mungbean.

3.2. Sampling techniques and Methods of Data Collection and Analysis

3.2.1. Data type and Sources

The study used primary data collected from 170 green mung bean producers (households) based on 2017/18 production season. To supplement the primary data, secondary data about the study area and the distribution of major inputs and prices were collected from concerned wereda Offices (like wereda Agricultural Office and Cooperative Offices) and from published and unpublished sources. The data is cross-sectional and quantitative in nature; and were collected on inputs use, socio-economic, plot level characteristics and output variables. Village level variables (like distance to all weather roads, and input and output prices) were collected from key informants through group discussion to capture spatial heterogeneities.

3.2.2. Sampling techniques and sample size

A three-stage sampling design was used to collect the information from farmers. In the first stage, Jille dhummuga was purposively selected for the following main reason; Amahara region is the major green mung beans producer of the country, oromiya zone is one of the known Green mung beans producer where Jillee dhummugaa wereda mostly produce green mungbeanbs. Second, the researcher knows the study area well; and finally. In the next stage, five administrative kebeles were also purposively selected on the basis of share in green mung bean production. In the final stage, sample households were selected in proportion with the farmer in each selected kebeles by systematic random sampling technique. A list of green mung bean farmers was obtained from Kebele Administration and Extension offices to aid this process.

Many literatures have shown that there are several approaches to determining the sample size. To decide on the sample size, this study has been adopted a sample size determination formula provided by Statistics Canada (2010). That is a step by step approach where first an initial sample size is calculated, and then it is adjusted for the population, design effect and the response rate. Based on this, the required sample size is determined as follows:

1. Initial sample size

$$n_1 = \frac{z^2 p^{\wedge}(1-p^{\wedge})}{e^2} = 96$$

Where

z = is desired level of confidence (at 95%) = 1.96

p hat = is precision of an estimated proportion, assumed to be = 0.5 and

e = is required margin of error = 0.1

2. Sample size adjusted for the size of the population (usually for small and medium)

$$n_2 = n_1 \frac{N}{n_1 + N} = 92$$

Where

N = is the target population (2487)

3. Sample size adjusted for design effect (deff > 1), assumed to be =1.76

$$n_3 = diff * n_2 = 162$$

Since the population of the wereda is relatively large, The Cochran formula for sample size allows calculating an ideal sample size given a desired level of precision, desired confidence level, and the estimated proportion of the attribute present in the population of the study area.

4. Final sample size adjusted for response rate (r) = 95% was assumed

$$n = {}^{n_3}/_{r} = 170$$

Based on this approach, a total of 170 farmers from the 5 kebeles proportional to the size were selected. Accordingly, 43, 39, 37, 22, and 29 farmers were selected from Balchi, Mudifacha, Batte, Marawwa and Allaala respectively (Table 1).

Table 1. Selection of farm households producing Green mungbean

Kebele	Number of Household	Sample
Balchi	622	43
Mudifacha	572	39
Batte	547	37
Marawwa	323	22
Allaala	423	29
Total	2487	170

Source: own summery

3.2.3. Methods of Data Collection

The primary data collection was done through a structured questionnaire prepared for farm households. The questionnaire was designed and pre-tested in the field and refined in the office before the implementation of the actual survey for its validity and content, and to make overall improvement of the same and in line with the objectives of the study. The interview was conducted by enumerators with diploma and degree holders, who are fluent in local language and have got training on the content of the questionnaire and interview techniques. Close supervision and day to day check-up was done by the researcher. Sufficient primary data regarding production activities were collected at household and plot levels.

The household level data includes demographic characteristics, access to basic facilities, and household assets and knowledge attributes in the target crops, income sources and household membership to organized groups (farm related). The plot level data include fragmentation, plot and farm size under operation in the 2017/18 cropping season.

Relevant secondary data and data specific to the study area as a whole and having little difference among households were collected based on the group discussion made with key informants who were selected purposely based on their age and sex at each kebeles to supplement the primary data being collected. Relevant government sectors like district Office of Agriculture, Office of Cooperatives Development, Local Administration Offices, and Rural Land Administration Office, Maruwwa adere Farmers' Cooperative Union Office.

3.2.4. Method of Data analysis

Before analysis, the collected data were entered to the computer and cleaned. The data then were analysed using both descriptive statistics and econometric analysis.

3.2.4.1. Descriptive Statistics

Descriptive statistics was used to achieve objective one and they include means or averages, ratios, frequency distributions, percentages, standard deviations along with the minimum and maximum were used in analysing the socioeconomic characteristics of the farmers, input and output variables and problems encountered by green mung bean farmers in the study area. In sum, it is used to present a detailed summary of the output and input variables involved in the frontier production function for individual farmers.

3.3. Analysis of the Stochastic Frontier Model

From the basic micro-Economics theory, Technical efficiency defined as obtaining the greatest possible production of goods and services from available resources. In other words, resources are not wasted in the production process. Technical efficiency is not enough for firms to maximize profits. The firm must choose among the technically efficient options to produce a given level of output at the lowest cost is economic efficiency.

In an output oriented manner, technical efficiency is measured as a ratio of realized output to the potential output. The reliability of this measure of technical efficiency depends on how accurately the potential output is measured. It is in general assumed that the potential output is obtained by following the best practice methods, given the technology. This implies in turn that the potential output is determined by the underlying production frontier, given the level of inputs. Since by definition technical efficiency is the discrepancy of the actual (realized) output from the production frontier, its measurement cannot proceed without the estimation of the production frontier.Giannis Karagiannis and Vangelis Tzouvelekas (2005)

According to G.E. Battese and G.A. Tessema (1992), Frontier production functions assume the existence of technical inefficiency of the different firms involved in production such that, for specific values of factor inputs, the levels of production are less than what would be the case if the firms were fully technically efficient.

The area of efficiency analysis has become the central issue of performance analysis since the groundbreaking work of Farell in (1957). Technical efficiency (TE) can be defined as the ability of a decision-making unit (e.g. a farm) to produce the maximum possible output from a set of inputs and technology. In other words, TE is the ability of a firm to produce on production frontier. Any feasible points below the frontier line are all technically inefficient. Allocative efficiency (AE) is the ability of a firm to produce a given level of output using cost minimizing input ratios. The product of TE and AE is simply Economic Efficiency (EE). Fekadu Geleta and Bezabih Imana (2008)

Technical efficiency measurements are basically 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 under two frontier methodologies: parametric and non-parametric frontier models. The parametric frontier model may further be classified into deterministic and stochastic frontier models. The parametric models are basically estimated based on econometric methods and the non-parametric technical efficiency model, often referred to as Data Envelopment Analysis (DEA), involves the use of linear programming method to construct a non-parametric 'piecewise' surface (or frontier) over the data (Coelli et al., 1998) cited by FekaduGeleta and BezabihImana (2008)

3.4. Empirical Model

The general SPF model developed independently by Aigner et al. (1977) and Meeusen and van den Broeck (1977) in which an additional random error, v_i , is added to the non-negative random variable, u_i , is specified as follows:

$f(x) = \beta_o + \sum_{i=1}^{n}(\beta_i X_i + \varepsilon_i)$ --- (3.1)

$\ln \gamma i = \ln(\beta 0 + \sum_{i=1}^{n}(\beta_i X_i + \varepsilon_i)$ -- (3.2)

Where, Y_i measures the quantity of output of the i^{th} firm, X_i, represents input quantities, β is a vector of parameters, and $Y_i = f(X_i : \beta_i) + \varepsilon i$is the production function where ; $\varepsilon i = vi + ui$; V_i represents the independently and identically distributed N(0; σ^2) random errors, independent of ui; and ui represents non-negative random variables associated with technical inefficiency in production, independently and identically distributed as half-normal, ~| (0, | 2 u N σ u . Jondrow et al. (1982) proposed that farm-level technical efficiencies could be estimated by the conditional expectation of exp( ) −ui . The maximum likelihood estimation of Eq. (1) yields estimators for β and γ ,

$\delta^2 = \delta_u^2 + \delta_v^2$ -- (3.3)

δ^2 - δ_v^2 = δ_u^2 -- (3.4)

$\delta^2 / \delta_v^2 = \gamma + 1$ -- (3.5)

$\Upsilon = \delta_u^2 / \delta_v^2$ -- (3.6)

Where, the γ parameter has a value between 0 and 1. A value of γ of zero indicates that the deviations from the frontier are due entirely to noise, while a value of one would indicate that all deviations are due to technical inefficiency. δ_u^2 is the variance parameter that denotes deviation from the frontier due to inefficiency; δ_v^2 is the variance parameter that denotes deviation from the frontier due to noise and δ^2 is the variance parameter that denotes the total deviation from the frontier. (Battese and Coelli, 1995).

The first part of Eqn. (1) is typically assumed to be normally distributed and represents the usual statistical noise. The second part is non-positive and represents technical inefficiency—that is, failure to produce maximal output, given the set of inputs used. Realized output is bound from above by a frontier that includes the deterministic part of the regression, plus the part of the error representing noise; so the frontier is stochastic (Schmidt and Sickles, 1984). In the prediction of firm level technical efficiencies, Battese and Coelli (1988) pointed out that the best predictor of

3.5. Stochastic Frontier Model

This method was developed in response to the criticisms raised against the deterministic parametric model. The deterministic frontier production model was criticized because it assumed that all the deviations from the frontier are results of technical inefficiency. However, a firm could perform sub-optimally because of factors outside its influence apart from the inefficiency factors (i.e., factors under its control). And, the deterministic frontier production function failed to satisfactorily isolate the effects of these two groups of factors that affect technical efficiency of a firm.

The stochastic frontier production function was autonomously introduced by Aigner et al. (1977) and Meeusen and Broeck (1977) cited by Coelli et al. (2005). The basic advancement of the model is that it segregates technical inefficiency effects from the random noise. That is, the model contains a composed disturbance term having two error elements. One error element explains the effect of random (uncontrollable) factors such as weather, measurement error, etc and the other error element is associated with systematic factors which are believed to be the sources of technical inefficiency.

The stochastic frontier production model is defined as,

$Y_i = f(X_i : \beta_0) + v_i - u_i$, i = 1, 2, . . . N ---------------------------------------(3.7)

$Y_i = f(X_i; \beta_o)\exp(\varepsilon_i)$, where i = 1,2,3,…,n ---------------------------------------(3.8)

$\varepsilon_i = v_i - \nu_i$ --- (3.9)

Here, Y_i represent the observed output level of the ith firm; $f(X_i; \beta_i)$is convenient frontier production function (e.g. Cobb-Douglas or translog); X_i denotes the actual vector of input used by the ith firm; β stands for the vector of unknown parameters to be estimated; and n represents the number of sample firms. $\varepsilon_i$is a composed disturbance term made up of two elements (ν_i and u_i). ν_i is a random error that accounts for the stochastic effects beyond the firm/farmer's control (e.g. weather, natural disaster, and luck), measurement errors as well as other statistical noise. According to Aigner et al. (1977) cited by Coelli et al. (2005), the symmetric component (v_i) is assumed to be independently and identically distributed as, N(0,δ_v^2). On the other hand, u_i captures the technical inefficiency of the firm. $u_i s$ are non-negative truncated half normal random variables with zero mean and constant variance, δ_u^2.

From the above definition of technical efficiency, the technical efficiency of an individual firm is measured as,

$TE_i = {Y_i}/{f(X_i; \beta_o)\exp(\nu_i)}$ -- (3.10)

$TE_i = {f(X_i; \beta_o)\exp(\varepsilon_{i=} u_i - v_i)}/{f(X_i; \beta_o)\exp(\nu_i)}$ -------------------------- (3.11)

$TE_i = \exp(-u_i)$ ---(3.12)

Where TE_i , the ratio of actual output to potential (frontier) output is technical efficiency of the ith firm; Y_i represents the output of firm; $f(X_i; \beta_o)\exp(\nu_i)$ is the stochastic frontier output; $v_i{\sim}N(0, \delta_v^2)$; and $u_i{\sim}\ N(0, \delta_u^2)$.

3.6. Model specification

Following Aigner et al. (1977), the translog production function has been used recently by many studies to estimate technical inefficiency (for example Geta et al., 2013; Yami et al., 2013; and Beshir et al., 2012). Therefore, the translog production function stated below in (3.5) is used for the study for its flexibility for which it places no restriction unlike the Cobb-Douglas production function. The empirical Cobb-Douglas stochastic frontier production function with double log form can be expressed as

$\ln Y_i = \beta_0 + \sum_{i=1}^{n} \beta_i \ln X_i + v_i - u_i$ Cobb-Douglas) ---------------------------------- (3.13)

Where, i=1,2,- - - n=110 green mung bean grower, and X= vector of five input variables

Based on the above model, a stochastic frontier model for green mung bean farmers is given by

$\ln Y_i = \beta_0 + \beta_{1i} \ln X_{1i} + \beta_{2i} \ln X_{2i} + \beta_{3i} \ln X_{3i} + \beta_{4i} \ln X_{4i} + \beta_{5i} \ln X_{5i} + \beta_{6i} \ln X_{6i} + \alpha_{1i} D_{1i} + \alpha_{2i} D_{2i} + \alpha_{3i} D_{3i} + \alpha_{4i} D_{4i} + v_i - u_i$ --------------------------------------- (3.14)

α 's and β's are unknown parameters to be estimated

$v_i - u_i$ = Error term

Where

Ln = Natural logarithm,

Yi = (output) represents total Yield of mungbean of the i^{th} farm (Kg/ha)

X_{1i} = represents the cost of labour for different farm activities from first ploughing to threshing and weeding in birr of i^{th} farm per hectare

X_{2i} = Oxen-days represents the amount of oxen days used for ploughing from land preparation to planting / Ploughing of the i^{th} farm (oxen-day/ha)

X_{3i} = represents the operational area of green mung bean of the i^{th} farm and it is a continuous variable measured in hectare

X_{4i} = Seed used by the i^{th} farm (kg /ha)

X_{5i} = the cost of chemicals Pesticides birr per litre

D_{5i} = dummy for seed type of the i^{th} farm (1= improved seed 2 = otherwise)

Technical inefficiency effect model

The u_i's in equation (14) are non-negative random variables, called technical inefficiency effects, assumed to be independently distributed such that the technical inefficiency effects for the ith farmer, u_i, are obtained by truncation of normal distribution with mean zero and variance σ_u^2 , such that

$$u_i = \delta_0 + \delta_{1i}z_{1i} + \delta_{2i}z_{2i} + \delta_{3i}z_{3i} + \delta_{4i}z_{4i} + \delta_{5i}z_{5i}\ \delta_{6i}z_{6i} + \delta_{7i}z_{7i} + \delta_{8i}z_{8i} + \delta_{9i}z_{9i} + w$$

-- (3.15)

Where,

Z_{1i} = Sex, which is a dummy variable, which has a value 1 if the household head is male, 0 otherwise

Z_{2i} = Age of the farm operator of the i^{th} farm (years)

Z_{3i}= Education stands for the education level of the respondent quantified in terms of years of schooling

Z_{4i}= Family size stands for the size of the family measured by the number of persons living in the household (LFU)

Z_{5i} = off farm is Cash income earned by the i^{th} in Ethiopian birr and it is a continuous variable

Z_{6i} = Experience in mungbean farming (No. of years)

Z_{7i} = Proximity to all-weather road is a continuous variable measured in walking minutes, distance from the household residence to the nearest all weather road.

Z_{8i} = Dummy for mungbean training of the i^{th} farm (1= Trained, 2= Otherwise)'s

Z_{9i} = Access of credit is a continuous variable, amount of agricultural credit for the i^{th} farmer and measured in Ethiopian birr

Z_{11i} = Livestock represents the number of livestock the i^{th} household had measured in Tropical Livestock Unit (TLU).

Z_{13i} = Farm size stands for the total area of farm land under operation of the i^{th} farmer cultivated during 2012 in hectare. Where: -δ's are unknown parameters to be estimated and i^{th} W's are unobservable random

3.7. Hypothesis Testing

In spite of the magnitude and significance of the variable parameter, γ, it is also important to explain the various null hypotheses employed in this work. Three hypotheses were tested to examine the adequacy of the specified model used in this study, the presence of inefficiency and exogenous variables to explain inefficiency among smallholder green mung bean producers. Table 3 files the hypothesis tested. The generalized likelihood ratio statistics was used to test the hypotheses. It is specified as:

LR (λ) = -2 [{lnL(H_0))} - {lnL(H_1)}] --- (3.16)

Where L(H_0) and L(H_1) are the values of the likelihood functions derived from restricted (null) and unrestricted (alternative) hypothesis. This has a chi-square distribution with degree of freedom equal to the difference between the numbers of estimated parameters under H_0 and $H_{1.}$ however, where the test involves a γ, then the mixed chi-square distribution is used. H_0 , is rejected when the estimated chi-square is greater than the critical (Table 2). The result of hypotheses tested is presented in the result discussion section of this study.

Table 2: Hypothesis testing

Restrictions	Description
1. H_0:β_i = 0	Coefficient of the second-order variables in the traslog model are zero (Cobb-Douglas)
2. H_1: β_i≠ 0	Coefficients of the second-order variables in the translog model are different from zero.
H_0 : γ= δ_0= δ_1 =--- = δ_{13}	Inefficiency effects are absent from the model (all farms are fully efficient)
H_1:γ > 0, δ_i≠0, i=0,1,---13	Inefficiency effects are present in the model (all farms are not fully efficient)
H_0: δ_1=--- = δ_{13} = 0	There are no farm specific factors on technical inefficiency
H_1 δ_1=--- = δ_{13}≠ 0	There are farm specific factors on technical inefficiency

It is assumed that some farmers produce on the frontier and others do not. Therefore, the need stand up to find out factors causing technical inefficiency. The technical inefficiency model has been developed for this study to concentrate on this important issue. The technical inefficiency effects model includes farm and farmers' specific characteristics, institutional and other environmental factors. The above-mentioned variables included in the model are explained in detail below with their expected effects on technical inefficiency

3.8. Descriptions of Variables

The variables used for the estimation of stochastic frontier model are selected footed on farming practices of the study area and through reviewing from earlier studies on pulse crops efficiency studies in general and green mung bean efficiency study in particular. Kumbhakar and Bhattachary (1992) noted that socio-economic, demographic, environmental, institutional and non-physical factors are expected to affect efficiency. According to Jayne Gentry, (2010) describe that Crystal and Salin II genotype of green mung bean having consistent performance in all region of Australian for 5 years have an average of 20% higher yield than the other. According to mungbean production guideline the Soil requirement for Mung beans production was best on fertile, sandy loam soils with a pH in the range of 6.3 and 7.2. Mung beans require slightly acid soil for best growth while it does not tolerate saline soils.

Green mung bean affected by different pest diseases and insects, such us powdery mildew, tan spot, halo blight, charcoal rot, gummy pod, tobacco sterile virus and helicon verpa mungbean management guideline second edition (2010). This shows that pesticides applied on mungbean have great impact on the efficiency of crop production.

A total of six input variables were used for the estimation of the frontier production function which includes land allocated for green mung bean (in hec), pesticides applied (kg), oxen days used for ploughing and planting, amount of seed (kg) cost of labour and dummy variable for the seed type, since some farmers used hired labour and most farmers used family labour, for this reason opportunity cost has been used to estimate the production of green mung beans. Nine socio economic and policy variables (sex, age and education level of the household head, family size in labour force unit, distance to all weather roads from the residence measured in walking minutes, livestock ownership, off-farm income, mungbean farm experience, operational farm size during 2010/11, with descriptive review of tenure status, credit, extension contact measured as the proportion of variable were used to analyse the inefficiency effects model. The detail of these input variables is presented as follows: Teodor. R, et, al (2014), M.A. Haque, et,al (2014) have been used such variable to measure technical efficiency green mungbean.

3.8.1. Variables included in stochastic production frontier model

Dependent variable

In this study, only output variable is used.

Output: is measured as the total physical quantity of green mung beans grain yields in kg/hec and influenced by the production inputs, it was hypothesized that the inefficient use of inputs will decline the production frontier towards inside.

Independent variables: these variables that can affect the output

Operational area: is land area under green mung bean production quantified traditionally by hectares. According to Abate Bekele et,al (2009) large farm land has significantly efficient than the small farm size. Large farms received higher production whereas small farms received higher gross return. Rahman, M. et,al (2012) describe marginal farms received higher net return and benefit cost ratio. In similar farm size on technical efficiency is concerned, the literatures offers mixed results, some argue that large farms are efficient than small farms (Galluzzo, 2013), and the justification behind this argument is that large farms use the existing resource efficiently. This variable is aimed at capturing the effect of scale production on technical efficiency of the farm and positively affects productivity.

Pesticide: Green mung bean affected by different pest diseases and insects, such us powdery mildew, tan spot, halo blight, charcoal rot, gummy pod, tobacco sterile virus and helicon verpa mungbean management guideline second edition (2010). This shows that pesticides applied on mungbean have great impact on the efficiency of crop production. Pesticide is measured as the total physical amount of chemical pesticide used in green mung bean production in lit or kg and assumed to affect the productivity positively.

Oxen-days: is a continuous variable quantified as the number of days used to plough the plot from land preparation to planting and assumed to affect productivity of green mung beans. Shafiqul Q. et al, (2011), Ali, M. et,al (1997) and others describe the variable oxen-day as one of the important variable in measuring the technical efficiency.

Seed: is a continuous variable measured as the physical quantity of seeds in Kg including own seed, purchased and exchanged sources and assumed to be optimum to get the expected output. The amount of seed determines the population of plants in any field of crops and therefore, it directly affects per plot yields. Based on Australian Mung bean management guide 2nd edition (2010) 24 kg of mungbean seed was the average amount of seed per hectare

Variety of the seed: - the variety of seeds used is continues variable which can determine the productivity of the yield per plot, specially the genetically improved variety of seed have significant in the production yield per plot with relative to natural one. Jayne Gentry, (2010) describe that Crystal and Salin II genotype of green mung bean having consistent performance in all region of Australian for 5 years have an average of 20% higher yield than the other

Labour: is important input variable and captured through the cost of labour. Since, some of the farmers used hired labour for harvesting and most of them used family labour for the different agricultural activities, so opportunity cost has been used to estimate the value of labour in the frontier production function. It was measured in birr paid to person's days for the different farm operations, that is, land preparation, planting, weeding and spraying, harvesting and threshing for all family and hired labour with one person-day being equal to 8 hours of labour.

3.8.2. Variables included in technical efficiency model

Dependent variable

Technical efficiency: is unobserved variable that will be estimated from an inefficiency one-sided error term ($U_i \geq 0$) efficiency component that represents the technical inefficiency of the farm (Thiam et al. 2001cited by Khan and Saeed, 2011).

Independent variables: these variables are exogenous variables that are assumed to be out of the control of the farmer

Gender: is a dummy variable, which has a value of 1 if the i^{th} farmer is male headed, 0 otherwise. Male had a positive technical efficiency than female in pulse production. Moreover, intuitively, it is assumed that male farmers are technically efficient because of the physical nature of farm activities. Therefore, the direction of gender towards technical efficiency will be determined in this study.

Age of the household head: is a continuous variable which is always assumed to be positively related to inefficiencies that means negatively related to technical efficiency. That is, older farmers are assumed to be technically inefficient. This evidenced by some research results (Kyi and Oppen, 1999; Khan and Saeed, 2011). However, some studies have shown that age of the farmer is positively related to technical efficiency (Ajao et al., 2012). Therefore, the direction of this variable to affect the level of technical efficiency is indeterminate and will be determined in this study.

Education level of the household head: is a continuous variable measured in maximum grade attended. Education is an important factor that sharpens managerial capabilities of farmers. It helps farmers in timely decision making. Education of farmers may enable them to make good use of information about production inputs, thus improving the efficient use of inputs. Empirical evidences show that education is positively associated with technical efficiency on irrigated rice farmers (Kyi and Oppen, 1999; Khan and Saeed, 2011).

Family size: since majority of labour force in rural area is supplied by family members and easy accessibility of labour might influence production positively. It is a proxy for agricultural labour and assumed to be positively correlated with technical efficiency. However, it may or may not lead to higher productive efficiency. Therefore, its direction to affect efficiency is indeterminate and will be determined in this study. To use this variable in the technical inefficiency model it has to be converted to the same denominator, Labour Force Unit (LFU).

Proximity to all weather roads: It can stimulate the technical progress of nearby rural areas by making easy access to improved technologies (adopting new technologies) and facilitating agricultural marketing activities. Jacoby (2000) observed that in Nepal, the quantity of fertilizer per hectare decreases when the travel time to the city rises. According to him, isolated farmers can adapt to their remoteness and develop other technologies substituting for example modern inputs by traditional inputs. It is therefore, hypothesized that it is negatively related to the level of technical efficiency as it was measured in walking minutes to reach to all weather roads from farmers residences.

Access to credit: Since access to credit is an important source of financing agricultural activities (mainly to buy agricultural inputs) for the poor farmers and taken as indebtedness, and it is hypothesized that farmers who have access to it are more efficient than others. And it is a continuous variable measured in Ethiopian birr.

Experience of the farmer: - the experience of the producer or farmer in the green mung bean production is an important variable in the study area. It is hypothesized that farmers who have more experience are more efficient than others.

Livestock: as earlier mentioned in the description of the study area, farmers produce crops and rare livestock together (crop-livestock production system). The livestock supplements crop production in various ways. It provides draft power, manure, and transportation. The income obtained from livestock serves to invest on crop production especially to purchase fertilizer. The livestock also uses as shock absorber; agriculture is a risky business dependent on nature.

Off-farm income: is cash income earned by the i^{th} farmer measured in Ethiopian Birr. Intuitively some individuals argue that it positively contribute to productivity and efficiency of farms simply it enables to access inputs, while others argue that it shares times allocated to farming activities; therefore, it affects efficiency negatively. Therefore, the effect of this variable is indeterminate and will be determined in this study.

Extension contact: is a dummy variable and has a value 1 if the producer contact with extension or expert, 0 otherwise. It is assumed that extension contact affects technical efficiency positively. Similar findings were also reported by other studies which found a positive relationship between farm level efficiency and availability of extension services (Kaliranjan, 1981; Kaliranjan and Flinn, 1983; Kaliranjan and Shand, 1985; Bravo-Ureta et al., 1994 cited in Khan and Saeed, 2011). However, Hassena et al. (2000) have shown that extension contact has a negative effect on efficiency level of farmers. Therefore, the direction of this variable towards technical efficiency is indeterminate and will be determined in this study.

Farm Land size: as far as the effect of farm size on technical efficiency is concerned, the literatures offers mixed results, some argue that large farms are efficient than small farms (Galluzzo, 2013), and the justification behind this argument is that large farms use the existing resource efficiently. Others intuitively argue that an increase in cropping land means that the farmer will have more crops that compete with target crop production to labour and other fertilizer use and thus affect technical efficiently. Therefore, the variable has a mix of effect on technical efficiency so we cannot suggest a priori for this study. Farm land size is a continuous variable that represents the total land cultivated by the farmer during 2012 cropping season and traditionally measured in hectares.

Land tenure status: ceteris paribus, land ownership reduces risk and consequently, should enhance expected returns and encourage farmers to invest in more productive technologies (Gebremedhin and Swirton, 2003). However, some empirical studies, have reported a negative association between landownership and farm efficiency (Binam et al., 2003; Deininger et al., 2004). Therefore, the direction of land tenure status towards technical efficiency will be determined in this study.

Slope of the farm land: – the slop of the farm land have effect on the productivity since it exposed to pressure of wind and water erosion in addition to difficulties to plough. The variable is a dummy variable indicating the slope of wheat plot which would take a value of 1 if the plot is flat (plain) or 0 if sloppy;

Table 3: The description and expected sign of socioeconomic variables

Variables	**Descriptions and units**	Expected sign
Sex of HH	1 = if the HH is male 2 = otherwise	+
Age of HH	Years	+/-
Education of HH	Years of formal education attained	+
Family size	Family size in Labour force unit	+
Livestock ownership	Amount of livestock the household had in TLU	+
Off-farm income	Cash income earned by the HH in Ethiopian birr	+/-
Distance to all weather road	Walking hours/minutes	-
Access to credit	Amount of borrowed in Ethiopian birr	+
Group membership	1 = if the HH belongs to a group 2 = otherwise	+
Farming Experience of HH	Years	+
Sowing characters	1 = by line 2 = otherwise	+/-
Extension contact	1 = if the HH have extension contact 2 = otherwise	+
Training	1 = if the HH get training on green mungbean 2 = otherwise	+
Total operational farm	Total operational farm in hectare	+/-
Fragmented farm for green mung bean	Fragmented/plot farm for green mung bean	+/-
Owner ship status of mungbean farm land	1 = ownership 2= otherwise	+/-

CHAPTER FOUR:
RESULT AND DISCUSSION

This section presents descriptive and econometric results for variables used in the study. Descriptive results such as demographic characteristics of the household, plot level characteristics, use of agricultural inputs, access to basic facilities livestock capacity and asset of the household, off farm income and occupation of the household and the social network of the household are presented. The results of hypotheses tests, frontier model and determinant sources of technical efficiency are also presented. Results of stochastic frontier production function and technical inefficiency effects model for the selected Green mungbean producers have been discussed.

4.1. Description of the Study Households and Plot Characteristics

4.1.1. Demographic characteristics

The results of descriptive statistics for the entire variables considered are given in Table 4. Their mean, minimum, maximum and standard deviation values (for continuous variables) and frequencies and percentage (for discrete variables) were described.

Sex and Marital status of the households

The study show that majority of the household heads were males (75.29%) and 24.71% were female household heads of which 8.24% of them were without husbands for divorce reasons. Most of the respondents (88.82 %) are married. This may contribute widely to the use of family labour by the households as the partners and children constituted to the majority of labour force.

Table: - 4. Sex and Marital status of the household

Input variables	No of respondent	Labels	Frequency	Percentage
Sex of the household	170	Male	128	75.29
		Female	42	24.71
Marital status	170	Married	151	88.82
		Single	5	2.94
		Divorced	14	8.24
		Widow		

Source : Owen computation (2019)

Age and educational Status

The age of the household ranged from 25 to 70 years. The average age of the household growing green mung bean was 40.98 years. The entire female household and (96%) of the household were found between the ages of 25 and 59 years. This indicates that the majority of the household heads were able to work full adult workload. Education improves marginal skills and an intention to adopt new technology. Educated farmers are also willing to employ practical experimentation on their plots and have an implication an agricultural production. Among 170 sample house hold in the study area, the year of education of the household head ranged o year or no formal education to 8 years of formal education. Only 25.8% of the sample former conducts formal education from 2 year to 8 years while female household were less educated than the male household . This non-schooling shows that low focuses to formal education.

Table 5. Descriptive of Household background

Input variables	Units	obse	Minimum	Average	Maximum	Std. Deviation
Age of male household	year	128	25	41.51	70	9.3
Age of female household	year	42	27	39.36	52	6.66
Age of household		170	25	40.99	70	8.74
Family size of male household	number	128	2	5.43	10	1.87
Family size of female household	number	42	2	4.41	7	1.58
Household family size		170	2	5.19	10	1.83
Education of male Household	years	128	0	1.44	8	2.54
Education of female Household	years	42	0	0.71	6	1.49
Education of the Household		170	0	1.22	8	2.33

Source: Owen computation (2019)

Household family size

The Total numbers of household's member determine the availability of labour power needed in farm production. The result of this survey study shows that out of 959 family members, the average family size was 5.19 per household with minimum of 1 and maximum of 10 persons with standard deviation of 1.83 without converting in to the labour force unit LFU. The family size is an important variable affecting the level of technical efficiency. Since family size affects allocation of financial and human resources depending upon the composition of family. This shows that when households are compared with family size using the same denominator, they have had smaller standard deviation. The household size is also categorized into economically active person (51.51%) and economically inactive person (48.49%) and the ratio of dependency for the sampled farmers was near to 1: 1.1, this displays that every economically active person in the household had to support less than one economically inactive persons. In traditionally operated agriculture, like in the study area the larger the household size the more labour force is available for the farm activities.

Table: 6 Household family sizes in age category

Age group of the sample household	Frequency	Percentage
Under 5	152	15.85
6-9	159	16.58
10-15	146	15.22
16-24	102	10.63
25-59	392	40.88
60 and above	8	0.83
Total	959	100

Source: Owen computation (2019)

Livestock Production

Since the peoples of the study area are known for their semi farming or mixed farming (farming-livestock) production system, livestock ownership is considered and taken as a proxy variable for wealth. The average livestock holding measured in Tropical Livestock Unit (TLU) for sample households was estimated to 7.3 TLU ranging from 0.9 to 22.39 TLU with standard deviation of 4.78. However, about 57% of the household possessed a livestock greater than the average. In general, this illustrated that there is a high population of livestock with a wider variability in livestock ownership among the sample households in the study area described in Table. Another socio-economic variable included in the inefficiency model is off-farm income earned by the household during the cropping season (2010 E.C). The average amount was 4907.35 birr ranging from 0 to 15000 birr with a standard deviation of 4821.85. Majority /67% of the households get income from off-farm business were remittance was common in the study area.

Table.7 Livestock population in the study area by Tropical Livestock Unit (TLU)

Animal Type	TLU value each variety of livestock	Total Value
Sheep	0.09	67.5
Goat	0.09	145.35
Plough ox	1.1	267.3
Cow	0.8	311.2
Heifer	0.5	202.5
Calf	0.2	62.8
Camel	1.4	151.2
Donkey	0.36	33.08

Source: Owen computation (2019)

4.1.2. Plot level characteristics

The sample households have an average farm size of 2.16 hectare ranging from .75 hectare to 4.2 hectare with a standard deviation of 0.77 during 2010 E.C production season. The average size of green mungbeab farms was 0.574 hectare with a standard deviation of 0.246. The higher standard deviation of farm area for all sample farms shows a higher scattering in data relating to the farm area ranged from .15 to 1.5 hectare. From the collected Plot level data of sample farmer for green mungbean was ranging from 0.15 to 5. From these mungbean grower, about 95.5% of them were own plots

4.1.3. Use of agricultural inputs

In this study, the mean, minimum, maximum and standard deviations of major inputs considered are given in Table 8. The major inputs traditionally used in green mungbean cultivation include oxen days for land preparation and planting, seed, labour used from land preparation to harvesting and threshing, land and fertilizers. It is evident from Table 8 that there was a wide variation in both the input use and crop yields as shown by the larger values of standard deviations. Such variations in the level of input use indicate that available resources were not utilized efficiently.

The average number of oxen days for land preparation and planting to one hectare of green mungbean was 13.73 with standard deviation 6.777. The quantity of seed determines population of plants in any field crops and therefore, it directly affects yield per hectare. The average quantities of seed used on the green mungbean farms in the study area were 20.16kg with standard deviations of 4.008. This shows that there is a higher dispersion in green mungbean seed rate application from its mean (Table 8).

The primary goal of an individual farm household is to gain a maximum attainable pulse yield from a given combination of inputs. The average green mungbean yield obtained by the sample farms were 6.58quet/hec. Maximum farm yields can be used as a proxy for yield potential and average yields are considered to be the yield for common farmers (Lobell et al., 2009).The results were almost half lower than the national average productivity of 12.35quen/hec of green mungbaen for the same cropping season (CSA, 2013).

Pulse production involves intensive use of labour and in various farming practices like land preparation, weeding, harvesting and threshing. The average cost of labour days consumed per hec was 1962.11 birr per hec to green mungbean production with a standard deviation of 883.78. Because some of the households reported that they used hired labour for both weeding and harvesting and most of the households used family labour. Most of the farmers mainly used hand weeding to protect their green mungbaen farms from weeds infestation and required more labour.

Another input variable used in green mung bean cultivation is inorganic fertilizers and manure/compost in very contradictory majority 86.4% of the mungbean grower were not use any fertilizer or manure. Only few growers (13.6%) of the respondent use fertilizer in the mungbean production. Few farmers used manure/compost relatively they access to manure/compost because of the population of livestock.

Table.8 Descriptive statistics of variables used to estimate the production function

Input Variable and output	Obs	Mean	Std. Dev.	Min	Max
Output (yield)	170	791.11	251.69	200	1800
Farm plot of mungbean	170	.574	0.246	0.25	1.5
Oxen day for mungbean farm	170	13.73	6.777	2.4	36.67
seed cost	170	20.16	4.008	13.5	30
Labour cost	170	1962.11	883.78	388.8	5130
Cost of Pesticide	170	135.37	150.059	0.67	600

Source: Owen computation (2019)

4.1.4. Access to public services and social networks

In this study, access to extension, training and all weather roads are considered public services. The conceptualization of agricultural growth suggests that extension can impact agriculture in two ways. First by facilitating the distribution of new technologies to farmer's thereby increasing agricultural productivity; and second by improving human capital and managerial skill of farmers to advance their efficiency level. This indicates that extension contacts improve farmers' access to pulse related information and improved technological packages. But this variable was included in the inefficiency model. Yet, 50.7% of the household gets extension service on the production of the green mungbean while 49.3% of the household was not getting any extension service on the production of the pulse. Similarly, 89.6% of the households received nothing about green mungbean production based specific trainings. It is believed that farmers who have access to credit will have an opportunity to obtain inputs timely and enable them to increase production and productivity in general and it is the most important variable for resource poor farmers in particular. While (80.6%) of the respondent were not have access to credit. Interest was the great obstacle to have credit. This is because of that interest is strongly forbidden in religious of the society in the study area.

4.1.5. Major constraints to Mungbean agriculture in the study area

As shown in Table 10, about 28.4% and 55.2% of the household reported that soil fertility decline is the most serious and serious problem for productions in the study area. Low soil fertility 65.7% High cost of inputs 74.6% Lack of quality seeds 73.1% Small land holding 64.2% Lack of labour 78.8% Lack of markets 84.8% Lack of information on markets

This problem is aggravated by the frequently arrival of drought. About 68.7% of the households reported that climate variability (expressed in terms of shortage and untimely raining (late coming and early stop). About 80.6% of the households reported that there was lack of new improved varieties and quality seeds for mungbaen crops, 88.1% of the households reported that disease and pests are the serious problem for mungbean. These are major productivity problems that may result in higher yield gaps (Schneider and Anderson, 2010).

Table 10: descriptive of major constraints reported on Mungbean production in the study area

Major constraints	Level impact	Frequency respondent	Percentage respondent
Pesticide utilization	Very strong	49	28.4
	Strong	101	59.7
	Low	20	11.9
	Total	170	100.0
Soil fertility	very strong	48	28.4
	Strong	94	55.2
	Weak	25	14.9
	very weak	3	1.8
	Total	170	100.0
improved seed	very strong	41	23.9
	Strong	96	56.7
	Low	23	13.4
	very low	10	6.0
	Total	170	100.0
fertilizer price	Strong	71	41.8
	Low	41	23.9
	Very low	58	34.3
	Total	170	100.0

Source: Owen computation (2019)

4.2. Estimation of Stochastic Frontier Production

4.2.1. Selection of functional form and hypotheses tested

Before proceeding to the analyses of technical efficiency and its determinants, it was necessary to select the appropriate functional form and detect the presence of inefficiency in the production of green mungbean for the sample households. In an empirical study, results can be affected by the choice of functional form. In a one-step modelling approach, both Cobb-Douglas and translog frontier model can be used. Various restrictions were imposed on the model defined by 13 and 15. To check whether these restrictions were valid or not, the generalized likelihood ratio tests were used.

The results of these tests of hypothesis for parameters of the stochastic frontier and inefficiency effects model for green mungbean farms in Jille dhummugaa district. The first column of the table files the restrictions (or null hypotheses) imposed. The second column files the crops on which this study is focused. The third column presents the value of log likelihood statistics when the restrictions present in the first column are imposed on the original models. The forth column files the value of the likelihood ratio statistics (test). The fifth column represents the critical $\chi 2$ value. The sixth column files the degree of freedom on which the value of critical $\chi 2$ table is read. The last column presents the decision (whether the restriction is valid or not).

The first null hypothesis tested is that the coefficients of the interaction terms of input variables are zero favouring the Cobb-Douglas functional form (H0: $\beta i = 0$). The values of the logarithm of likelihood function for Cobb-Douglas and translog frontier model for mungbean was 6.266402 and 11.7633. Therefore the generalized likelihood ratio test is used to decide the functional form as follows:

$$LR (\lambda) = -2 [\{lnL(H0)\}- \{lnL(H1)\}]$$
$$= -2 [6.2664-11.7633] =$$
$$= 10.99$$

The value of the likelihood ratio statistics were found to be 10.99 which were greater than the critical $\chi 2$ value of 0.000 with 1 degree of freedom at 1 percent level of significance. We rejected the null hypothesis and thus the translog functional form is preferred to Cobb Douglas functional form.

This shows that the decision to use the restricted model was rejected in favour of the translog functional form since LR statistics for all models were greater than the critical. This indicates that the results from the translog model are more precise and consistent compared to the Cobb-Douglas (restricted) model.

The second null hypothesis is concerned with technical inefficiency effects. It specifies that technical inefficiency effects absent in the model (H0: $\gamma = \delta 0 = \delta 1 = --- =\delta 9 =0$) which means all green mungbean farmers/farms in the study area were efficient was tested against the alternative (H1: $\gamma > 0$ and $\delta i \neq 0$ where i = 0,1, ---, 9). However, when one or more of the restrictions involve a one-sided alternative then this statistic does not encompass a $\chi 2$ distribution. When the null hypothesis involves λ=0, the H1 can only involve positive values of γ. According to Coelli (1995), the distribution of any likelihood ratio statistic involving the γ parameter has distribution which is a mixture of $\chi 2$ distribution. The calculation of the appropriate critical value for the mixed $\chi 2$ distribution is very complex, when more than one parameter restrictions are involved. To escape from such difficulties of deriving the appropriate distribution, Table of Kodde and Palm (1986) is used to estimate critical values. Since this table files lower and upper bounds for the suitable critical value, when a mixture of equality and inequality restrictions are involved (Coelli, 1996).

As a result, we rejected the null hypothesis of no technical inefficiency effects given the specification of the stochastic frontier and inefficiency effect model. The result of the second hypothesis revealed that the stochastic production function had a better fit to the data than the average production functions. In short sum, H0: $\gamma = 0$, means that the inefficiency effects are absent in the efficiency model for green mungbaen 100% efficient-is strongly rejected. This indicates that the explanatory variables specified in the model make a significant contribution in explaining the inefficiency effect associated with green mungbean production in the study sites.

The third null hypothesis, H0: $\delta 1$ = --- $\delta 9=0$, which specifies that the coefficients of the explanatory variables in the efficiency model are simultaneously zero as another question of particular interest to this study was tested. Firm-specific factors considered in the inefficiency model have a significant influence on the level of technical inefficiency associated with green mungbaen farmers. Thus, we rejected the null hypothesis. This implies that there firm-specific factors which influence upon the level of technical inefficiencies among the sampled households or farms.

In sum, the findings of the third hypotheses suggest that inefficiency effects are presented in the model, that is green mungbaen producers had inefficiencies in maximizing their potential outputs from existing inputs and so the decision to exclude them was rejected. Similar results have been obtained by Geta et al. (2013); Yami et al. (2013); Beshir et al. (2012) and Amaza et al. (2006).

4.2.2. Parameter estimates

The maximum likelihood estimates of the parameters of the stochastic frontier production function (SFPF) and inefficiency model for the green mungbean farms in Jille dhummuga district defined by equation 3.13 and 3.15 are presented in Table 11 along with its p-values. In the frontier model, the coefficient of oxen day was positive and significant at significance level of 1%. This might indicate the farm land preparation increases by increases the yield by .248. The coefficients of land allocated was negative and significant at significance level of 1% indicating that increasing the mungbean farm land by 1 hectare decease the yield by .27. This may because of the farm plot management. Since smaller farm land might easy from land preparation to harvesting. The coefficient Seed used was negative and insignificant implying that an increase at certain optimum level in these inputs would decrease the output. The coefficients of labour cost and pesticide were negative in green mungbean farms and insignificant in the cultivation implying that an increase in labour cost for green mungbaen production would reduce the yield. This might for the excess of working power and over utilization of pesticide with relative to the plot size.

The maximum likelihood estimates for the parameter γ is 1 for mungbean at 1 percent level of significance. This indicates that 100 % of the variation in output of green mungbaen is probably due to the inefficiency effects of farmer's specific attributes. That is the majority of error variation is due to the inefficiency error, u_i and not due to the random error v_i. Thus, farm productivity differentials mainly related to the variation in mungbean farms management at farmers condition.

The average technical efficiency level of green mungbean in the study site is 84.9%, indicating that farmers are only producing on average 84.9 percent of its maximum possible output level, given the state of technology at their hand. In mungbean production, about 15.1 percent inefficiency exists, which needs to be addressed in order to increase green mungbean productivity.

.

Table 11. MLE for parameters of SFPF inefficiency effects model for green mung bean production

Variable	Coefficient	P-Value	t-Value
Constant	6.404731	0.000 ***	9.49
Ln(Operation area)X_1	-0.2724393	0.000***	3.63
Ln(Oxen day)X_2	0.248	0.000***	3
Ln(Seed)X3	-0.8553	0.428	-0.79
Ln(Labour)	-0.0027	0.98	-0.02
Ln(Pesticide cost)	-0.0048	0.608	-0.51
Ln(Seed type)	-0.1538	0.1*	-1.65
Inefficiency model			
Constant (δ_o)	-1.081309	0.485	-0.70
Gender	-.6210406	0.479	-0.71
Age	-.031535	0.221	-1.22
Education	.0077052	0.921	0.10
Family Size	-.0136098	0.907	-0.12
Proximity to roads	.0035602	0.693	0.39
Experience	.2856682	0.071*	1.81
Farm land	-.1262918	0.624	-0.49
Livestock	-.1004833	0.264	-1.12
Off farm Income	-.0000139	0.748	-0.32

Source: Owen computation (2019)

4.2.3. Determinants of technical inefficiency of green mungb bean farms

In order to overcome the problem of inefficiency, both development practitioners and policy makers need to know the important sources of inefficiency that obstruct the efficiency of farmers. Kumbhakar and Bhattachary (1992) noted that socio-economic, demographic, environmental, institutional and non-physical factors are expected to affect efficiency. Using the specification of equations 3.13 and 3.15, the study makes an attempt to investigate determinants of technical inefficiency. And the coefficients of the explanatory variables in the technical inefficiency model are of particular importance in terms of formulating policy options. The estimates of technical inefficiency effects model provide some important insights. The parameter estimates in Table 11 have the relevant directions, indicating the impact of explanatory variables on technical inefficiency. Out of the nine variables used, one variable was found to affect significantly the inefficiency of green mungbean farmers (Table 11).

The coefficient for experience of mungbean production has an expected sign indicating that the variable is positively related with technical inefficiency in green mungbean production. It was significant at 10 percent level of significance in mungbean production. This effect might happen due to the access of having green mungbean specific farming information or knowledge. This implies that more experience of green mungbean production was expected to raise technical efficiency of farmers. This is an indication that knowledge and orientation on green mungbean technologies and practices have strong influence on technical efficiency This result is in line with the study by Geta et al (2013) found that farm experience had a significant negative effect on farmers inefficiency in maize production, and others (by Sibiko et al., 2013 and Beshir et al., 2012).and contradict the studies of Wilson et al. (1998) found a negative relationship between experience and efficiency in potato production in UK, implying that farmers with fewer years of experience achieved higher levels of efficiency. Rahman (2002) also reported similar results for Bangladesh rice farmers

Table 12 Description of Technical Efficiency

Variable	Obs	Mean	Std.Dev	minimum	Maximum
TE	170	0.849	0.0838	0.3648	0.948

Source: Owen computation (2019)

4.2.4. Distribution of technical efficiencies

The estimated mean technical efficiencies of green mungbean farms were found 84.9%, indicating that farmers were producing 84.9% of their maximum possible output level given the state of the technology at their disposal. The frequency distribution of technical efficiency levels is given in Table 12 and Figure 3. The average predicted technical efficiency for green mungbean farms ranges from 36.4% to 94.6% indicating that a wider differential in the efficiency level of farms; while majority 75.3% of the efficiency of the sample farmer were in between 80% to 95% It is also obvious from Table 12 and Figure 3.1that out of total sample farms. This implies that a large number of green mung bean farms in the sample faced inefficiency problems. Out of total sample farms, about 24.7%

of the farms are being operated between the efficiency level of 36% and 79% and majority 60% of green mungbean farms are being operated at a higher efficiency level greater than the average efficiency level of 84.9%.

Table 13 Distribution of Technical efficiency

Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE
1.	0.807	50	0.899	99	0.841	148	0.909
2.	0.886	51	0.920	100	0.814	149	0.826
3.	0.716	52	0.873	101	0.890	150	0.790
4.	0.862	53	0.896	102	0.760	151	0.872
5.	0.891	54	0.930	103	0.923	152	0.857
6.	0.933	55	0.868	104	0.903	153	0.725
7.	0.932	56	0.893	105	0.906	154	0.927
8.	0.365	57	0.904	106	0.882	155	0.902
9.	0.752	58	0.814	107	0.907	156	0.804
10.	0.769	59	0.870	108	0.861	157	0.945
11.	0.809	60	0.846	109	0.829	158	0.875
12.	0.916	61	0.930	110	0.840	159	0.891
13.	0.720	62	0.826	111	0.744	160	0.905
14.	0.857	63	0.825	112	0.938	161	0.888
15.	0.837	64	0.828	113	0.914	162	0.862
16.	0.658	65	0.777	114	0.790	163	0.937
17.	0.934	66	0.661	115	0.882	164	0.901
18.	0.948	67	0.919	116	0.662	165	0.811
19.	0.827	68	0.850	117	0.869	166	0.847
20.	0.830	69	0.720	118	0.895	167	0.901
21.	0.810	70	0.902	119	0.879	168	0.884
22.	0.829	71	0.870	120	0.740	169	0.892
23.	0.722	72	0.819	121	0.839	170	0.872
24.	0.936	73	0.925	122	0.779		
25.	0.909	74	0.853	123	0.895		
26.	0.828	75	0.832	124	0.849		
27.	0.482	76	0.731	125	0.841		
28.	0.664	77	0.923	126	0.862		
29.	0.849	78	0.905	127	0.772		
30.	0.898	79	0.782	128	0.891		
31.	0.815	80	0.898	129	0.930		
32.	0.732	81	0.852	130	0.875		
33.	0.860	82	0.865	131	0.899		
34.	0.879	83	0.795	132	0.917		
35.	0.901	84	0.893	133	0.800		
36.	0.633	85	0.897	134	0.938		
37.	0.921	86	0.889	135	0.814		
38.	0.725	87	0.852	136	0.907		
39.	0.595	88	0.898	137	0.869		
40.	0.943	89	0.919	138	0.876		
41.	0.889	90	0.788	139	0.939		
42.	0.939	91	0.929	140	0.943		
43.	0.750	92	0.923	141	0.851		
44.	0.844	93	0.903	142	0.874		
45.	0.811	94	0.864	143	0.780		
46.	0.881	95	0.900	144	0.865		
47.	0.876	96	0.897	145	0.896		
48.	0.922	97	0.869	146	0.875		
49.	0.918	98	0.759	147	0.904		

Source: Owen computation (2019)

In sum, the results discussed here show that producers of the selected crops were not successful in using best practices and achieving the maximum possible output from new and existing technologies. Mean technical efficiency of green mungbean farmers was 84.9% indicating that about 15.1% increase in yield is feasible with the current technology and the same input quantities. Moreover, a considerable gap still exists between the efficiency level of the least technically efficient farmer 16% and that of the mean technical efficiency for green mungbean. This also suggests that a considerable amount of productivity (or output) is lost due to technical inefficiency.

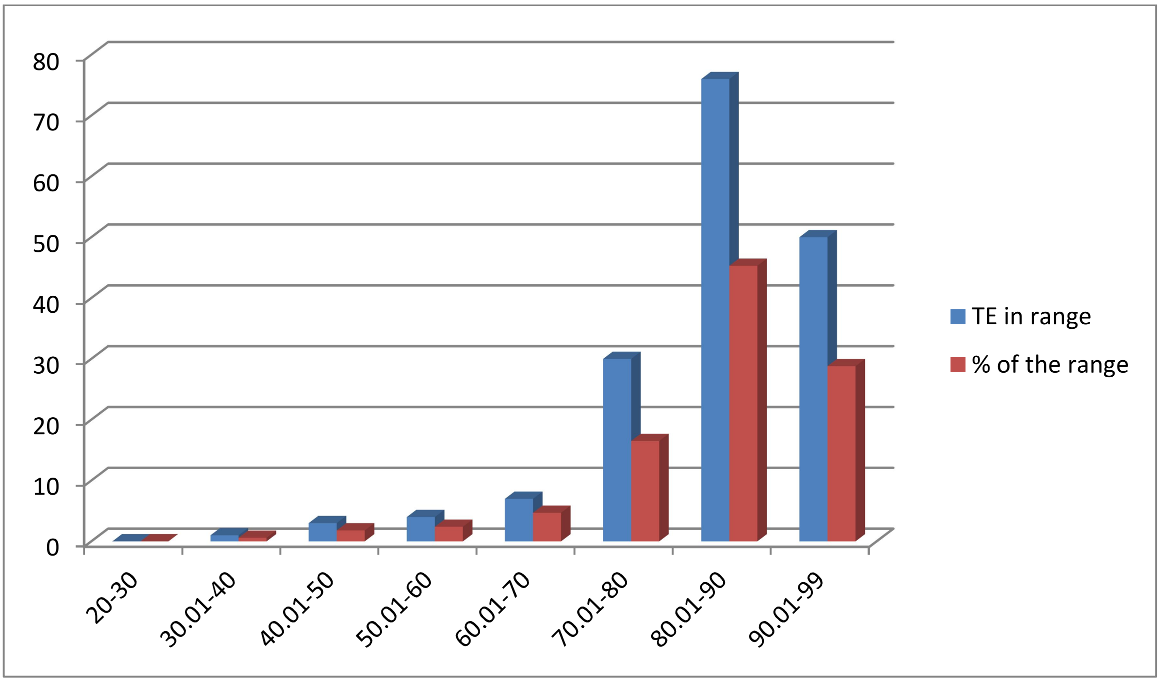

Figure 6: distribution of technical Efficiency

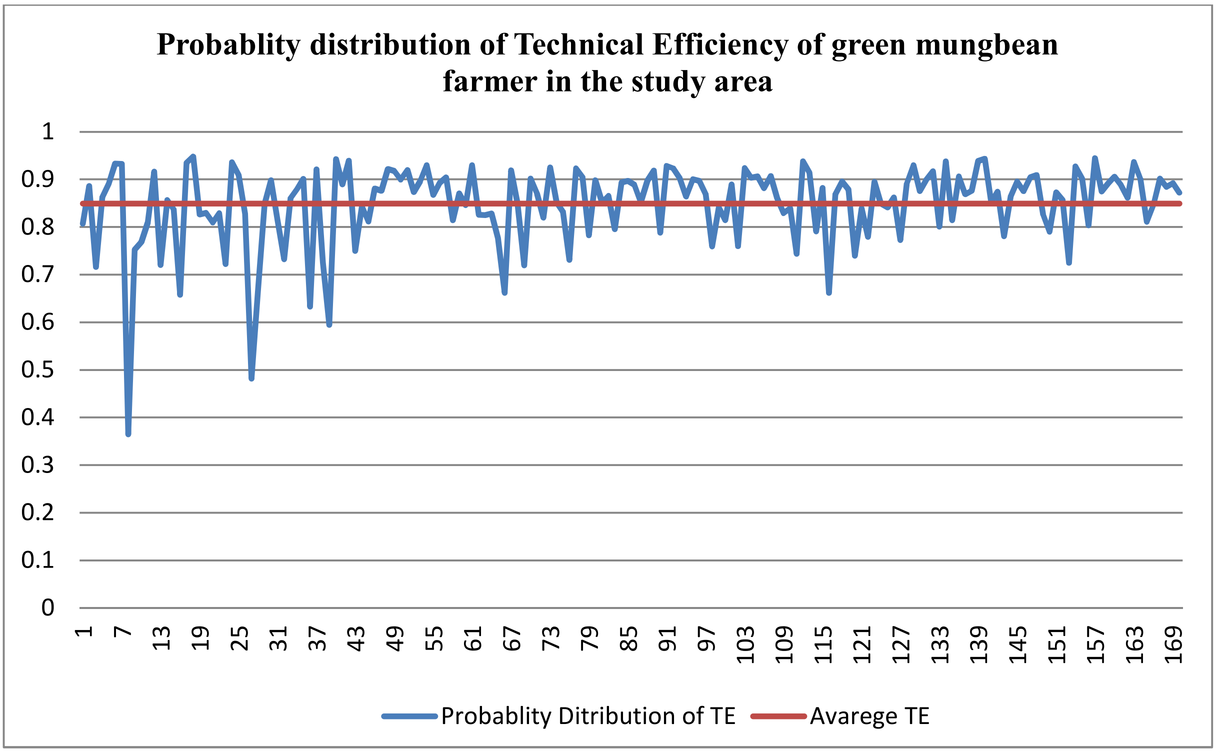

Figure 7: probability distribution of Technical efficiency

CHAPTER FIVE

5. SUMMERY, CONCLUSION AND POLICY IMPLICATIONS

In this chapter the main findings of the study are summarized and policy recommendations drawn from the study are briefly discussed.

5.1. SUMERY

Green mungbean is gaining attention as a short-season crop that can tolerate dry land conditions and increase soil nutrient. Increasing productivity and efficiency of green mungbean production in particular could be an important role towards achieving food security. The major finding of this study, the level of technical efficiency of green mungbean farmers in the study area 84.9% where there is a gap of 15.1% less the attainable yields. The plot size of green mungbean, oxen day, pesticide and experience of green mungbean farming are among the major variables that determine significantly the technical efficiency of green mungbean farmers in the study area.

5.2. CONCLUSSION

Economic efficiency in agricultural sector mostly depends on productivity. Productivity in agriculture varies due to differences in weather condition (drought, inconstant rainy season, shortage of rain) environmental degradation and utilization of technology, in the setting in which the production occurs and in the efficiency of the production process. Dry land areas are experiencing low agricultural yields due to severe water shortages weather variability and salinity, leading to food scarcity. Green mungbean is gaining attention as a short-season crop that can tolerate dry land conditions, and increase soil nutrient. It is a source of high-quality protein for human consumption and serves as a multipurpose crop. The main objective dealt with this study was to assess the economic efficiency of green mung bean producers and its determinant factors in oromiya zone, jille dhummuga district of Amhara region of Ethiopia. The study used the farm-level data collected from a total of 170 green mung bean farmers and estimated the stochastic frontier production function (SFPF) by incorporating inefficiency effects. We find that SFPF best fits the data better than the Cobb-Douglas production function.

The econometric analysis conducted to assess the levels of technical efficiency of green mung bean and its determinants indicated that the productivity and efficiency levels of green mung bean were significantly determined by the use of variable inputs such as land, labour and seed, and the interaction of land and oxen days. The use of land and oxen day had a significant and positive effect in improving productivity mung bean.

The results of efficiency analysis show that the mean technical efficiencies were about 84.9%. This indicated that most farmers in the study area were not efficient, suggesting that efficiency improvement is one of the possible opportunities for increasing green mungbean production with available input resources and technology. These technical efficiency indexes also indicated that an average farmer was able to produce 15.1% less of the attainable yields or the national average productivity of green mungbean.

The estimated inefficiency effect model revealed that the productivity and levels of technical efficiency of green mung bean was determined by the number of socioeconomic factors such as gender, age, education and distance to all weather roads, credit, livestock, group membership, extension contact, farm size and experience of mungbean production. Mungbean farm size, oxen day of the mungbean farm, seed type and mungbean production experience of the farmer have significant influence on the technical efficiency of green mungbean production. Gender was found to be a key variable in influencing the productivity of green mung bean. This indicates that male household head are more efficient than their female headed counterparts. This might be explained by the fact that female farms are most unlikely to attend agricultural extension meetings, field days and host demonstrations and trainings.

The technical efficiency of the sample farmers was highly influenced by the experience of green mungbean farm has significant effect on the productivity of green mungbean. The imperical result indicates that experience of green mungbean production. This might be describing the experience on the farm increases the knowledge of crop related activities and develop practical skill for mungbean production.

5.3. POLICY IMPLICATIONS

The empirical result of oxen day was positive and significantly influences technical efficiency in relating with the farm land preparation. the policy implication drawn from this study include support policy initiatives designed to improve rural financial markets to provide easy and affordable credit services for the rural poor mostly for ploughing oxen. The empirical results indicate that seed type specially improved seed is a key factor associated with higher levels of technical efficiency. The possible policy implications drawn from this study encourage efforts designed to increase the level of knowledge among smallholder farms through organizing mungbean research center, organizing mungberan producer association and short term trainings by using the available human and infrastructural facilities like Farmers Training Centres (FTC).

The technical efficiency of green mung bean producers was influenced by the policy variable distance to all weather roads. This implies that farms near to the roads are more efficient than farmers residing far from all-weather roads. This might be related to the availability of more access for transportation and market activities near to all weather roads. Therefore, the possible suggestions drawn from this result include diversifying rural livelihoods and integrating crop-livestock farming systems for nearby areas to all weather roads and encourage strategies designed to reach remote areas with extension services and information to help those inefficient farmers.

The empirical result indicates that experience of green mungbean production. This might be describing the experience on the farm increases the knowledge of crop related activities and develop practical skill for mungbean production. The possible policy implications drawn from this result include creating forum for experience sharing with experienced farmers and provision of trainings on crop specific attribute and improved practices.

Farm size was found key variables influencing the technical efficiency of green mung bean farmers positively. The variable Sample farmers reported that soil fertility decline, climate variability, rising prices of fertilizers, lack of new improved seed varieties and quality seed, crop disease and pests were the most important problems to the study area which needs appropriate policy intervention to address these problems. Finally, the study recommends further empirical work to be conducted on the effects of infrastructures like irrigation and roads on technical efficiency using a large number observe.

Reference

Ali, M., Malik, I.A., Sabir, H.M., and Ahmad, B. 1997. The Mungbean Green Revolution in Pakistan.

Abate, B., Machiel F., Gezahegn, A., and Syed A., (2009) Effect of Farm Size on Efficiency of Wheat Production in Moretna-Jirru District in Central Ethiopia

Aigner. D.J., Lovell. K.C.A. and Schmidt .P.S.1977. Formulation and Estimation of Stochastic Models. Journal of Econometrics, 6: 21-37.

Asogwa, B.C., Umeh, J. and Penda,S.T. 2012. Technical efficiency analysis of smallholder farmers in rural and periurban areas of Nigeria. J.Hum ecol, 37(1): 57-66

AVRDC - The World Vegetable Center (2010) Mung bean Seed Production Training Manual

Coelli. T.J. D.S.P. Rao. C.J. O"Donnell and G.E. Battese. 2005. An Introduction to Efficiency and Productivity Analysis. 2nd Edition.

Coelli. T.J. and Battese .G.E. 1996. Identification of Factors which Influence the Technical Inefficiency of Indian Farmers. Australian Journal of Agricultural Economics, 40(2): 103-128.

Daniel S., Bravo –vreto B.E. and Quiroga R.E. 2008. Technical efficiency among peasant farmers participating in natural resource management in central America. Journla of agricultural economics, 60(1): 202-219

Dawit Kelemework, J.S. David and E.G. Fonsah. 2012. Innovation Systems and Technical Efficiency in Developing-Country Agriculture. Selected Paper Prepared for Presentation at the Southern Agricultural Economics Association Annual Meeting, Birmingham, AL.

Department of Agriculture, Forestry and Fisheries REPUBLIC OF SOUTH AFRICA (2010) Mung bean production guide line

Doughton, J.A. and McKenzie, J. (1984) Comparative Effects of Black and Green Gram (Mung Beans) and Grain Sorghum on Soil Mineral Nitrogen and Subsequent Grain Sorghum Yields on the Eastern Darling Downs.

ECX (2014) Ethiopia Commodity Exchange Rings Bell for mungbean Addis Ababa.

Ellis, F. 1993. Peasant economics: farm households and agrarian development, 2nd ed. Cambridge University press: Cambridge

Ethiopian Agricultural policy and Investment Framework (2010-20200)

F. Rasul, M A. Cheema, A. Sattar, M. F. Saleem, and M.A. Wahid (2012) Evaluating The Performance Of Three Mungbean Varieties Grown Under Varying Inter-Row Spacing

Fekadu Gelaw. 2004. Analysis of Technical Efficiency of Wheat Production: A Study in Machkel District. M.Sc. Thesis Presented to School of Graduate Studies of Haramaya University.

Geta, E., Bogale, A., Kassa, B. and Elias, E. 2013. Productivity and efficiency analysis of smallholder maize producers in Southern Ethiopia. J. Hum.ecol. 41(1):67-75

Giannakas, K.,R. Sctoney and V. Tzouvelkas. 2001. Technical efficiency, technological change and output growth of wheat farms in saskatchwan. Canadian journal of agricultural economics. 49:135-152

Giller, K.E. (2001) Nitrogen Fixation in Tropical Cropping Systems.

Grains Research and Development Corporation (2011). An Economic Analysis of GRDC Investment in the Mungbean Improvement Program

Greene. W.H. 2003. Econometrics Analysis. 5th edition. New York: New York University.

Habte U. (2018) Evaluation of Adaptability of Mung Bean Varieties in Moisture Stress of Eastern Harerghe Zone.

Hika W. (2016) economic efficiency of sesame production in babogambel district of west wollega zone, oromia region, Ethiopia page 27

Heuzé V., Tran G., Bastianelli D., Lebas F., 2015. Mung bean (Vigna radiata). Feedipedia, a programme By INRA, CIRAD, AFZ And FAO.

Jayne Gentry, (2010) Mung bean management guide 2nd edition Department of Employment, Economic Development and Innovation of Australia

Kenneth L. Casavant, CraiGL Infanger and Deborh E. Bridges. 1999. Agricultural Economics and Management.

Kumhakar, S. C. and Bhattacharya. (1992). Price distortion and resource efficiency in Indian agriculture: a restricted profit function approach. Review of economics and statistics. 74:231-239

K. M. M. Rahman , M. I. Mia and M. A. Alam (2012) Farm-size-specific technical efficiency: a stochastic frontier analysis for rice growers in bangladesh

Mazumder, R. and Gupta,M. 2013. Technical efficiency and its determinants in Backward agriculture: The case of paddy farmers of Hailakandi district of Assam. Journalof regional development and planning , 2(1):35-53

Mohammed Ahmed1*, Muhammed Siraj2 and Said Mohammed3 (2015) Marketing practices and challenges of Mung Bean in Ethiopia Amhara Regional State: North Shewa Zone in focus

Muhammad Azim Khan1, Khalid Naveed2, Kawsar Ali1, Bashir Ahmad and Samin Jan3 (2012) Impact Of Mungbean-Maize Intercropping On Growth And Yield of Mungbean

M.J. Robert Nout, Neelam Khetarpaul, Martinus van Boekel and Raj Bala Grewal (2014) Nutritional characteristics of mung bean foods

Pataczek, L., Zahir, Z.A., Ahmad, M., Rani, S., Nair, R., Schafleitner, R., Cadisch, G. and Hilger, T. (2018) Beans with Benefits—The Role of Mungbean (Vigna radiata) in a Changing Environment.

Parihar, C.M., Jat, S.L., Singh, A.K., Majumdar, K., Jat, M.L., Saharawat, Y.S., et al. (2017) Bio-Energy, Water-Use Efficiency and Economics of Maize-Wheat-Mungbean System under Precision-Conservation Agriculture in Semi-Arid Agro-Eco-System.

Peoples, B.M. and Craswell, E.T. (1992) Biological Nitrogen Fixation: Investments, Expectations and Actual Contributions to Agriculture.

Q. M. Shafiqul Islam1, M. S. Rahman2, M.A. Hossain3 And M.S. Hossain4 (2011) Economic Analysis Of Mungbean (Vigna Radiata) Cultivation In Some Coastal Areas Of Bangladesh

Rahman. S. 2002. Profit Efficiency among Bangladesh Rice Farmers. University of Manchester, School of Economic Studies. Discussion Paper Series No. 0203.

Robert L. Myers (2003) Alternative Crop Guide of MUNGBEANS A Food Legume Adapted to Hot, Dry Conditions

Sharma, S.N., Prasad, R. and Singh, S. (1996) Residual Effects of Growing Mungbean and Uridbean on the Yield and Nitrogen Uptake of a Succeeding Wheat Crop.

Shahidur Rashid ,Chilot Yirga , Befekadu Behute, And Solomon Lemma /2010/ Pulses Value Chain In Ethiopia Constraints And Opportunities For Enhancing Exports

Shah, Z., Shah, S.H., Peoples, M.B., Schwenke, G.D. and Herridge, D.F. (2003) Crop Residue and Fertiliser N Effects on Nitrogen Fixation and Yields of Legume-Cereal Rotations and Soil Organic Fertility.

Teodor Robu1, Creola Brezeanu1,2, Petre Marian Brezeanu2 Silvica Ambarus2 (2014) Assessment Of Mung Bean Yield Potential Production In The North Eastern Region Of Romania

Torkamani, J. and H.J. Brain. 1996. A study of Economic Efficiency of Iranian Farmers in Ramjerd district. Application of Stochastic Programming Department of Agricultural Economics, College of Agriculture Shiraz University, Shiraz, Iran.

Thippeswamy T.G, Lalitha J, Shinde M (2015) Enhancement of Ascorbic Acid in Processed Yellow Cultivar Mung Bean Seeds.

Walley, F.L., Clayton, G.W., Miller, P.R., Carr, P.M. and Lafon, G.P. (2007) Nitrogen Economy of Pulse Crop Production in the Northern Great Plains.

Wilson. P. and Hadley.D. 1998. Measuring and Explaining Technical Efficiency in UK Potato Production. Journal of Agricultural Economics, 49(3):294-305.

Yadav, M.R., Parihar, C.M., Jat, S.L., Singh, A.K., Kumar, D., Pooniya, V., et al. 2016) Effect of Long-Term Tillage and Diversified Crop Rotations on Nutrient Uptake, Profitability and Energetics of Maize (Zea mays) in North-Western India.

Xu. X. and Jeffrey.S.R. 1998. Efficiency and Technical Progress in Traditional and Modern Agriculture: Evidence from Rice Production in China. Agricultural Economics, 18:157-165.

Zhu Yi-Shen1*, Sun Shuai1, Richard FitzGerald2 (2018) Mung bean proteins and peptides: nutritional, functional and bioactive properties

Appendix I

```
Stoc. frontier normal/half-normal model          Number of obs   =        170
                                                 Wald chi2(6)    =     137.01
Log likelihood =  11.763302                      Prob > chi2     =     0.0000
```

lny	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lny						
lnx1	-.2724393	.0749833	-3.63	0.000	-.4194039	-.1254747
lnx2	.2473329	.082529	3.00	0.003	.085579	.4090869
lnx3	-.0855305	.1078426	-0.79	0.428	-.2968982	.1258371
lnx4	-.0027847	.1195458	-0.02	0.981	-.2370902	.2315208
lnx5	-.0048156	.0093998	-0.51	0.608	-.0232388	.0136076
lnx6	-.1538572	.0934765	-1.65	0.100	-.3370678	.0293534
_cons	6.404731	.6746247	9.49	0.000	5.082491	7.726971
lnsig2v						
_cons	-3.418169	.3881584	-8.81	0.000	-4.178945	-2.657393
lnsig2u						
z1	-.6210406	.8782356	-0.71	0.479	-2.342351	1.10027
z2	-.031535	.025754	-1.22	0.221	-.0820119	.018942
z3	.0077052	.0781466	0.10	0.921	-.1454594	.1608697
z4	-.0136098	.1166479	-0.12	0.907	-.2422354	.2150159
z5	.0035602	.0090201	0.39	0.693	-.0141189	.0212392
z6	.2856682	.1582144	1.81	0.071	-.0244263	.5957627
z7	-.1262918	.2573944	-0.49	0.624	-.6307756	.3781921
z8	-.1004833	.089871	-1.12	0.264	-.2766271	.0756606
z9	-.0000139	.0000431	-0.32	0.748	-.0000984	.0000706
_cons	-1.081309	1.548733	-0.70	0.485	-4.116769	1.954151
sigma_v	.1810315	.0351344			.1237524	.2648223

•

Appendixes II

Survey Questionnaires

This survey questionnaire was organized to collect relevant data's for my Thesis entitled as the ANALYSIS OF ECONOMIC EFFICIENCY OF GREEN MUNG BEAN IN ANRS OROMIA ZONE. The topic more focuses on the economic efficiency of the green mungbean including other variables in the production of the pulses. This data has great value for my effort and has pivotal role to indicate remedial solution for the problem area on the analysis. So I would like to thanks heartily all who participated on filling of this survey questionnaires. Thank you again for all your support.

A. Interview Background

1. Name of the enumerator ________________________Date of interview ___________
2. District _________________ kebele _______________ Sub kebele (got) __________
3. Name of the supervisor _______________________ date checked _______________

B. Household information

1. Sex of the house hold head, 1 = Male 2 = Female
2. Age of the household head ____________________
3. What is the Educational status of the household head? 1 = No formal education, 2 = primary school 1-8, 3 = secondary school to preparatory school 9-12, 4 = certificate and above
4. Marital states of the household head, 1 = married 2 = single 3 = divorced 4 = widow
5. Household family size ____________________

C. Detailed Household family background information

1. Please indicate the following details in the table for all the household members living at home in the last one year (2010 E.C) in category of age.

Number of family member on age category	under 5 years	6-9 years old	10-15 years	16-24 years	25-64 years	Greater than 64 years old
Number of the family member						

2. occupation of the household

1=farming, 2 = Salaried employment, 3 = Self-employed off-farm, 4 = Household chores, 5 = student

D. Farmer Assets

1. What types of assets does the household currently own?

Descriptive of assets	Asset type	Number of Assets	Estimated current value
Communication items	Radio		
	Television		
	Mobil Phone		
Transportation	Bajaj		
	Bicycle		
	Motor bicycle		
	Donkey		
	Horse and cart		
	Others specify ____		
Farm tools	Plough Hoe/mattock		
	Ox-plough		
	Plough set		
	Others specify		
Roof of the House	Iron roofed house		
	Grass roofed house		
	Others Specify		
Wall of the house	Wood and mud		
	Stone and mud		
	Cement		
	Ashewa girf		
	Others specify		

1. Type of facility	2.Do you currently have access 1= Yes 2 = No	3. If yes, distance in walking hrs	4. If no, why 1 = Not available 2 = Financial constraints 3 = No need	5.utilization of these facilities 1 = Good 2 = Average 3 = Poor
Electricity				
All weather road				
Farmers training centre(FTC)				
Schools				
Health services				
Animal health services				
Credit services				
Mobile network access				
agricultural extension services				
Agricultural inputs providers				
Output markets (mainly used)				
Input markets (mainly used)				

E. Access to basic facilities

F. Farm experience, production and plot characteristics (2017/18 production season)

1. Years of experience in farming ______________________
2. Years of experience in green mungbean farming ______________________
3. Have you got extension contact on the mungbean growing? 1 = yes 2 = no
4. If yes, number of extension contact made with extension agents in 2017 __________
5. Have you training on mungbean production? 1 = yes 2 = no

G. How many plots of total operational farm land do you have in hectare? _______________

1. What is the size of plots used for mungbean planting in hectare? __________
2. What is the plot ownership status of mungbean plantation plots? 1 = ownership 2 = otherwise
3. The slop of mungbean plantation plots, 1 plane/ flat 2= sloppy
4. The soil fertility of mungbean plantation plots, 1= fertile 2= otherwise

H. Major inputs in the green mung bean production activity

1. Why did you plant green mung bean (purpose of producing)? 1= income source 2. Family consumption 3. Profit 4. Diversifying 5. Other (specify)………
2. Where is the source of the mungbean seed you have used? 1= Agricultural office 2 = otherwise
3. The quality of the green mung bean seed 1 = high quality 2= otherwise
4. The variety of mung bean seed used for planting is 1 = genetically improved 2 = local seed
5. The amount of green mung bean seed used per hectare? _______________
6. The price of green mungbean seed per kilogram
7. Would you have use fertilizer in the green mungbean production farm land? 1 = yes 0= no
8. If your answer is yes Fill in the details below for each type of fertilizer you have used in the green mungbean production?

8.1. if your answer is yes	8.2. type of fertilizer used 1 = inorganic 2 = manure/compost	8.3.The amount of inorganic fertilizer used in kilogram	8.4. price per/kilogram inorganic fertilizer	8.5.The amount of manure/ compost used in quintal	8.6. if you have bought manure/ compost price per quintal
Chemical fertilizer					
Manure/compost					

9. Would you have used herbicides and pesticides in the mungbean production plot farm? 1= yes 0 = no
10. If yes, what is the amount of herbicides and pesticide you have used in the plots in litre or kilogram?______

11. How much is the price of one litre or kilogram of the one you have used? Herbicide ______ pesticide ______
12. In which Season mostly you have produced green mung beans? 1= Meher, 2= Belg
13. How you have planted green mung bean? 1 = cultural sowing 2 = by line using guidance
14. What is the amount of green mung bean production yield in 2017/18 production you have got? _______
15. The amount of the green mung bean you have sold from the 2017/18 yeild? ______

I. Livestock inventory and ownership

Please indicate in details the livestock inventory in the last one year

1. Type of Livestock	2. Number currently owned	3. Purpose of keeping this animal (See codes*)	4. Average selling price per animal (In birr)
Cattle			
Cows			
Breeding bulls			
Oxen			
Heifers			
Calves			
Sheep			
Goats			
Poultry			
Beehives			
Donkeys			
Horses			
Mule			

1. Major constraints mungbean production	Rank on a scale			
	Have Strong impact	Have same impact	Indifferent	Have Low impact
Low soil fertility				
Pests and diseases				
Lack of improved crop varieties				
Lack of access to inputs High cost of inputs				
Timely unavailability of seeds				
Lack of quality seeds				
High climate variability				
Small land holding				
Lack of labour				
Lack of markets				
Lack of information on markets				
Others (**specify**)_____				

Purpose of keeping this animal: 1 = Insurance, 2 = Store of wealth, 3 = Finance future expenditure, 4 = Prestige, 5 = Manure production, 6 = Milk production, 7 = Animal draft, 8 = Other (Specify)___________________

J. Major mungbean production constraints

K. Fill in the details for the use of labour and oxen power, Amount of human labour and oxen labour allocated in the process of green mung bean production

plots	Oxen day		Total labour use in persons days/ Man days																	number of hired Labour/ days	harvested mungbean in (kg)
			Land preparation			Planting			Weed control				harvesting			Threshing					
	Ploughing frequency	Total ploughing days	Male	Female	Children	Male	Female	Children	Weed frequency	Male	Female	Children	Male	female	children	Male	female	children			
1																					

1. If you hired labor, average payment per person/day _______________Birr
2. If you sold green mung bean to the market, amount sold______ quintals and Price per quintal; ________Birr.
3. Was there any kind of stress in the production? 1 = yes 2 = no
4. If yes, sources of the stress?____1 = Pests; 2 = Diseases; 3 = Water logging; 4 = Drought; 5 = Frost; 6 = Flood; 7 = damage by livestock; 8 = Other, specify ___________

L. Income and food security

Please provide the following details on the household income sources in the last one year (Ask for each source one at a time and if the household does not get income from that source, move to the next)

1. Income source	2. Do you get income from this source 1 = Yes 2 = No	3. Who gets it? 1=Household head 2= Spouse, 3=Other members	4. Estimated amount from this source in the last 12 months	5. contributing to total household income 1=A lot 2=Moderate 3= A little 4= Not at all
Sale of crops				
Sale of livestock				
Remittances				
Safety net payment				
Sale of other products(firewood coal, etc)				
Regular employment				
Casual employment				
Petty trading				
Others (specify)_________				

5. Have you membership to organized farmers group? 1 = cluster farming group 2 = farmer cooperatives 3 = if others specify ________
6. How much is the Frequency of meetings per year of the group you are membership? Cluster farming group_____ farmer market cooperatives _______ others ________
7. What is your Perception of empowerment in production and marketing decision of the group? __________

M. Access to market, credit and extension information and services, and social networks (2012/13 season)

1. Did you have access to production and market information of green mung bean? 1=yes 0= No
2. If yes, please indicate the source in the table bellow

3. Source of information	4. Indicate your source of information	5. Frequency Of getting the information 1= frequently2 = rarely	6. Distance, walking hour for the information	7. effective information 1= A lot 2= some what 3 = a little
Other Farmers				
Wereda trade office				
Extension officer				
Farmer cooperatives				
Mass media (Radio/TV)				
Middle man's/ brokers				
Farmer organization				
Market place				
Family and friends				
Traders				
Internet				
Print materials (Posters, bulletins)				
Others specify _				

8. Did you have access to credit facilities (2017/18)? 1 = Yes 2 = No. If your answer is yes , please fill the following table

9. Credit source	10. Have you ever borrowed? 1 = yes 2 = no	11. If yes Amount borrowed	12. For what Purpose you have borrowed (see codes)	13. If it have an interest, put Interest rate
Relative and friends				
Banks				
Micro finances				
NGOs				
Others specify___				

Purpose for borrowing: 1=Purchase of food, 2=Purchase of household assets, 3=Payment of fees, 4=Cover medical costs, 5=Buying inputs, 6 = Buying livestock inputs, 7=Cover educational costs, 8= other (specify) ___

14. If you have not borrowed, why?

1 = Borrowing is risky 2 = no interest free credit access while interest is religiously forbidden, 3 = interest rate is high 4 = too much bureaucracy 5 = collateral problem 6 = no money lenders in this area 7 = lenders don't provide the amount needed 8 = own financial capacity for this purpose 9 = others, specify_____

15. Why did you plant green mungbean (purpose of producing)? 1. For market, since it attractive price 2. For Family consumption 3. For productivity, since it is drought tolerant crop 4. For soil health, since it increases soil fertility 5. For its fast growth to harvest, 5, others (specify)………
16. Do you have continues demand for green mungbeans product? 1 = yes 2 = no
17. For whom you have sold your mung bean product? 1= consumer 2 = retailer 3 = wholesaler 4 = cooperatives 5 = exporter 6 = others specify ____________

Appendix III

Afan oromo Questionnaire

Survey Questionnaires

This survey questionnaire was organized to collect relevant data's for my Thesis entitled as the ANALYSIS OF ECONOMIC EFFICIENCY OF GREEN MUNG BEAN IN ANRS OROMIA ZONE. The topic more focuses on the economic efficiency of the green mungbean including other variables in the production of the pulses. This data has great value for my effort and has pivotal role to indicate remedial solution for the problem area on the analysis. So I would like to thanks heartily all who participated on filling of this survey questionnaires. Thank you again.

N. Interview Background

1. Name of the enumerator ________________________Date of interview ____________

2. District _________________ kebele _______________ Sub kebele (got) __________

3. Name of the supervisor ________________________ date checked _______________

O. Odeeffannoo abbaa/haadha warraa

6. Sala abba warraa, 1 = dhiira 2 = dubara/dhalaa
7. Umrii abbaa manaa ____________________

8. Haala barnootaa abbaa/haadha warraa? 1 = barumsa idilee kan hin baranne, 2 = sadarkaa 1ffaa 1-8, 3 = sadarkaa lammaffaafi qophaa'ina/preparatory 9-12, 4 = sartifikeetiifi sanii oli
9. Haala gaa'elaa/tidaarii, 1 = kan fuudhe/heerumte 2 = kan hinfuudhin/hineerumin 3 = kan walhiikan 4 = kan jalaa boqotte/kan irraa boqote
10. Baayyi'ina maatii ____________________

P. Odeeffannoo matii abbaa/haadha warraa

3. Gabatee armaan gadii keessatti maatii abbaa warraa bara 2010 A.LI mana san jiraatan umrii isaaniitiin adda baasii guuti?

Lakkoofsa maati umriin	Bara 5nii gadi	Bara 6-9	Bara10-15	bara16-24	Bara25-64	Bara 64fi oli
Lakkofsa maatii						

4. Haala hojii abbaa warraa/haadha warraa? 1=qotee bulaa 2= horsisee bulaa, 3 = qotee horsiisee bulaa 4 = hojii dhuunfaa kan biraa, 5 = joollee guddistuu, 6 = baratаа

Q. Qabeenya abbaa warraa

2. Qabeenya abba warraa amma manaa qabu?

Ibsama qabeenyaa	Bifa qabeenyaa	Lakk. qabeenyaa	Tilmaama gatii qabeenyaa
Meshaa walqunnamtii/ communication asset	raadiyoo		
	Televiziyona		
	Moobayilii		
Meeshaa geejibaa	Bajajii		
	Saykilii		
	Gala		
	Harree		
	Gaarrii fardaa		
	Kan biraa yoo jirate __		
Miha qonnaa	Qottoo, akafaa KKF,		
	Qotiyoo qonnaa		
	Miha qonnaa		
	Kan biraa yoo jiraate		
Mana gubbaan	Mana qorqorroo		
	Mana citaa		
	Kan biraa yoo jiraate		
Minjaala/ girgiddaa manaa	Mukaa		
	Dhakaafi maragaa		
	Mana bulukketii		
	Mana garafamaa		
	Kan biraa yoo jiraate		

R. Mijjee/dhiheenya bu'uura misoomaa

2. Bifa bu'uura misoomaa	2, mijjee/ dhiheenya qabdaa? 1 = eyee 2 =lakkii	3. yoo 'eyee' jette sa'aa meeqa sitti fixa?	4. yoo 'lakkii' jette maalif 1 = hinjiru 2 = hanqina maalaqaaf 3 = hinbarbaadu	5. itti faayyadama kee 1 = gaarii 2 = haata'uu 3 = kufaadha
Ibsaa				
Karaa gannaa bonaa				
Jedugala leenjii qonnaa(FTC)				
Mana barumsaa				
Buufata fayyaa				
Buufata fayyaa beelladootaa				
Jedugala liqii				
Neetworkii/ shabaka				
Jedugala ekisteenshinii qonnaa				
Dhiheessa galtee qonnaa				
Gabayaa				

S. Muuxannoo qonnaa, oomishtummaa fi haala lafa qonnaa kan bara oomisha (2010/11A.L.I)

1. Bara meeqa qonna qotte ______________________
2. Bara meeqa Mashoo qotte ______________________
3. Oomisha maashoo irratti deeggarsa ogeessa qonnaa argattee? 1 = eyee 2 = lakkii
4. Yoo 'eyee' jette ganna darbe yeroo meeqaaf deegarsa argatte? __________
5. Oomisha Mashoo irratti leenjii argattee? 1 = eyee 2 = lakkii
6. Lafa qonnaa heektaara meeqa qabda? _______________
7. Lafa hangam gahu mashoo facaafte heektaaraan? __________
8. Lafti maashoo facaafte keeti moo keetimiti? 1 = kiyyaa 2 = kiyyaamiti
9. Lafti maashoo facaafte diriira? 1 = diriira 2= diriiraamiti
10. Lafti maashoo facaafte boodda(gabbataa)/fertile? 1= booddaa/fertile 2= miti

T. Galtee/imputs/oomisha maashoo irratti faayyadamtu

1. Facaasaa/ sanyii mashoo eessaa argattaa? 1= waajjira qonnaa 2 = bakka biraa
2. Qulqullina facaasaa/sanyii maashoo? 1 = bay'ee qulqulluu 2= bay'ee qulqulluu miti
3. Facaasaa/sanyii mashoo ati fayyadamtu? 1 = sanyii filatamaa/genetically improved 2 = kanuma baramaadha

4. Heektaaratti facaasaa/sanyii maashoo waan hammam gahu facaafta? ___________
5. Gatiin facaasaa/sanyii mashoo kiiloo tokko meeqaan bittu? __________
6. Lafa mashoo irratti xaa'oo yookan dikee hinfayyadamtuu? 1 = eyee nanfaayyadama 2= lakkii

7. Yoo 'eyee' jette gabatee armaan gadii guuti?

yoo nanfayyadama jette	kam fayyadamta 1 = xaa'oo 2 = dikee/kompostii	xaa'oo kilo meeqa faayyadamte	gatiin xaa'oo faayyadamtee meeqa	dikee/compostii kuntaala meeqa fayyadamte	dikee yoo kan bitte ta'e kuntaalli meeqa
Xaa'oo					
Dikee					

8. Maashoo facaafterratti qoricha farra ilbisaa fi qorichaa armaa faayyadamtee? 1= eyee 2 = lakkii

9. Yoo eyee jette, waan hammam gahu faayyadamte? Kiiloo/liitiriin ______

10. Gatiin kiiloo/liitirii tokkoo meeqa? Qooricha farra ilbsaa ______ qoricha aramaa ______

11. Maashoo yoom bal'inaan facaaftu? 1= ganna, 2= Balgi/arfaasaa

12. Maashoo akkamitti facaaftu? 1 = sararaan 2 = bittinsuun/facaasuun

U. Qabeenya beelladaa,

Qabeenya beelladaa bifaan gabatee armaan gadii keessatti guuti

1. gosa beelladaa	2. lakk. Hamma qabu	3. maaliif akka horsiisu (koodii laali)	4. gatii tilmaamaan qarshin
Sa'a			
Qotiyoo			
Jibicha			
Goromaa			
Jabbilee			
Gala			
Re'ee			
Hoolaa			
Harree			
Handaaqqoo			

Maaliif sa'a horsiistu: 1 = qabeenya kuufachuuf, 2 = qabeenya fuulduraaf, 3 = kabajaaf, 4 = oomisha aannaniif, 5 = bu'aa isaaniif, 6 = kan biraa___________________

1. Rakkoolee ijoo oomisha maashoo	Sadarkaa isaanii			
	Bay'ee cimaa	cimaa	Xiqqaa	Ba'ee xiqqaa
Lafa gabbataa/ soil fertility				
Dhukkuba maashoo				
Hir'ina Sanyii filatamaa				
Cimina Gatii dhiheessa adda addaa				
hanqina facaasaa/sanyii				
Hanqina facaasaa/sanyii qulqulluu				
Jijjiirama qilleensaa				
Hanqina lafaa				
Hanqina hojjataa humnaa				
Hanqina gabayaa				
Hanqina odeeffannoo gabayaa				
Kan biraa yoo jiraate_____				

V. Rakkoolee ijoo oomishtummaa mashoo irratti muudatan

W. Oomishtummaa maashoo

1. Maaliif maashoo facaafta? 1 = gabayaaf, gatiin ishii bareeda waanta'eef 2 = Qallabiif, nyaataaf barreda waanta'eef 3 = oomishtummaaf, rooba xiqqoon waan firooftuuf 4 = Lafa akkarsiisuuf, lafa waangabbistuuf 5 = yeroo gabaabaa keessatti waan geessuuf 6 = kan biraa yoo jiraate
2. Ganna darbe lafa maashoo facaafterraa kuntaalan yookaan kiiloo meeqa argatte? _______
3. Maashoo ganna darbe oomishterraa meeqa gurgurte kuntaalaan/kiiloon ______
4. Oomisha maashoo kee yoo gurgurtee jiraatte kuntal meeqa gurgurte?______
5. Gatiin kuntaala tokkoo qarshii meeqa/meeqattiu gurgurte?________
6. Maashoon yeroo hunda gabayaarratti hinbarbaadamtii? 1 = eyee 2 = lakkii
7. Mashoo eenyutu sirraa bita? 1= warra nyaatu 2 = warra charaaccharu 3 = warra jumlaa gurguru 4 = waldaa gamtaa 5 = warra biyya alaatti gurguru 6 = kan biraa _____________
8. Yoo maashoo oomistu sodaan simuudate jira? 1 = eyee 2 = lakkii
9. Yoo eyee jette, madda soda keetii kami? 1 = ilbisoota(raammii hanga hantuuta); 2 = dhukkuba; 3 = bishaan; 4 = gogiinsa; 5 =cabbii 6 = galaana; 7 = horii/loon; 8 = kan biraa yoo jiraate ______
10. Yoo hojjataa humnaa qabattee jiraatte kaffaltiin hojjataa humnaa guyyatti qarshii meeqa?______

X. **Gatii human namaa fi human qotiyoo oomisha maashootiif faayyadamte gabatee armaan gadii keessatti of'eeggannoon guuti**

Bal'ina lafa maashoo	Oxen day		Human namaa waliigala fayyadamte (nama guyyaan)																	Hojjataa humnaa guyyaatti meeqa qabatta?	Kuntal meeqa oomishte/ gashatte
			Qophii lafaaf			Facaasaaf			Aramaaf				buqqissuuf			tumuuf				
	Yeroo meeqa qotte	Guyyaa meeqa qotte	dhiirra	Dubara	joollee	Dhiira	dubara	joollee	Yeroo meqa	Dhiira	Dubara	joollee	dhuiira	dubara	ijoollee	Dhiira	dhalaa	ijoollee		

Y. Galiifi wabii nyaataa

Madda galii abbaa warraa kan bara darbee akka armaan gadiitti guuti (tokkoon tokkoon gaafadhu yoo guuti)

1. madda galii	2. madda galii kanarraa galii argatte? 1 = eyee 2 = lakki	3. eenyutu argate? 1=abba warraa 2= haadha manaa, 3=maatii/betasaba	4. tilmaamaan bara darbe madda galii kanarraa meeqa argatte	5. gahee galii waliigalaa maatii keessaa qabu? 1=bay'ee 2=giddugallessa 3= xiqqo 4= humaa hinqabu
Midhaan gurguruun				
Horii gurguruun				
qarshii biyya alaarra ergamu				
Seftineetii				
Muka qoraanii, kasalafi kkf gurguruun				
Mindaa hojii yeroo/guyyaa				
Daldala xiqoo				
Kan biraa ________				

1. Ati miseensa gurmii qotee bulaa kam kee jirta? 1 = gurmii qonna kilasteraan 2 = waldaa hojii gamtaa 3 = kan biraa ________ 4 = miseensaa miti
2. Yoo miseensa taa'e baratti yeroo meeqa walgeessu? ____________________
3. Oomishtummaa dabaluufii gatii gabayaa murteessuu keessatti guurmiileen kun yoo gahee qabaatan ibsi?_____ ____

Z. Mijjee gabayaa, liqii, odeeffanno fii deeggarsa ekisteenshinii qonnaa bara darbee

1. Oomishtummaafi gabayaa maashoof odeeffannoo hinargattaa? 1=eyee 2 = lakkii
2. Yoo eye jette, please indicate the source in the table bellow

Madda odeeffannoo	Madda odeeffannoo kee mallatoo"X"n agarsiisi	Irra deddeebii odeeffanno itti argattu, 1= bay'ee 2 = darbee darbee	Odeeffannoo argachuuf fageenya deebtu sa'atiin	odeeffannoo argattee 1= gaariidha 2= hanga ta'e gaariidha 3 = xiqqaadha
Qoteebulaa biraa				
Waajjira daldalaa				
Ekistenshinii qonnaa				
Waldaa Hojii gamtaa				
Miidiyaa hawasummaa (Radio/TV)				
Daldalaa				
gabayyaa				
Maatiifii hiriyaa				
Daldaltoota				
Meeshaalee maxxansaa (Posters, bulletins)				
Kan biraa				

3. Liqii argachuuf haala mijjee qabduu? 1 = eyee 2 = miti. Yoo eyee jette, gabatee armaan gadii guuti

4. Madda liqii	5. Liqeeffattee beektaa? 1 = eyee 2 = miti	6. Meeqa liqeeffatte?	7. Maaliif liqeeffatte (koodii laali)	8. Yoo dhala qabaate meeqa?
hiriyaa				
Baankii				
አ.ብ.ቁ.ተ				
NGOs				
Kan biraa___				

Maaliif liqeeffate: 1= qallaba bitachuuf, 2=qabeenya dhaabbataa itti bitachuuf, 3=kaffaltii adda addaaf, 4=bahii mana yaalaaf 5=xaa'oofi facaasaa bitachuuf, 6 = loonii itti bituuffi, 7= bahii barnoota joolleef, 8= kan biraa ___

9. Yoo hinliqeeffanne ta'e, maaliif? 1 = liqiin balaa waan qabuuf 2 = liqiin dhalaan bilisaa waan hinjirreefi dhalli amantaan dhorkaa waan ta'eef, 3 = dhalli isaa guddaa waan ta'eef 4 = argachuuf rakkisaa wanta'eef 5 = rakkina wabii 6 = qaami maallaqa liqeessu hinjiru 7 = kan liqeessu hanga barbaanne nuhinliqeessu 8 = maallaqa kanaaf ta'u qaba 9 = kan biraa___________________________////

=====Thank you for all your support ======