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Assessment of Technical Efficiency of smallholder faba bean farmers: The case of Kersa Malim District, South West Shewa Zone of Oromia, Ethiopia

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Abstract: **The objective of this paper was to assess the technical efficiency and factors affecting efficiency of faba bean production in Kresa Malima district of Oromia region, Ethiopia. A sample of 181 respondents from six kebeles of Kersa Malima District in 2014 cropping season were selected using a random multi-stage sampling technique. Stochastic frontier and translog functional form with a one-step approach were used to assess the technical efficiency and factors affecting technical efficiency of farmers. The result showed that the mean technical efficiency of faba bean was found to be 69 percent. This implies that given the existing technology and level of inputs the output could be increased by 31%. The technical efficiency analysis also showed that about 60 percent of the farmers were above the average and 38 percent were below the average of mean technical efficiency. The production efficiency of faba bean farming was determined by education, livestock holding, distance to all-weather roads, distance to faba bean plot and slop negatively. Age, extension contact and family size were positively affect inefficiency of faba bean farmers.**

Keywords: **Stochastic frontier, Technical efficiency, small holder faba bean farmers.**

1. INTRODUCTION

Faba bean (*vicia faba L,)* is one of the most important pulse crops grown in the highlands of Ethiopia both in terms of area coverage and volume of annual national production. Ethiopia is considered as one of the center of secondary diversity for faba bean [1]; [2]. According to Central Statistical Authority, of the total 1,558,442 ha of land cultivated to pulses 443,108 ha of the area was allotted to faba bean from which over 8.4 million quintals of grain is annually produced [3]. The crop is grown in several region of the country with annual rainfall of 700-1000 mm and altitudes of 1800 to 3000 m above sea level. The major producers of faba bean are Amhara, Oromia, SNNPR and Tigray [3], most of the crops is being produced with rain fall under marginal situation by small-scale farmers either singly or in mixtures with field pea.

Faba bean is a crop of manifold merits in the economic lives of the farming communities in the highlands of Ethiopia. It serves as sources of food and feed with a valuable and cheap protein as compared to animal products. It plays significant roles in soil fertility restoration as suitable rotation crops that fix atmospheric nitrogen, thereby result in savings for smallholder farmers from less fertilizer use [4]. For example, nitrogen fixation by faba bean was found to have significance spillover effect to subsequently grown wheat in Ethiopia [5]. It is also a good source of cash to the farmers, and generates foreign currency to the country.

In Ethiopia, improved Faba bean variety contains 25-28% protein [6]. In addition to protein, the Faba bean contains energy, fat, carbohydrate and fibre [7]. Other nutrients which can be found in the Faba bean are iron, magnesium, potassium, zinc, copper, selenium and various vitamins [8]. As the Faba bean has high nutritional value, it is considered to be a suitable substitute for meat and milk [9]. In Ethiopia people with an Orthodox religious background have a strong culture with regards to diet which is prepared by pulse crops. Especially during fasting time, food is prepared by pulses such as chick peas, split peas, Faba beans and lentils [10].

Despite, playing a major role in the economic lives of the farming communities in highland Ethiopia, however, the huge potential for growing and exporting this crop, achievements to date are very low because of several yield limiting and reducing factors such as inherent low-yielding potential of the indigenous cultivars [11]; [2], chocolate spot (*Botrytis fabae*), rust (*Uromyces viciae-fabae*), root rot (*Fusarium solani*) and abiotic stresses like drought, soil acidity and waterlogging are among important production constraints that deserves priority as research objectives.

In Ethiopia, there is considerable agreement with the notion that an 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 given inputs into outputs. In any production of output, there are three types of efficiencies (technical, allocative 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. Allocative 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 allocative efficiencies [12].

Efficiency is a very important factor of productivity growth, especially in developing agricultural economies where resources are meager and opportunities for developing and adopting better technologies are dwindling [12]. 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. So this study attempts to assess technical efficiency of farmers and identifies the socio-economic variables affecting efficiency.

2. RESEARCH METHODOLOGY

Study area

The study was conducted in Kersa Malima district of South West Shewa zone of Oromia Regional State of Ethiopia. South West Shewa zone of Oromia Regional State comprises twelve districts. Kersa Malima is one of the twelve districts of South West Shewa zone of Oromia Regional State of Ethiopia. Geographically, Kersa Malima is located between 8.48º latitude and 38.68 º longitudes and has area coverage of 59,905 km^2 [13]. Lemon, the capital town of the study district, is located at 60 km south west of Addis Ababa town.

Most of its area are high lands (Dega) and mid lands (Weina Dega) with an altitude ranges from 1850 to 2900 meters above sea level. The two types of soils dominated in the district are chromic and pellic vertisol and eutric nitosols. In this district there are about 31 Kebeles (Kebele is the lowest administrative unit under Ethiopian condition) out of which 27 kebeles were producing faba bean crops. The farming system in the district is mixed crop-livestock type, whereby crops contribute larger share to farmers’ income. The five major crops grown in the area are wheat (31.25%), teff (19.79%), barley (18.17%), faba bean (10.19%) and chick pea (6.30%) [13].

Sampling procedures

In order to select sampled farm households, a multi stage sampling design was employed. In the first stage, Kersa Malima district was purposively selected on its huge potential in faba bean production from south west Shewa zone. In the second stage, six kebeles were purposively selected on the basis of share in total area of this crop with the consultation of Bureau of Agriculture in the Wereda. In the final stage, 181 sample households were selected using systematic random sampling methods from a unit of faba bean growers listed from the six kebeles.

Data types and methods of collection

Data for this study were collected from primary and secondary sources. A designed structured questionnaire was employed to collect primary data pertaining to demographic and socio-economic characteristics, farm characteristics, agricultural inputs and outputs of faba bean, variables related to institution policy and production problems encountered from the sample households in 2013/14 cropping season. Primary data collection was done during May 2014 by close supervision and day to day checkup of Holetta Agricultural researchers and technicians. To supplement primary data, secondary data were also gathered from concerned zonal and district Bureaus of Agriculture and Rural Development offices and from published [3] sources. The data was cross-sectional and quantitative in nature.

Data Analysis

To achieve the objective of this study, descriptive and inferential statistics were used. In descriptive statistics; means, standard deviations, percentages and frequency counts were used to describe socioeconomic characteristics of farm households, inputs, output variables, frequency distribution efficiency levels and responses on faba bean production constraints. The stochastic frontier production function and the inefficiency model are simultaneously estimated with the maximum likelihood method using the econometric software, FRONTIER 4.1 computer program [14].

Theoretical framework

The stochastic frontier production function method was adopted to estimate the technical efficiency of smallholder faba bean farmers in the study area. For various reasons, this model is appropriate because agricultural production in general exhibits shocks, and hence there is a need to separate the influence of stochastic variables (random shocks and measurement errors) from resulting estimates of technical inefficiency [15]. The model was independently proposed by [16]; [17]. The stochastic frontier production model can be generally specified as:

$Y_i = exp\ (x_i;\beta + v_i - u_i)$ where i = 1,2,…,n (1)

Where Y_i = denotes the output for the i^{th} sample farm of faba bean, X_i represents a (1 x K) vector whose values are functions of inputs and explanatory variables for the i^{th} farm, β is the coefficient vector (K x 1) of unknown parameters to be estimated, V_is are assumed to be independent and identically distributed random errors not under the control of the farmers which have normal distribution with mean zero and unknown variables, σ_v^2 that is $V_i \sim N(0, \sigma_v^2)$, u_is are non-negative unobservable associated with the technical inefficiency of production such that for a given technology and levels of inputs, the observed output falls short of its potential output $U_i \sim N(0, \sigma_u^2)$ or it is a one-sided error term ($U \geq 0$) efficiency component that represents the technical inefficiency of the farm. In other words, U_i estimates the shortfall in output Yi of faba bean from its maximum value given by the stochastic frontier function. In other words, the basis of a frontier function can be illustrated with a farm using n inputs for faba bean ($X_1, X_2, \ldots, X_n$) to produce output Y of faba bean. Efficient transformation of inputs into output is characterized by the production function $f(X_i)$, which shows the maximum output obtainable from various input vectors. The stochastic frontier production function assumes the presence of technical inefficiency of production. Hence, the function is defined as:

$$Y_i = f(X_i, \beta) + \varepsilon_i\ ; \forall\ i = 1,2, - - - n \quad (2)$$

Where N = 181 (No of hhs), ε_i is the error term that is composed of two elements, that is

$\varepsilon_i = V_i - U_i$

The stochastic frontier analysis has been preferably applied in many agricultural economic research like By [18]; [19]; [20]; [21] and [22] and the approach describes technical efficiency (TE) of an individual farm is defined as the ratio of the observed output (Y_i) to the corresponding frontier output (Y^*) conditioned on the level of inputs used by the farm and mathematically specified as:

$$TE = \frac{F(x_i;\beta).exp(v_i - u_i)}{F(x_i;\beta).exp(v_i)} = exp(-u_i) \quad (3)$$

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Where $F(x_{i;}\beta).\exp(v_i-u_i)$ is the observed output (Y) and $F(x_i\beta).\exp(v_i)$ is the frontier output (Y*). V_i is the error term permits random variations in output due to factor outside the control of the farmer like weather and diseases as well as measurement error in the output variable, and is assumed to be independently, identically and normal distributed with mean zero and constant variance $(\sigma^2_{v)}$; i.e.~ $N(o,\sigma^2_v)$. The U_i is inefficiency component of non-negative random variables independently and identically distributed as (σ^2_u) , i.e., $u_i\sim N(\mu_{i,}u^2_{u)}$, but if $u_i = 0$, the assumed distribution is half-normal. [23] Suggested the technical inefficiency model which is illustrated by:

$$\mu_i = z_i\delta \tag{4}$$

Where Z_{it} is a (1 x M) vector of explanatory variables associated with the technical inefficiency effects in the ith time period, δ is an (M x 1) vector of unknown parameter to be estimated.

For this investigation, the technical efficiency levels and its determinants were simultaneously estimated using the single stage maximum likelihood estimation method. This estimation procedure guarantee that the assumption of independent distribution of the inefficiency error term is not violated. The maximum likelihood estimation of the stochastic frontier model yields the estimate for beta (β), sigma squared (σ^2) and gamma (γ), and are variance parameters; γ measure the total variation of observed output from its frontier output. We use the parameterization following [24] and give as, $\sigma^2 = \sigma^2_{v} + \sigma^2_{u}$ and $\gamma = \sigma^2_u / (\sigma^2_v + \sigma^2_u)$, where the gamma lies between zero and one ($0 \leq \gamma \leq 1$). If the value is close to zero, then the deviations are as a result of random factors and /or if the value is very close to 1, then the deviation are as a result of inefficiency factors from the frontier

Model specification

Following [16], many agricultural studies has been used the translong production function to estimate technical inefficiency (for example [25]; [26]; [18] and [19]. To conduct this study, the translog production function stated below is used for its flexibility for which it places no restriction unlike the Cobb-Douglas production function.

$$\ln Y_i = \beta_0 + \sum_{i=1}^{5} \beta_i \ln x_i + (Vi-Ui) \quad \text{Cobb-Douglas} \tag{5}$$

$$\ln Y_i = \beta_0 + \sum_{i=1}^{5} \beta_i \ln x_i + \frac{1}{2}\sum_{i=1}^{5}\sum_{j=1}^{5} \beta_j (\ln x_i)(\ln x_j) + (Vi-Ui) \tag{6}$$

Where i=1, 2, ---n=181, and x= vector of five input variables. The stochastic production model for faba bean production in Kersa Malima is given by:

$$\begin{aligned} \text{Ln (output)}_i &= \beta_0 + \beta_1\ln(\text{Area}) + \beta_2\ln(\text{seed}) + \beta_3\ln(\text{fert}) + \beta_4\ln(\text{lab}) + \beta_5\ln(\text{oxndays}) + \tfrac{1}{2}\beta_{11}\ln(\text{Area})^2 + \tfrac{1}{2}\beta_{22}\ln(\text{Seed})^2 \\ &+ \tfrac{1}{2}\beta_{33}\ln(\text{Fert})^2 + \tfrac{1}{2}\beta_{44}\ln(\text{Lab})^2 + \tfrac{1}{2}\beta_{55}\ln(\text{Oxendays})^2 + \beta_{12}\ln(\text{Area})\ln(\text{seed}) + \beta_{13}\ln(\text{Area})\ln(\text{Fert}) + \beta_{14}\ln(\text{Area})\ln(\text{Lab}) \\ &+ \beta_{15}\ln(\text{Area})\ln(\text{OxenDays}) + \beta_{23}\ln(\text{Seed})\ln(\text{LFert}) + \beta_{24}\ln(\text{Seed})\ln(\text{Lab}) + \beta_{25}\ln(\text{Seed})\ln(\text{Oxendays}) + \beta_{34}\ln(\text{Fert})\ln(\text{Lab}) \\ &+ \beta_{35}\ln(\text{Fert})\ln(\text{Oxendays}) + \beta_{45}\ln(\text{lab})\ln(\text{Oxendays}) + vi\text{-}ui \end{aligned} \tag{7}$$

Where output represents total yield of the ith plot in kilo gram (kg); Area represents area of faba bean of the ith plot in hectare (ha); Fert represents the total amount of inorganic fertilizers used per plot in kg; oxen days represent the amount of oxen days used for plowing from land preparation to planting; Seed represents the amount of seed used per plot in kg; Lab represents the total cost of labour per day for different farm activities estimated at market price and ln represents Natural logarithm.

Inefficiency model specification for the target commodity of individual producer is given by

$$\mu = \delta_0 + \sum^{15} \delta_j Z_{ji} \quad \mu = \delta_0 + \delta_1\text{Age} + \delta_2\text{Educ} + \delta_3\text{Distextser} + \delta_4\text{Distinputmkt} + \delta_5\text{Distoutputmkt} + \delta_6\text{Extncont} + \delta_7\text{famsiz} + \delta_8\text{Gpmemship} + \delta_9\text{train} + \delta_{10}\text{Acsscredit} + \delta_{11}\text{Livestok} + \delta_{12}\text{Distwroad} + \delta_{13}\text{Distplot} + \delta_{14}\text{Slop} + \delta_{15}\text{fertility}$$

where the variable in the above inefficiency model are defined as follows, Age represents the age of the household in years; Educ stands for the education level of the household in years of forma education completed; distextser is the average time in minutes spent by the farmer to reach extension service from his home; Distinput mkt is is the average time in minutes spent by the farmer to reach input market from his home; Distoutputmkt is is the average time in minutes spent by the farmer to reach output market from his home; Extncont stands for the number of extension contact made with Das and experts; famsiz stands for the size of the family; Group membership represents a dummy variable with a value =1 if the household participate in farmers group, 0 otherwise; train stands for the number of trainings on improved varieties, diseases and insect pests, crop production and management; Acsscredit is a dummy variable, which has a value 1 if the i^{th} farmer has no credit constraint, 0 otherwise; Livestok represents the total number of livestock owned in TLU; Distwroad is the distance from the household residence to the nearest all weather roads in walking minutes; Distplot is a dummy variable, which has a value 1 if the i^{th} farmer's plot is a plain, 0 otherwise; fertility is a dummy variable having a value 1if the land is fertile, 0 otherwise.

Hypothesis testing

In spite of the magnitude and significance of the variable performance, γ, it is important to explain the various null hypotheses employed in this study. Three hypotheses were tested to test the adequacy of the specified model used in this study, the presence of inefficiency and exogenous variables to explain inefficiency among smallholder faba bean producer (Table3). The generalized likelihood ratio statistics was used to test the hypothesis. It is specified as:

$LR(\lambda) = -2 [\{\ln L(H0)\} - \{\ln L(H1)\}]$

Where (H0) and L(H1) are the values of 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 number of estimated parameters under H_1 and H_0. Yet, where the test involves a γ, then the mixed chi-square distribution is used. The H_0 is rejected when the estimated chi-square is greater than the critical (Table 2). The result of the hypothesis tested is presented in the result discussion section of this study.

3. RESULT AND DISCUSSION

Descriptive statistics

The summary of the descriptive statistics related to the variable used for the analysis is presented in table 3. The result indicate that faba bean productivity in the study area were 19.34 qt/ha and relatively higher than the national average productivity of 18.93 qt/ha [3]. The product was obtained by using 205.9 qt/ha of seed, 103.28 qt/ha of fertilizer, 16.7 oxen days/ha and 92.3 labour man days/ha. The average age of the household head was 43 year with a range of 20 to 80 years. Most of the households (67.4%) are in the range of 31 to 55. The age structures of the surveyed households member result indicate that 48.95% of the population were economically active i.e. 16 – 55 years, whereas 47.07 % were under age of 16 and 3.98% are above 55. This figure shows that every economically active person in the house hold had to support more than one economically inactive person. The average family sizes for the household in the study area were 6.8 with a minimum of 1 and maximum of 14 persons and a standard deviation of 2.54. This average household size is very large as compared to average adult equivalency of 4.99. This indicates that there is highest dependency ratio. When we compare the sex of the family member, 52.5 % were male and 47.5 were female.

Among the total 1055 family members of sample households who are above or equal to the age of 7 years, 77.44% are literate in qualitative sense as they can at least read and write and most of whom learned through formal education. Among 181 sample household heads, 74.52% have attended formal education while 13.26% of the sample household heads are illiterate others 86.74% are literate.

The average farm size allocated for faba bean production in the study area 0.44 ha from a total average of 2.71 ha. This showed that an average household allocated more than 27% of the farm land for faba bean. Out of 181 respondents asked, 47.06% were responding that they grow only improved faba bean varieties, 2.94% utilize improved and local and 50.0% were not grow improved faba bean varieties in the study area. In the study area, 85.78% of the households use their own land, 9.31% rented land by paying an average of 4017.68 birr/ha which ranged from 1000 up to 12,000 birr/ha base on the fertility of the soil and 4.99% sharecropped. The survey result showed that out of 181 respondents, about 50.3% of them had an access to credit facility the remaining 49.7% of them did not have any access to credit facility. Moreover, even if they have access to credit, most of them were not borrowed money from different sources. The average number of contact made by extension staff with farmers on different crop and livestock technologies were 17.64 days, and faba bean growers received a two day crop specific training. The main reason explained by farmers was that, borrowing is risky, beaurocracy, high interest rate and others. The respondents reported that 97.79% of the household are organized in one or more than one farmers groups and only 2.21% were reported that they are not a member of any group.

The average livestock holding for sample households was 8.3 TLU with a minimum value of 0 and a maximum value of 26.7. On average the respondents spend about 0.43, 0.69, 0.69, 0.41 and 16.59 minute walk to reach the nearest input market, output market, extension service, all weather road and plot of land respectively.

Estimate of stochastic production frontier model

Before doing 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 faba bean for the sample households. In a one-step modeling approach, the two models Cobb-Douglas and Translog frontier were used. Different restrictions were imposed on the model defined by 4 and 6. The generalized likelihood ratio tests were used to check whether these restrictions were valid or not. The result of the test hypothesis for parameters of the stochastic frontier and inefficiency effects model for faba bean farms in Kersa Malima district was presented in Table 3 below. The first null hypotheses of these test was revealed that the coefficient of the interaction terms of input variables are zero favoring the Cobb-Douglas functional form (H_0: β_{ij} =0). The values of the log likelihood function for Cobb-Douglas and translog frontier model for faba bean was -189.67 and -176.17. Therefore the generalized likelihood ratio test is used to decide the functional form as follows: LR (λ) = -2 [{lnL(H0)}- {lnL(H1)}]

= -2 [-189.67 + 176.17] =27

The value of likelihood ratio statistics was found to be 27.0 which is greater than the critical value of $\chi2$ value of 25 with 15 degree of freedom (the number of restrictions for the interaction terms in the model) at 5 percent level of significance. We rejected the null hypothesis and thus the translog functional form is preferred to Cobb-Douglas functional form for more precise and consistent results. The second null hypotheses that specifies technical inefficiency effects are absent in the model (H0: $\gamma = \delta0 = \delta1 =$ --- $=\delta15 =0$) that means all faba bean farmers efficient in the study area were tested against the alternative (H1: $\gamma > 0$ and $\delta i \neq 0$ where i = 0,1, ---, 15) is rejected with generalized likelihood ratio test statstics of 79.2 which are larger than 5.41 critical values at 5 percent significance level with 1 degree of freedom (Table 1) [27]. 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 (all faba bean producers) are 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 faba bean production in the study area. The final null hypotheses, H0: $\delta1 =$ --- $\delta15=0$, which describes that the coefficient of the explanatory variable in the efficiency model are simultaneously zero and strongly rejected with generalized likelihood ratio test statistics of 72.5 faba bean farms which are greater than 30.57 critical values with 15 degree of freedom and at 5% level of significance. This specifies that there were firm-specific factors which influence upon the level of technical inefficiencies among the sampled households or farms.

Table 1. Sample households selected from each kebele

Peasant Associations	Number of faba bean producer households	Sample household drawn
Elala Seden	704	49
Kusaye Boda	177	12
Elala Wako	616	43
Taha Gola	692	48
Karsa Warko	185	13
Baye Giche	236	16
Total	**2610**	**181**

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Table 2. Descriptive statistics for the variables used in the analysis.

Input variable	**Units**	**Minimum**	**Average**	**Maximum**	**Std. deviation**
Yield	Qt/ha	0.10	19.34	72.00	12.40
Area	Ha.	0.03	0.44	3.75	0.40
Seed	KG/ha	100.00	205.90	320.00	30.58
Fertilizer	KG/ha	13.33	103.28	200.00	50.85
Labour	Man days/ha	10.97	92.29	480.77	73.82
Oxen power	Ox days/ha	2.00	16.70	80.77	11.67
Age of hhh	Years	20.00	43.35	80.00	12.16
Education	Years	0.00	4.00	16.00	3.75
Distance to input mkt.	HRs.	0.01	0.43	5.00	0.52
Distance to output mkt.	HRs.	0.0.1	0.69	4.00	0.60
Distance to EXT. service	HRS	0.01	0.69	4.00	0.60
EXT. contact	Days	0.00	17.64	120.00	18.47
Family size	No.	1.00	6.80	14.00	2.45
Training	No. days	0.00	2.04	20.00	3.37
Livestock	TLU	1.03	8.30	36.70	4.88
Distance to ALL WRs	HRs.	0.00	0.41	2.00	0.44
Distance to plot of land	MIN.	1.00	16.50	180.00	21.99
Farm size	Ha.	0.38	15.75	2.71	2.21
Discrete variable	**Labels**		**frequency**	**%**	
Membership	1, if the household belongs to FG		177	97.79	
	0, otherwise		4	2.21	
Access to Credit	1, has access to credit,		91	50.3	
	0, otherwise		90	49.70	
slop	1, if the land is gentle slop,		115	63.54	
	0, otherwise		66	36.46	
Fertility	1, if the land is fertile,		164	90.61	
	0, otherwise		17	9.39	

Source: own survey results 2014

Table 3. Hypotheses tests for model specification and statistical assumptions.

Hypothesis	L(Ho)	LR(λ) statistics	critical χ2 value	df	Decision
1. H0: $\beta ij = 0$	-189.67	27	25	15	H0 rejected
2. H0: $\gamma = 0$	-187.17	79.2	5.41^{*}	1	H0 rejected
3. H0: $\delta 1 = --- = \delta 15=0$	-183	72.5	30.57	15	H0 rejected

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Parameter Estimates

Table 4, shows the maximum likelihood estimates of the parameters in the translog stochastic frontier and inefficiency model for the faba bean producer farmers in Kersa Malima districts. In the frontier model, the coefficient of land allocated to faba bean was positive and significant implying that an increase at certain optimum level in these inputs would increase faba bean output. The coefficient of labour utilized was also positive and significant at one percent. The average person days employed per hectare in one season was 92. This possesses some challenges for the sustainability of the enterprise since the area already has other crops being cultivated. The second challenge posed by this high labour demand is the possibility of an increase in wage which might crowd out low income earners from the labour market thus rendering them less effective in production. Efforts should therefore concentrate on designing labour saving technologies that reduce labour demands and improve on efficiency. However, seed, fertilizer and oxen days are not found to be significant variable to determine output level of faba bean production. The coefficient of interaction between faba bean area and fertilizer, seed and oxen days, fertilizer and oxen days and labour and oxen days were positive and significant showing that these inputs have a complementary relationship, implying that an increase in these inputs proportionally would increase faba bean yield.

The maximum likelihood estimates for the parameter γ is not significant but different from zero, (0.91) for faba bean at 1 percent level of significance. This indicates that the vast mass of the error variation in output of faba bean 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, ui and not due to the random error vi. Thus, farm productivity differentials mainly related to the variation in faba bean farms management at farmers condition. The average technical efficiency level of faba bean in the study site is 0.69, indicating that farmers are only producing on average 69 percent of their maximum possible output level, given the state of technology at their hand. In faba bean production, about 31 percent inefficiency exists, which needs to be addressed in order to increase faba bean productivity.

Table 1. Maximum likelihood estimates for parameters of stochastic frontier production function and inefficiency effects model for faba bean grower in Kersa Malima district

Variable	parameters	coefficient	t-ratio
Constant (β0)	β_0	6.35***	16.11
Ln (Area)[A]	β_1	13.29***	14.13
Ln (Seed)[S]	β_2	-17.55	-18.70
Ln (Fertilizer)[F]	β_3	-20.99	-25.88
Ln (labor) [L]	β_4	27.21***	28.94
Ln (Oxen)[O]	β_5	-8.97	-95.41
Ln $(A)^2$	β_6	50.89***	69.35
Ln $(S)^2$	β_7	23.68***	32.70
Ln $(F)^2$	β_8	11.16***	19.00
Ln $(L)^2$	β_9	44.36***	60.54
Ln $(O)^2$	β_{10}	-18.67	-25.53
Ln (A) Ln (S)	β_{11}	-11.42	-12.90
Ln (A) Ln (F)	β_{12}	14.60***	16.79
Ln (A) Ln (L)	β_{13}	-61.32	-69.10
Ln (A) Ln (O)	β_{14}	-73.74	-83.13
Ln (S) Ln (F)	β_{15}	-53.02	-74.78
Ln (S) Ln (L)	β_{16}	-19.56	-22.13
Ln (S) Ln (O)	β17	64.70***	73.25
Ln (F) Ln (L)	β18	-10.66	-12.67
Ln (F) Ln (O)	β19	14.37***	17.69
Ln (L) Ln (O)	β_{20}	24.77***	27.95

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Constant	δ_0	-3.12	-1.78
Age	δ_1	6.12**	0.32
Education	δ_2	-6.87	-2.23
Dist. To ext. service	δ_3	0.29	0.59
Dist. To input mkt	δ_4	1.05	1.42
Dist. To output mkt	δ_5	1.10	1.30
Extension contact	δ_6	3.62***	2.53
Family size	δ_7	5.38***	0.60
Membership	δ_8	0.55	0.51
Training	δ_9	-4.02	-0.58
Access to credit	δ_{10}	0.84	1.29
TLU	δ_{11}	-0.22	-2.59
Distance TAWRs	δ_{12}	-1.46	-1.83
Distance to plots	δ_{13}	-1.79	-1.48
Slop	δ_{14}	-0.45	-0.76
Soil fertility	δ_{15}	0.29	0.32
σ^2_s		1.51*	4.90
γ		0.91	30.99

N=181

*,**,& *** show significant at 10%, 5% & 1% respectively.

Source: own survey 2014

Determinants of technical efficiency

To assess the determinants of technical efficiency, the estimates of an inefficiency model was performed simultaneously with that of the stochastic production frontier model and the results are presented in table 3. In the inefficiency model, a negative coefficient means an increase in efficiency or a positive effect on productivity. On the other hand, a positive coefficient means an increase in inefficiency or a negative effect on productivity. Among the fifteen variables tested, six variables were found to affect significantly the inefficiency of faba bean farmers (Table 4).

Farmers' age has a positive relationship with technical inefficiency and statically significant at 1% as was unexpected. This implies that an increase in farmer's age would lead to an increase in farmer's inefficiency. The result showed that farmers with longer experience of faba bean production are more technically inefficient compared to those having lower production experience. This scenario can occur if older farmers in faba bean production are conservative for new technologies and stick to traditional production system while younger farmers are more risk

takers, open to new technologies and not tied with traditional production systems. Hence, age of farmers is not an important factor in improving the efficiency of farmers. This study is in line with other studies [18]; [28] and [29] and in contrast with many other studies [30] and [31] in Nigeria.

The coefficient on education had the expected negative sign. The negative coefficient of education implying that, increasing ones education would improve technical efficiency level of the farmers. Education reduces inefficiency by helping farmers acquire skills and adopt required technologies for production. Similar results have been reported in other areas on maize and rice [32]. A review of the efficiency studies and education found that 4-6 years of schooling provided a threshold upon which its effect on efficiency was pronounced. For this study, the average year of education was 4.

The coefficients of distance to extension service, input market and output market were positive which was in the priori expectation, indicating that farmers living with distant areas from extension service, input market and output market operate farm activities inefficiently than the nearby farmers. The result suggests that technical inefficiency of sample farms would significantly decrease with the development of road infrastructure that reduce home to extension service, input and output market distance.

The estimated coefficient for extension contact has the unexpected sign indicating that the variable is positively related with technical inefficiency in faba bean production. It is significant at 1 percent level of significance and statistically significant. This might happen if the extension agents were lacking specific information or knowledge related to faba bean production and unable to transfer for the farmers.

A positive and significant relationship was found to exist between degree of inefficiency and family size of individual farmers. The result is unexpected that family size is found to determine efficiency negatively. That is, as household size increases inefficiency increases. This result is similar with the research findings of [33] and it contradicts with findings of [34].

The coefficient of group membership in the inefficiency effect model is positive and which was not in the priori expectation. This implies that farmers involved in farmers' group manage their faba bean plots inefficiently. Previous studies suggesting that farmers who belong to a group are most likely to benefit from better access to information on improved inputs and practices [22] and [35]. For this particular study, the variable was not contributed towards reducing inefficiency.

In this study, the coefficient of training is negative as a priori expectation. The training given to improve production capacity of the farmer was hypothesized to determine the efficiency of the farmers positively and significantly. A number of farmer training centers were established to train farmers for a given period of time. This could be due to the fact that training improves the managerial as well as the technical ability of farmers.

The coefficient of credit accessibility is positive and statistically insignificant in faba bean production. This findings in line with that of [36]; they found no significant relationship between technical efficiency and credit accessibility. To the contrary, [28] and [30] found positive and significant relationship between credit and farmers technical efficiency.

Livestock holding was hypothesized that farmers who have better livestock holding are efficient than others. Timely ploughing and threshing is decisive in the production of crops thus access of livestock is important to better production. The result in table shows that, the coefficient of livestock in tropical livestock unit is negative as it was expected; however, it was statistically insignificant in affecting the level of technical inefficiency in faba bean production.

The coefficients of distance to all weather roads is negative which was not in the priori expectation, indicating that farmers living with distant areas from all-weather roads operate more farm activities efficiently than the nearby farmers. The coefficient of distance to faba bean plot is negative which was not in the priori expectation, indicating that households living in distance area from farm plots operate more farm activities efficiently than the nearby farmers. This might be related to the availability of most farm plots near to the residence.

Fertility of the plot: fertility is a dummy variable where, 1 stands for fertile land and 0,

Other-wise as perceived by the sample households. Producing on fertile land was hypothesized to be more effective in maximizing faba bean output than producing on infertile land. Result of estimation models have revealed that coefficient of fertility is positive and non-significant to affect level of inefficiency. This result is in line with the findings of [37]. They found that inherent level of soil fertility and technical efficiency has indirect relationship. To the contrary, [38] found positive and significant relationship between soil fertility and technical efficiency of lentil production. The coefficient of slop is negative and insignificant. This might be due to relative homogeneity of the study area.

Distribution of technical efficiencies

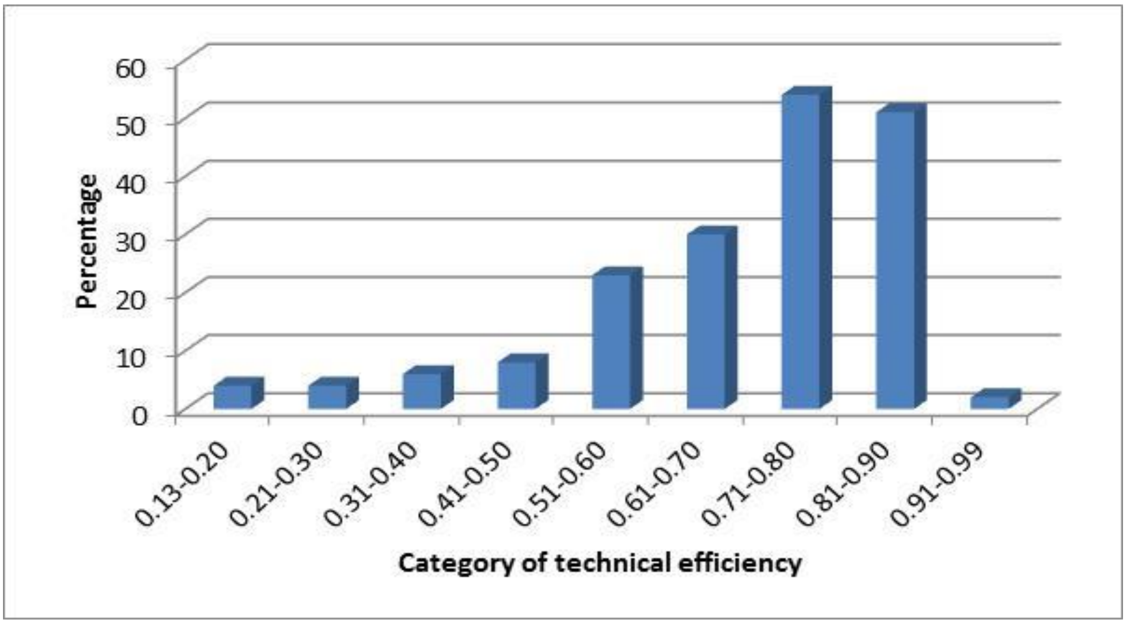
The estimated mean technical efficiencies of faba bean farms was found 0.69, indicating that farmers were only producing 69% of their maximum possible output level given the state of the technology at their disposal. This indicates that farmers are not efficient in producing faba bean and faba bean yield can be increased on average up to 31% by taking examples of more efficient farmers without disseminating any new technologies. Or it is an indication to the farmers that there is a possibility of minimizing input level by up to 31% without affecting the level of output.

The frequency distribution of technical efficiency levels is given in Table 19 while the trend is illustrated in Figure 4. The average estimated technical efficiency for faba bean farmers ranges from as low as 0.13 to as high as 0.91 indicating that a wider differential in the efficiency levels of farms. Table and figure showed also that out of 100 farms, 12.15% of faba bean farmers are being operated below 51% level of Technical efficiency. This revealed that a small number of faba bean farmers in the sample faced inefficiency problem, whilst most of the farmers (87.29%) produce faba bean with the range of 0.51 to 0.90 efficiency level.

Table 2. Technical efficiency of sample farmers producing Faba bean (N=181)

Description	Household head level estimates
Mean	0.69
Minimum	0.13
Maximum	0.91
Standard deviation	0.16

Source: Own Computation Model Output (2014).



Source: own survey 2014

Figure 1. Distribution of technical efficiency of sample farmers

In summary to increase faba bean farming efficiency, efforts need to be invested in improving farmers' education through enhancing the universal primary education and training farmers about specific crop production packages practically as well as theoretically which are being implemented in local communities.

Major constraints of faba bean production

As shown in the following table, the productivity of faba bean in Ethiopia is still, far below its potential due to abiotic and biotic factors. Among them high cost of inputs, lack of improved varieties, high climate variability, low soil fertility and disease and insects were the most important constraints of faba bean production in the study area (Table). About 75.3% of the household reported that high cost of inputs is the most serious problem for faba bean production in the study area. About 66.3% of the household reported that lack of improved varieties is the most serious problem for faba bean production in the study area. About 50.3% of the respondents reported that high climate variability (explained in terms of shortage and untimely raining) (late coming and early stop, early coming and early stop) is the most serious problem for faba bean production in the study area. About 49.2%, 35.9% of the farmers responded that low soil fertility, pests (diseases and insects) and small land holding were also the other bottleneck of faba bean production.

Table 3. Major constraints of faba bean production as ranked by sample farmers (Own survey result, 2014).

Problems	Labels	Frequency	Percent
High cost of inputs	1= most important,	133[a], 19[b], 29[c]	75.3[a], 10.5[b], 16.0[c]
Lack of improved varieties	2= indifferent and 3=	120, 21, 40	66.3, 11.6, 22.1
High climate variability	Least important respectively	91, 42, 48	50.3, 23.2, 26.5
Low soil fertility		89, 31, 61	49.2, 17.1, 33.7
Disease and insects		65, 57, 59	35.9, 31.5, 32.6
Small land holding		65, 73, 43	35.9, 41.3, 23.8
Timely unavailability of seed		63, 60, 58	34.8, 33.1, 32.0
Lack of quality seeds		47, 77, 57	26.0, 42.5, 31.5
Lack of access to inputs		45, 62, 74	24.9, 34.9, 40.0
Lack of labour		32, 93, 56	17.7, 51.4, 30.9
Lack of market		11, 82, 88	6.1, 45.3, 48.6
Lack of market information		10, 82, 89	5.5, 45.3, 49.2

[a, b, c] shows most important, indifferent and least important labels respectively

4. CONCLUSION AND RECOMMENDATIONS

This study was designed to analyze technical efficiency and identify its determinant factors influencing technical efficiency of faba bean smallholder growers in South west Shewa zone of Oromia Regional State, Kersa Malima district. Cross-sectional data collected from sample farmers in Elala Seden, Kusaye Boda, Elala Wako, Taha Gola, Karsa Warko and Baye Giche peasant associations were used.

The study used the farm-level data collected from a total of 181 faba bean producer and estimated the stochastic frontier production function (SFPF) by incorporating inefficiency effects. We find that SFPF best fits the data using translog production function better than the Cobb-Douglas production function. Moreover, the traditional average response function is not an adequate representation of faba bean farm level data for 2013 cropping season.

The result of study showed that area of faba bean, seed, fertilizer, labour and oxen days are the major factors associated with change in faba bean output. The effect of land area allocated to faba bean production and human labour on output is positive and the coefficient is statistically significant at 1% inefficiency of faba bean production. The quantity of seed and fertilizer applied and oxen days used have negatively associated on faba bean output, and statistically non-significant. The interactions of land and fertilizer, seed and oxen days, fertilizer and oxen days had also a significant and positive effect to improve the yields of faba bean.

The results of efficiency analysis show that the mean technical efficiencies was found to be 69% with minimum 13% and maximum of 91%. This indicated that about 60% of farmers in the study area were efficient and produced above the average efficiency level while 40% of the farmers were inefficient and producing below the average efficiency level, suggesting that efficiency improvement is one of the possible opportunities for increasing faba bean production with available input resources and technology. Thus, an average farmer is producing 31% less than the achievable potential output.

The sources of inefficiency were estimated using the δ - coefficients. Inefficiency factors are those relating to farmers' demographic, socio- economic, institutional and plot specific factors. These include the farmers' level of education, distance to extension service, distance to input market, distance to output market, extension contact, household size, member to a group, training, credit accessibility, livestock holding distance to weather road distance of plots from home, slop and soil fertility.

Among the variables considered education, training, livestock holding, distance to all weather roads, distance to plot from home, and slop are insignificant to determine inefficiency of farmers. To the contrary, positive and significant coefficients of age, extension contact and household size indicate that inefficiency of farmers would be determined positively as the level of these factors increase.

The recommendation of this study is that technical efficiency in smallholder faba bean production could be increased by 31% on average through better use of available resources, especially area of faba bean land and labour given the current state of technology. Thus, government or other concerned bodies in the developmental activities working with the view to increase production efficiency of farmers in the study district should work on improving productivity of faba bean farmers by giving especial emphasis for significant factors of production and inefficiency.

In conclusion, the existence of inefficiency in faba bean production along with major inefficiency variables indicate that there is a room for improving efficiency and increase faba bean production using the readily available resources and technology. Hence, integrated developmental efforts that will decrease the existing level of inefficiency will have significance importance in improving faba bean production and productivity.

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