**Analysis of Technical Efficiency in Faba Bean (*Vicia Faba L*.) Production in Ethiopia, the Case of Wereillu District**

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# ABSTRACT

*The objective of this study was to examine the extent and determinants of smallholders’
technical efficiency of Faba Bean (Vicia Faba L.)* *production* *in Wereillu district. Stochastic production frontier model with Cobb-Douglas functional form was used to model farmers’ technical efficiencies and sources of efficiency differentials. The study was based on cross-sectional data collected from 351 farm households during the 2021/22 production year. The test result indicated that the mean technical efficiency level of faba bean producer farmers is 53.6 percent which indicated that the improvement in technical efficiency could be increased by 46.4 percent with the current available technology and without increasing the input level. The study revealed that seeds, oxen and land were risk-reducing inputs, while agrochemicals fertilizer and labor were classified as risk-increasing inputs. The result also revealed that, faba bean production is significantly influenced by seed and land size. Moreover, the factors influencing inefficiency include, the age of the household head, experience with faba bean production, plot distance, and seed type have negative coefficients, and indicate that increasing these variables will improve technical efficiency. Therefore, government should improve farmer productivity by addressing production issues, promoting modern farming methods, encourage farmers to use appropriate inputs* *and offering improved technologies in addition to the improved varieties. Encouraging older farmers to share experience, self-motivated farmers to rent and share land, and providing training and resources. Organizations should also consider social responsibilities and government political meetings which competing for limited agricultural time during planting.*

**Keywords:** Faba bean, Stochastic Frontier Analysis, Technical Efficiency, Inefficiency

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# INTRODUCTION

Grain legumes have a greater effect on crop production, dietary diversity, and income for smallholder farmers around the world (Kebede, 2020). Ethiopia is a significant producer and supplier of grain legumes due to its diverse agro ecology, in which faba bean is Ethiopia's most widely grown pulse crop, with 504,570 hectares coverage and 1,070,636 tons of production. It is grown on 180,245 hectares of land in the Amhara region, producing 346,352 tons, and on 28,583 hectares of land in the South Wollo Zone, producing 46,566 tons (CSA, 2021). The average faba bean yield in the South Wollo zone is very low, at about 1.63 t ha-1, compared to the national average of 2.12 t ha-1. In order to meet the increased demand for food due to population growth and rising incomes, crop yields will need to increase significantly over the coming decades.

The availability of suitable land and water resources for crop production, as well as biophysical limitations on crop growth, will ultimately determine how much food the world can produce (Ruiz, 2020). However, if the use of agricultural inputs is inefficient both in terms of output maximization and cost minimization feasibility, requiring and introducing new technology might not produce the anticipated agricultural output. According to a theory known as efficiency improvement of agricultural producers, agricultural productivity can be increased not only by using new agricultural technologies but also by enhancing the managerial skills of decision-making units (farmers) (Saiz-Rubio and Rovira-Más, 2020). Making sure that products are produced in the best and most profitable way possible is one way to ensure that businesses produce their goods efficiently. Efficiency is crucial for every sector of the economy to avoid resource wastage (Atnafu and Balda, 2018).

The faba bean crop, which is now cultivated on 1200 hectares in the Wereillu district, is expected to support 10,000 households, according to the ICARDA (2020) study report; throughout the previous ten years, its productivity could not be increased sustainably as required level. However, low output is believed to be due to poor technical efficiency, low input application rates, and poor management techniques. If the existing production system is not efficient, introduction of new technology could not bring the expected improvements in the productivity of faba bean and other crops. Hence, given the existing technology, improvements in the level of technical efficiency would enable farmers to produce the maximum possible output from a given level of inputs. Moreover, improvement in the level of technical efficiency increase productivity. In addition, the district's production efficiency study has not been conducted yet, making it crucial to identify the causes of smallholder farmers' inefficiency and low productivity. Therefore, this study is designed to analyze technical efficiency in faba bean production of small holder farmers in Wereillu district.

# **METHODOLOGY**

****Description of the study area****

Wereillu is one of the districts found in Amhara region, South Wollo Zone, which is 481 km far from Addis Ababa. Its geographical coordinates are 10o26՛0՛՛ north, 39o26՛0՛՛ east. It is one of the highland districts of South Wollo. But it encompasses all *kola, woina-dega, dega* and *wurch* climatic zones sharing 2, 31, 64 and 3% of the district respectively. The rainfall pattern is predominantly bimodal, the short (belg) rains falling from mid-January to the end of May and the main or kiremt rains falling from June to mid-October (Gedamu et al., 2021). Cereals as wheat (*triticum aestivum* L.), teff (*eragrostis teff* L.), pulse (*fabaciea* L.) and other oil and spices are the source of food and cash income.



Figure 1: Location map of the study area

Methods of data collection and analyses

### Sampling technique and sample size

The data was collected from a survey that was conducted from March to April in Wereillu district of Amhara region. The sample households were selected using a three-stage sampling procedure. Based on the information from South Wello Zone Agriculture and rural development office, out of the 20 rural South Wollo zone districts, the Wereillu district was purposively selected for the first stage due to its extensive faba bean production. For the second stage, three faba-bean producer kebeles were randomly selected. In the third stage, as presented in Table 1, among the 2869 households of faba-bean producers in the three kebeles, 351 sample households were randomly selected using proportionate-to-size sampling methods in accordance with Yamane's formula (1967).

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

$$\frac{2869}{1+2869(0.05)^{2}}=351 $$

Where; n: is the required sample size; N: is the total number of farm households in the study area; e = is the level of precision which is assumed to be 5%.

**Table 1**: Number of sample farmers selected per the study kebele of Wereillu district

|  |  |  |  |
| --- | --- | --- | --- |
| Name of the kebele | Total faba-bean producer | Sample Size | Percent |
| 010 | 694 | 85 | 24.22 |
| 013 | 1218 | 149 | 42.45 |
| 014 | 957 | 117 | 33.33 |
| Total | 2869 | 351 | 100.0 |

Source: District agricultural office, (2023)

### Method of data analysis

Descriptive and inferential statistics, along with econometric models, were used to analyze the data. Descriptive statistics such as mean, standard deviation, frequency, and percentage were employed to analyze the data collected on socioeconomic, institutional, and agro-ecological characteristics of the sample households, while inferential statistics such as t-test and chi-square (χ2) tests were used to undertake statistical tests.

An econometric estimation method was used by specifying the production frontier using the Cobb-Douglas stochastic model. The model estimated the parameters of the production frontier, level of efficiency, and significance level of the different variables in the determination of the inefficiency of farmers.

Stochastic frontier is the most appropriate technique for efficiency studies which have a probability of being affected by factors beyond control of DMU. This is because of the fact that this technique accounts for measuring inefficiency as a result of these factors and technical errors occurring during measurement and observation. So as to capture effects of these errors, this study used stochastic frontier model.

The empirical application of this study is consistent with models developed by Aigner et al. (1977); Meeusen and van Den Broeck. (1977) and Just and Pope. (1978). The Cobb Douglas model is assumed for the deterministic part of the production frontier in equation (2) and presented as:

$βoX1^{β1}X2^{β2}X3^{β3}X4^{β4}X5^{β5}X6^{β6} Xe^{vi-ui}$ (eq.2)

The function of constant elasticity is can be transformed to linear logarithmic function

$Ln(y)=ln⁡(βoX1^{β1}X2^{β2}X3^{β3}X4^{β4}X5^{β5}X6^{β6}Xe^{vi-ui}$) (eq.3)

$Ln\left(βo\right)+β1lnx1+β2lnx2+ β3lnX3+β4lnX4+β5lnX5+vi-ui$ (eq.4)

Where: ln y = is the total output of faba-bean obtained from the ith farm in kg.

Faba bean land = the total size of land in hectare allocated for faba bean crop by the household.

Seed = the total quantity of faba bean seed used by the ith household measured in kg.

NPS fertilizer = the farmer currently used NPS fertilizer in kilogram applied by the household.

Chemicals = chemicals such as herbicides or pesticides used as an input particularly in faba bean due to serious weed, pest and disease attack by the ith household.

Human Labor = the total labor force (family, exchange and hired) which all are measured in terms of man-day.

Oxen power = the total number of oxen days used by the ith household

β0 is constant.

β1-β6 are parameters to be estimated and represents elasticity of production.vi and ui are as defined above.

β1+ β2+ β3+ β4+ β5+ β6 = returns scale

e=base of natural logarithm

The term εi (vi – ui) is a composed error term where vi represents statistical noise, which is
deviation from the frontier due to factors beyond control of the farmer and ui represents deviation due to technical inefficiency and are assumed to be independent of each other. $v\_{i}$ is assumed to be independently and identically distributed normal random errors with ($0, σ\_{v}^{2}$). This captures inefficiency as a result of factors beyond control of the farmer. ui s are non-negative random variables independently and identically distributed as $N^{+}(μ,σ^{2}u)$ which captures technical effects of the farmer on the ith land of faba-bean. ui s are assumed to follow half normal distributions with mean $μi$ and variance $σ^{2}u$.

The technical inefficiency model was estimated as the equation given below.

$V\_{i}=δ\_{o}+\sum\_{z=1}^{16}δ\_{k}Z\_{ki} $ $(eq. 5)$

Where, υi is the technical inefficiency effect Zk is the coefficient of explanatory variables.

On the other hand, a series of tests can be conducted to test the specification of the models.

Despite the size and importance of the performance variable, it is crucial to explain the different null hypotheses used in this study. Three hypotheses were examined in order to determine whether the study's chosen model was adequate and whether smallholder faba-bean producers' inefficiency could be attributed to exogenous or endogenous factors.

The theory was tested using generalized likelihood ratio statistics. It is noted as follows:

$LR (λ)=-2 [lnL(H0)-lnL(H1)]$ (eq.6)

Where L (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 H1 and H0. Yet, where the test involves a γ, then the mixed chi-square distribution was used. The H0 is rejected when the estimated chi-square is greater than the critical. A hypothesis test was run to ensure that the returns to scale were accurate.

# **RESULTS AND DISCUSSION**

## Results of Descriptive Analysis

### Summary Statistics of the Output and the Input Variables

The result for this study (Table 3) reveals that on average, farmers used 154.34 kilograms per hectare of seed, 10.99 kilograms per hectare of NPS fertilizer, 0.24 liters per hectare of agrochemicals, and 50.12-man days per hectare of labour in order to produce 1.127 tons per hectare of faba bean. The minimum and maximum production were 0.05 and 2.8 tons per hectare, respectively. The coefficient of variation for production was 488.66. The average yield of 1.127 tons per hectare of faba bean indicates that most farmers produce below the maximum yield per hectare. However, considering all the inputs in the production process, the frontier output remains unknown. Therefore, this study aims to estimate the determinants of technical efficiency.

**Table 2.** Summary statistics of output and input variables

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Unit** | **Mean** | **Min.** | **Max.** | **SD** |
| Output (Faba-bean yield ) | Kg ha-1 | 1127.55 | 50 | 2800 | 488.66 |
| Land for faba bean | ha | 0.47 | 0.125 | 2.5 | 0.34 |
| Seed | Kg ha-1 | 154.34 | 20 | 450 | 84.03 |
| NPS Fertilizer | Kg ha-1 | 10.99 | 0.001 | 180 | 26.63 |
| Agrochemical | Lt ha-1 | 0.24 | 0.001 | 6 | 0.88 |
| Labour | Man-days/ha | 50.12 | 21 | 125 | 39.19 |
| Oxen | Oxen-days/ha | 23.41 | 6 | 58 | 10.34 |

Source:Field survey data, 2022.

### Summary Statistics of the exogenous variables

A total of 14 variables were used to estimate determinants of technical efficiency and productivity of faba bean producers. The variables are listed in Table 3. The sample farmers' years of faba bean cultivation have mean value of 22.07 years and a standard deviation of 9.91, ranging from 2 to 60 years. The size of the faba bean lands and the plot distance from the homestead were additional variables used to estimate the technical efficiency (TE) of the farmer in the study area.  Up to 180 meters separate the faba bean plots from the home, with an average distance of 22.39 m and a standard deviation of 21.22. The sample household's market distance from the farmers' home ranged from 1 to 26 km, with a mean of 11.22 km and a standard deviation of 6.55. The majority of respondents (98.6%) had access to extension services and male farmers (86.3%) in the study area.

**Table 3**: Variables used in the inefficiency model analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Min** | **Max** | **Mean** | **St. Dev.** |
| **Inefficiency variables** |  |  |  |  |
| Age (years) | 20 | 85 | 43.36 | 13.38 |
| Education (Years of schooling) | 0 | 11 | 3.18 | 3.59 |
| Family size (number) | 1 | 11 | 4.91 | 1.61 |
| Land size (ha) | 0.125 | 2.5 | 0.47 | 0.34 |
| Faba bean production experience (years) | 2 | 60 | 22.31 | 9.91 |
| plot distance (m) | 0 | 180 | 22.39 | 21.22 |
| Distance to district market (km) | 1 | 26 | 11.22 | 6.55 |
| dummy variables  | Labels | Freq. | Percent  |
| Sex (dummy) | Yes If, the farmer is male  | 303 | 86.3 |
| Access to Extension (dummy) | Yes if, extension access  | 346 | 98.6 |
| Access to credit (dummy) | Yes if, credit access  | 224 | 63.8 |
| Members of group association (dummy) | Yes if, a member  | 349 | 99.4 |
| Fertility status (dummy) | Yes if, the land is fertile  | 230 | 65.5 |
| Seed type  | Yes, used improved seed | 300 | 85.5 |
| Responsibility  | Yes, if responsible | 118 | 33.6 |

Source: Own computation, (2023)

## Results of Econometric Analysis

This section presents the econometric model outputs of the study. In this section, the production function, efficiency scores and determinants of efficiency are discussed thoroughly.

### Hypothesis testing

Before discussing the model output, let us begin with likelihood ratio (LR) tests to assess
various assumptions related to the model specification. The first null hypothesis was $Ho: γ=0,$ which states that the inefficiency effects in the SPF were not random. The null hypothesis was disproved. This suggests that the typical average production function does not adequately represent the data. The second test examined the null hypothesis that every coefficient associated with inefficiency is equal to zero. The null hypothesis was thus disproved, demonstrating that at least one variable is accountable for the efficiency gap. The value is 1.733 under half-normal distribution assumptions, which is in line with the cross-sectional model result from the stochastic frontiers model (Table 5). Applying equation (3), the likelihood ratio test value for gamma ($γ$), which measures the impact of technical inefficiency on the variation of observed output, was estimated to be -357, or 0.643, in the same order. Thirdly, a hypothesis test was run to ensure that the returns to scale were accurate. To get a constant return model specification, all the dependent and independent variables were first divided by the faba bean plot size.

**Table 4**: Summary of tests of the assumption of stochastic frontier approach

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Hypothesis | Calculated χ2 (LR) | Critical χ2value (0.01)  | Df. | Decision |
| $H\_{0}: γ = 0$  | 23.85 | 6.63 | 1 | Reject  |
|  $H\_{0} δ1 = δ2…=δ14 = 0$ | 61.92 | 29.14 | 14 | Reject |
| $$∑β\_{i}=1$$ | 39.96 | 6.63 | 1 | Reject |

Source: Model output (2023)

Then, the log-likelihood values of the variable return model (alternative) and the constant return model specification (null hypothesis) were contrasted. As a result, the calculated value 39.96 was compared to the critical value of 6.63. Hence, the null hypothesis that constant returns to scale categorize faba bean production in the study area was rejected.

### Estimation of the stochastic production function

The model includes six explanatory variables, all of which are believed to have an effect on faba bean production in the study area. To include those farmers who did not apply inputs like NPS fertilizer and chemicals in the estimation of the frontier a very small value that approaches to zero was assigned for non-users. The model includes land size, seeds, NPS fertilizer, chemicals, labor, and ox power. Only two of the six input variables determined by the production function (land size and seed) had a significant effect on faba bean output variation among sample farmers. The production function's coefficients are interpreted as elasticity. As a result, the high output elasticity to seed and land size implies that faba bean production is somewhat sensitive to both. Assuming that all other inputs remain constant, these effects are negative and positive, respectively. This outcome is consistent with that of Yigezu *et al*. (2019).

**Table 5***:* Parameter estimates of the average and ML estimates of SPF distribution result

|  |  |  |  |
| --- | --- | --- | --- |
| Lnyield (Kg ha-1) | Parameter  | Coef. | St. Err. |
| Constant | 𝛽0 | 7.048\*\*\* | 0.392 |
| Lnlandsize (ha-1) | 𝛽1 | -0.197\*\* | 0.094 |
| Lnseed (kg ha-1) | 𝛽2 | 0.184\*\* | 0.087 |
| LnNPS (kg ha-1) | 𝛽3 | 0.001 | 0.008 |
| Lnchemical (lit ha-1) | 𝛽4 | 0.003 | 0.014 |
| Lnlabor(man-days ha-1) | 𝛽5 | 0.194 | 0.129 |
| Lnoxen(oxen-days ha-1) | 𝛽6 | 0.118 | 0.105 |
| σ2 = σu2 + σv2 | 0.511 |  |
| $$λ={σ\_{u}^{2}}/{σ\_{v}}$$ | 1.733 |  |
| Gamma (γ) | 0.634 |  |

Note \*, \*\*and\*\*\*significant at 10%, 5% and 1% significance level, respectively.

Source: Own computation, (2023)

Therefore, the elasticity of faba bean production with respect to faba bean land size was -0.197, showing that a 100% increase in land size results in a 19.7% decrease in faba bean production. The elasticity of faba bean production with respect to the amount of seed used was 0.184, showing that a 100% increase in the quantity of faba bean seed results in an 18.4% increase in faba bean output and production. The estimated value of gamma is also 0.634. This implies that technical inefficiency accounted for about 63.4% of the variation, while random error, which is caused by variables outside of the farmer's control, accounted for the remaining 36.6% (Table 5).

### Estimation of returns to scale

Returns to scale (RTS), which measures how much output increases with a proportional increase in all inputs, is calculated by adding the elasticity of the mean frontier production function with respect to all inputs. Thus, the RTS analysis can be used to determine each factor's productivity. It was discovered that the scale coefficient was 0.303, indicating diminishing returns to scale and clearly showing that faba bean producers be able to increase their output (Table 7). Despite being in stage II of the production surface, they do not effectively allocate resources, which suggest that production is inefficient. There is also room to increase production while reducing the rate of growth. As a result, the overall production of faba beans will increase by 0.697 for every proportional increase in all inputs.

**Table 6**: Elasticity and return to scale of the parameters in the production function

|  |  |
| --- | --- |
| **Variables** | **Elasticity** |
| Land size | -0.197 |
| Seed | 0.184 |
| NPS | 0.001 |
| Chemical | 0.003 |
| Labor | 0.194 |
| Oxen power | 0.118 |
| **Returns to scale**  | **0.303** |

Source: own computation, (2023)

### Efficiency scores and distribution of sample farmers

Given the chosen functional form used, estimation procedure implemented and the distributional assumptions made about the two error terms vi and ui, the technical efficiencies were estimated. The estimation result showed that the mean technical efficiency (TE) level of faba bean farmers were 53.6% with the minimum and maximum efficiency level of about 4 and 90% respectively (Table 7). This shows that there is a wide discrepancy among faba bean producer farmers in the level of TE which may in turn indicate that there is a room for improving the existing level of faba bean production through enhancing the level of farmers’ technical efficiency.

The mean level of TE further tells us that the level of faba bean output of the sample respondents can be increased on average by about 46.4% if appropriate measures are taken to improve the level of efficiency of faba bean-growing farmers. It also indicated that small farms in the study area, on average, can gain higher output growth at least by 58.4% (1-53.6/90) through improvements in technical efficiency. Moreover, from the total sample households, more than half scored above the mean TE score while almost half of the sample respondents produced less than the mean TE score of farmers in their vicinity (Table 7).

**Table 7**: Frequency distribution of technical efficiency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | Mean | Standard deviation  | Minimum  | Maximum  |
| ***Technical efficiency score*** | 0.536 | 0.217  | 0.041  | 0.900  |

 Source: own computation, (2023)

### Determinants of technical inefficiency of faba bean producers

The stochastic frontier half-normal model was employed to perform a regression analysis of the TE estimates produced by the model on socioeconomic and institutional variables that explain efficiency variations among farm households. The factors that were found to be significant in explaining the determinants of the TE of faba bean-producing farmers were age of the household head, land size, the experience in faba bean production, plot distance, seed type, and responsibility.

**Age of the household head:**  As predicted, at a 5% level of significance, the respondents' ages have a significant negative effect on the inefficiency of farmers who grow faba beans. This shows that as a farmer's age increases, his or her inefficiency decreases, which raises the level of TE by 1.8%. The result is consistent with the results of Mesfin, (2020) and Ahmed and Melesse*,* (2018). They contend that because farmers develop better farm management strategies as they age and gain experience, farmers may become more skilled over time.

**Land size:** The TE of sample farmers to produce faba beans was predicted to decline as the faba bean land area expanded. The outcome shows a significant and positive coefficient in the inefficiency model. According to the result, those who have a large total farm size are less efficient than their counterparts. This may be due to the fact that farmers with larger farms are unable to perform different farm operations on time and find it difficult to use agricultural inputs as recommended, thereby increasing their technical inefficiency. This achievement is consistent with those of Hassen *et al*, (2015); and Abate *et al*. (2019).

**Experience in faba bean production:** This variable assumed that more experienced farmers would typically be more technically proficient at producing faba beans than less experienced ones in the study area during the survey period. The findings show that more experience in faba bean production increases the sample farmers' level of TE because they have good managerial skills that they have practiced over time. This result is consistent with those made by Beyene *et al*. (2020); Sapkota and Joshi, (2021).

**Plot distance:** In this study's findings, the distance of the faba bean plot from the homestead had a positive and significant effect on faba bean production efficiency. A longer distance indicates the possibility of farmers leasing land for faba bean cultivation as well as having many scattered plots. Such farmers tend to be commercially oriented, and they tend to use various farm inputs more efficiently, thus leading to an increase in TE. This is in line with the conclusions of Mirity *et al.* (2020).

|  |  |  |
| --- | --- | --- |
| variables  | Coef. | St. error |
| Constant | 2.941\*\* | 1.461 |
| Age | -0.018\*\* | 0.009 |
| Education | -0.036 | 0.028 |
| Family size | 0.101 | 0.066 |
| Land size | 0.672\* | 0.371 |
| Experience in faba bean production | -0.023\*\* | 0.011 |
| Plot distance | -0.018\*\*\* | 0.006 |
| Market distance | -0.026 | 0.019 |
| Sex | 0.255 | 0.309 |
| Extension | -0.824 | 0.779 |
| Group membership | -0.968 | 1.136 |
| Credit Access  | -0.122 | 0.201 |
| Fertility Status | 0.047 | 0.206 |
| Seed type (improved =1) | -0.448\* | 0.259 |
| Responsibility | 0.415\*\* | 0.212 |

**Table 8:** Maximum likelihood estimates for parameters of the inefficiency model

Note \*, \*\*.and\*\*\* significant at 10, 5 and 1significane level

Source: own computation, (2023)

**Seed type**: The majority of farmers using local seeds could have a serious effect on their technical efficiencies because most improved seeds are relatively high yielding. The result of this study indicated that improved seed decreases the inefficiency level of the farmers. This is in line with the finding of Wongnaa and Awunyo-Vitor (2018).

**Responsibility**: Responsibility in different social and committee leadership positions allows the farmers to share information on improved production techniques by interacting with other farmers and experts, thereby improving efficiency. On the other hand, the responsible person spent his time on repeated meeting committee tasks which do not have knowledge sharing. Thus compete for the working time of agricultural activities, thereby increase inefficiency. In this study responsibility contributes for inefficiency which is in line with finding of (Wae, 2016).

# CONCLUSIONS AND RECOMMENDATION

Conclusions

The results of the study revealed that two of the six input variables land size and seed significantly influenced the variation in faba bean output among the sample farmers. The high output elasticity to land size and seed indicates that faba bean production is relatively sensitive to both land size and the amount of seed sown. The effects were negative and positive, respectively assuming that all other inputs remained constant.

Despite having a mean Technical Efficiency value of 0.536, the sample farmers' predicted efficiencies are very different. According to gamma's significant value of 0.634, which is a measure of technical inefficiency, the sampled farmers demonstrate a high level of inefficiency. The wide variation in TE suggests that the majority of farmers continue to use their resources inefficiently during the production process. Farmers can still increase their faba bean output by raising their current TE levels. Therefore, operating at a higher rate can increase production in the study area by 46.4% at the current level of inputs and technology.

The estimated stochastic frontier model with inefficiency parameters highlights significant variables like the age of the household head, land size, experience in faba bean production, plot distance, seed type, and social responsibility. In which the age of the household head, experience in faba bean production, seed type, and plot distance have significant and negative coefficients, Raising these variables is supposed to improve technical efficiency. However, it has been found that efficiency declines as farm size and farmer social responsibility increase.

As the household head gets older, farmers gain more production experience, leading to higher yields in Faba bean production. They can determine optimal planting and harvest times, implement pest control, and make informed decisions about seed, seed rates, crop protection strategies, and fertilization. Improved faba bean varieties increase productivity and yields by providing traits like disease resistance, drought tolerance, and higher nutrient content. Plot distance affects farmers' TE, as they often produce faba beans by renting or sharing the land on distant plots. To obtain better output in remote lands more effectively, farmers should regularly visit and use proper methods and inputs.

As the size of the land increases, it becomes harder to coordinate and optimize operations, which lowers technical efficiency. The outcome shows that a larger area of land required effective management, and more emphasis on the use of appropriate inputs based on the size of faba bean land, which frequently requires more labor and materials, especially in the study area where the faba bean crop faces serious disease and insect problems. On the other hand, as farmers take on more social responsibility, technical efficiency declines because they might not have as much time to devote to good land management. Increased farmer responsibility may lead to a lack of pertinent skills, which would further impede technical efficiency.

Recommendations

Given the limited resources in the study areas, efforts to strengthen the efficiency of
smallholder farmers who are the largest segment in agricultural production are indispensable. It can be advised that the government engaged in developmental activities with the aim of increasing the production efficiency of the farmers in the study area should work on improving farmer productivity by paying particular attention to crucial production factors for the given plots of land, encourage farmers to efficiently use appropriate inputs with recommended rates and agricultural research center should support farmers in adopting modern farming practices and technologies using intensive farming techniques, and providing improved seed varieties sufficiently at the recommended rates.

The district office of agriculture and concerned bodies should prioritize imparting knowledge to young farmers, as older farmers possess more production skills. This will ensure agricultural practices' viability and innovation, empowering young farmers to adopt improved technologies. This will not only close the generational gap but also increase productivity, and ensure long-term food security. The burden that government meetings and other social obligations imposed on farmers should be taken into account by the relevant organizations because these obligations compete for farmers' essential agricultural time for pick activities.

Above all the attention of policy makers should not be only to the introduction and
dissemination of yield enhancing externally supplied inputs to mitigate the existing level of
food deficiency and poverty more importantly the working culture and perception on
improved technologies in that area should be improved. So, the district office of agriculture should encourage motivated farmers to grow faba beans by renting and sharing land, fostering community and effective land utilization. Support in training and resources can also be provided to ensure successful cultivation.

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