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Technical efficiency of factors affecting soybean farming in Tanjab Timur Regency

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Abstract

This research was carried out with the aim of:

- Knowing the general description of soybean farming in Tanjab Timur Regency,
- Analyzing the level of technical efficiency of soybean farming in Tanjab Timur Regency,
- Analyzing the level of technical inefficiency of soybean farming in Tanjab Timur Regency.

The analytical tool used is Stochastic Frontier production function analysis with Cobb- Douglas and calculating the level of efficiency and inefficiency. This research was conducted in Tanjab Timur Regency. The sampling technique was the census method with a sample of 120 farmers. The data used is secondary and primary data. The research results showed that:

- The condition of the land in the research area is tidal land with an average production of 1,039,
- The use of production inputs in the research area is technically efficient, reaching 0.767. Socio-economic factors such as age and education variables have no real effect and increase inefficiency while experience variables, number of family members and extension have no real effect, but increase technical efficiency or reduce inefficiency,
- Simultaneously or partially age, education, experience, number of family members and extension has no real effect on production.

Keywords: Soybean Farming; Technical Efficiency; Frontier Production Function; Soybean Production; Technical Inefficiency

1 Introduction

Indonesia is a country with a tropical climate with huge land acreage and abundant biodiversity. Indonesia's climate conditions make it possible for various types of plants to grow, this is what causes Indonesia to receive the title as an agricultural country, meaning that the agricultural sector has a very significant role in the development of the national economic sector. Indonesia as a sovereign country is committed to maintaining national food security as reflected in concerning food, that the government together with the people strives to realize food stability or also known as national food security [1].

The agricultural sector is one of the main pillars supporting the national economy, this is because the agricultural sector is the livelihood of the majority of Indonesian people. As [2] in his book says, expansion of output from other economic sectors depends on output growth in the agricultural sector, both from the demand side as a source of food supply following continuous population growth and from the supply side as a source of raw materials for production in other

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sectors. Agriculture is a farming activity that includes various agricultural subsectors such as food crops, horticulture, plantations, animal husbandry, forestry and fisheries [3].

Various subsectors are included in the scope of agriculture, one of which is most widely cultivated or cultivated by farmers in Indonesia is the food crop subsector. This is because the availability and level of food consumption is one of the benchmarks for the level of welfare of a country's people. Food crops are one of the agricultural subsectors that the government continues to socialize because food crops are also called fuel to drive a country, including Indonesia [1].

Food crops continue to be developed and cultivated in order to repeat the New Order period where Indonesia became a food self-sufficient country. One of the food crop commodities that many people cultivate and cultivate is soybeans. Soybeans are one of the world's main food commodities replacing corn and rice and are the main source of vegetable protein for society [1].

Soybeans are the highest protein producing commodity among legume types. Soybeans contain an average of 35% protein, even in the case of superior varieties of soybeans they can contain 44-45% protein. The study of soybeans has quite an inherent relationship with the Indonesian people because it is a local food source. Soybean production in Indonesia has not been able to meet Indonesia's needs, where only 40-50% is able to contribute and the remainder is supported by imported soybeans amounting to 50-60% [1]; [4-5]. This is a phenomenon that must be considered and must continue to increase production so that it is in line with the central government's commitment to accelerating food self-sufficiency. Jambi Province is one of the regions that has taken a role in developing increased soybean production in Indonesia by implementing several programs such as the integrated approach program (PPT). This shows the government's seriousness in exploring the potential to develop food crops, especially soybeans [6-7]. It is known that soybean productivity in Jambi Province experienced fluctuations in the 2018-2022 period along with fluctuations in production and harvest area. In 2021 there was an increase in harvested area of 32.42% with production of 42.43%. In 2022 there will be a significant decrease in harvested area by 60% with production of 30.58% [8].

Soybeans are a source of raw materials for making typical Indonesian foods such as tofu and tempeh, so there will continue to be an increase in soybeans from year to year along with the increasingly rapid growth of Indonesia's population. This condition makes soybean cultivation have quite promising prospects both in terms of demand and price. Achieving self-sufficiency in soybeans requires good cooperation between regional and central governments and related parties so that they are able to meet the quantity and quality standards of soybean production for public consumption. Jambi Province consists of 11 districts and cities, one of the districts that carries out soybean farming is Tanjab Timur Regency [7].

Tanjab Timur Regency is one of the regions in Jambi province that plays a role in developing and increasing soybean production. Tanjab Timur Regency is included in the suboptimal land type. Suboptimal land is land that naturally has low productivity due to internal and external factors. Suboptimal land types consist of two, namely dry land and wet land. Dry land is grouped into acid dry land and dry land with a dry climate, while wet land is grouped into tidal swamp land, lowland swamp land and peat [9].

Tanjab Timur Regency, as one of the regions that carries out soybean farming, continues to strive to increase production so that it is in line with the central government program which seeks to gain production sufficient for national consumption. Tanjab Timur Regency is an area in Jambi Province which has 11 sub-districts, some of which carry out soybean farming, one of which is Rantau Rasau sub-district.

It shows that Rantau sub-district is one of the sub-districts with the largest production and harvest area in 2021 compared to other sub-districts, followed by Berbak sub-district, where production is 218 tons and harvest area is 113 ha. This shows that the Rantau Rasau sub-district has the potential to carry out soybean farming. The condition of soybean land in Rantau Rasau sub-district is suboptimal land of the tidal swamp type [10].

Tidal swamp land is swamp land whose water pools are affected by the ebb and flow of sea water and river water. Tidal swamp land is located in a flat area, so it often overflows and is flooded periodically. Based on the type of tidal water overflow, tidal swamp land can be divided into four categories, namely land types A, B, C and D. Type A land is swamp land in the lowest part, which is always flooded by tidal water, both large and small tides, during the rainy and dry seasons. Type B land is swamp land at a slightly higher level, which can only be flooded by high tides, while at small tides the water cannot overflow into the plot of land, while type C land is swamp land which is relatively dry and is never flooded even by high tide, but the tide has an effect through groundwater. Type D land is the driest swamp land, never flooded by large and small tides with a groundwater depth of more than 50 cm from the ground surface [10].

Rantau Rasau District is one of the largest soybean cultivation areas in Tanjab Timur Regency. Based on data we obtained from the Rantau Rasau sub-district Agricultural Extension Agency (BPP), soybean production, productivity and land area in 2018-2022 experienced fluctuations. The development of harvested area, production and productivity of soybeans in Rantau Rasau sub-district varies. It is explained that during the last five years, namely from 2018-2022, production, productivity and harvested area of soybeans in Rantau Rasau District experienced a fluctuation phenomenon, such as in 2021 there was an increase in harvested area of 35.39%, namely 226 ha, whereas in In 2022, there will be a 100% decrease in harvested area, namely 113 ha. In the same period in 2021 and 2022 there was an increase and decrease in production of 50.58% and 24.4% respectively [11].

In agricultural studies in relation to production, it is defined that production is the use of inputs to produce products or outputs. In the implementation of production, it is necessary to have production factors to support the implementation of production activities. [12] states that production factors are divided into 2 parts, namely physical factors and non-physical factors. Physical factors are input factors consisting of seeds, pesticides, fertilizer, land, irrigation and others. Meanwhile, non-physical factors are all efforts in utilizing physical factors. In another sense, the factors of production include land, capital, labor and management.

Rantau Rasau District has the potential to develop soybean commodities with a fairly large production scope in Tanjab Timur Regency, so soybean cultivation needs to be increased through the use of existing resources and other supporting production factors. Based on the initial survey obtained from information from Agricultural Extension Officers, the topographic condition of the land for soybean farming in the Rantau Rasau sub-district is Type B land. Type B land is wet land but there are dry periods so it can be planted with rice and secondary crops. Even with tidal land conditions, Rantau Rasau sub-district is able to become the sub-district with the largest contribution to soybean production in Tanjab Timur Regency [11].

Management of soybean land which is included in the tidal type is technically necessary to achieve efficient production in producing better output physically. Therefore, research is needed to find out what factors influence the productivity of soybean farming in this area. Based on these problems, the author is interested in conducting research on "Technical Efficiency of Factors Affecting Soybean Farming Production in Tanjab Timur Regency".

2 Material and Methods

This research was carried out in Tanjab Timur Regency. The location was chosen purposively considering that the location is one of the soybean farming production areas in Jambi Province. The method used in this research is a survey method by taking 120 samples from the population and using a questionnaire as a data collection tool. The object of this research is farmers who cultivate soybeans.

The scope of this research is limited to finding out whether soybean farming in is technically efficient and to find out what factors influence the technical efficiency of soybean farming production in Tanjab Timur Regency. The research was conducted from August to September 2023. The data required for this research is as follows.

- Identity of sample farmers: Name, Age, Number of family members, Level of formal education and length of farming.
- The amount of soybean production produced by farmers
- Production inputs used by farmers consisting of land area, fertilizer, seeds and labor.
- Other supporting data in this research.

The data collection methods used in this research were surveys, observations and interviews (Questionnaires). Before conducting research, a survey of the research location is first carried out to see the research location. After that, direct observations were made at the research location. Observation is a direct inspection of the research object, namely soybean farmers in the Tanjab Timur Regency. To obtain data from these observations, it is necessary to interview respondents using a list of questions (questionnaire) that has been prepared in advance in accordance with the research objectives, research needs and direct observations in the field. The secondary data collection method is obtained from information based on the problem to be researched, the results of previous research, scientific journals and agencies related to this research by quoting and conducting studies from books related to the problem being researched.

To determine the number of samples in a study, you must first know the population size of the area being studied. The research was conducted in Rantau Rasau sub-district, where Rantau Rasau sub- district has 11 sub-districts/villages. However, there are only three villages/sub-districts that carry out soybean farming. The research location was determined purposively, namely the Bandar Jaya sub- district and Marga Mulya Village with the consideration that these areas carry out soybean farming and are in accordance with main research. In this study, the population was soybean farmers at the research location, namely 120 people.

The analytical method used in this research is descriptive and quantitative analysis. Descriptive data analysis is analysis used to analyze data by describing or illustrating the data that has been collected and to describe the general picture of soybean farming in Rantau Rasau District, Tanjab Timur Regency. Quantitative analysis was used to answer the objective of determining the level of efficiency of soybean farming in the research area, assisted by analytical tools, namely Microsoft Excel 2010 and Frontier 4.1. Data analysis in this research uses the Stochastic Frontier Cobb-Douglas method. The results obtained using the Cobb-Douglas method are descriptive statistics of data, modeling, F test, T test, R square table which has the function of describing, determining and analyzing the influence of the variable x on variable y [12-13]. To analyze the technical efficiency of using production factors in soybean farming using the Frontier regression approach which is formulated as follows:

$$LnY = \ln \alpha + \alpha \ln X1 + \alpha 2 \ln X2 + \alpha 3 \ln X3 + \alpha 4 \ln X4 + \alpha 5 \ln X5 + \alpha 6 \ln X6 + Vi - Ui \text{ ………. (1)}$$

Where Y is soybean production (tons); X1 is land area (ha); X2 is seeds (kg); X3 is urea fertilizer (kg); X4 is phonska NPK fertilizer (kg); X5 is organic fertilizer (ltr); X6 is pesticides (ltr); X7 is labor (HOK); α0 is constant; α1 ... α6 is elasticity of the influence of production inputs on production (EXi/Yi); Vi is random error; Ui is variable assumed to be caused by technical inefficiencies in the product.

Furthermore, according to [14-15], the stochastic frontier model estimation method is carried out in two stages, namely the first stage using the Ordinary Least Square (OLS) method to estimate technological parameters and production inputs. The second stage uses the Maximum Likelihood Estimation (MLE) method to estimate all production factor parameters and variances of the two error components Vi and Ui. The MLE parameter is used to describe the relationship between maximum production that can be achieved using existing production factors.

As stated by [16-17] that the level of technical efficiency of farming can be measured using the following formula:

$$TE_i = \frac{Y}{Y^*} = \frac{E(Y_i|U_i, X_i)}{E(Y_i|U_i = 0, X_i)} = E[\exp(-U_i)/\varepsilon_i] \text{ …………………………………………. (2)}$$

Where TEi is technical efficiency of farmer i; yi is actual production from observations; yi* is estimated frontier production obtained from the stochastic frontier production function. Where 0 ≤ TEi ≤ 1.

If the TE value is closer to 1 then the farming can be said to be more technically efficient and if the TE value is closer to 0 then the farming can be said to be more technically inefficient. To answer the third objective, namely to determine the factors that influence technical efficiency in soybean farming in Tanjab Timur Regency, this was done using the Maximum Likelihood Estimation (MLE) method with the technical efficiency effect model as follows:

$$u_i = \beta 0 + \beta 1\, Z1 + \beta 2\, Z2 + \beta 3\, Z3 + \beta 4\, Z4 + \beta 5\, Z5 \text{ ………………………………….... (3)}$$

Where ui is technical inefficiency effect; β0 is Constant; Z1 is farmer's age (years); Z2 is farmer education (years); Z3 is farmer experience (years) Z4 is number of family members (people); Z5 is dummy for participation in extension activities D = 1; if you follow the extension D = 0; did not follow the extension.

The stages of testing the model with the R2 test, F test and T test can be seen as follows:

2.1 Coefficient of Determination (R2)

Testing the coefficient of determination (R2) is used to determine the part of the total variation that the data explains by the model. The R2 value can be formulated, where R2 is coefficient of determination. The characteristics of the coefficient of determination are as follows [16-17]; The R2 value is in the range of 0 and 1 (0 ≤ R2 ≤ 1), so the R2 value is always positive. Decision making criteria (a). R2 = 0, meaning that the variation of Y cannot be explained by X at all (b). R2 = 1, meaning that the variation of Y can be explained by X perfectly, so the observation point is on the regression line.

2.2 Simultaneous Test (F-test)

F test to find out whether all the independent variables have a significant influence on the model. The

testing hypothesis can be explained as follows

- H0: �2 = 0, The observed production factors have no significant effect.
- H1: �2 > 0, The observed production factors have a significant effect.

Where *Fh*�� is calculated F value; �2 is coefficient of determination; K is number of independent variables; n is number of samples.

This test is carried out by comparing the calculated F value with the F table with a significance level of α= 5% decision making criteria

- If the sig value < α: H0 is accepted and H1 is rejected, it means that the production factors are in the form of land area, seeds, urea fertilizer, NPK phonska fertilizer, organic fertilizer, pesticides, and labor together have no real effect on soybean production in Tanjab Timur Regency.
- If the sig value > α: H0 is rejected and H1 is accepted, it means that the production factors are in the form of land area, seeds, urea fertilizer, NPK phonska fertilizer, organic fertilizer, pesticides, and labor together have a real influence on soybean production in Tanjab Timur Regency.

2.3 Partial Test (T-test)

The T test is used to test whether the regression coefficient value of each production factor of land area, seeds, urea fertilizer, NPK fertilizer, Trichoderma pesticide, and energy used separately has a real effect on soybean production (Y), while the testing hypothesis can be explained as follows

- H0: ⍰1 = 0, It is suspected that the independent variable has no real influence on the dependent variable.
- H1: ⍰1 ≠0, It is suspected that the independent variable has a real influence on the dependent variable.

Where �- *h*���*ng* is calculated t value; *b* is *b* th estimated regression coefficient; �*b*� is Standard error of the *b*-�th estimate. The calculated t value obtained is then compared with the t table value at the significance level α = 5%. Decision making criteria

- If sig > α : H0 is rejected and H1 is accepted, it means the 1st production factor real effect on soybean production.
- If sig < α : H0 is accepted and H1 is rejected, it means the i-th production factor has no real effect on soybean production.

3 Results and discussion

3.1 Analysis of Soybean Farming Production Functions

Production function analysis was carried out with the aim of determining the effect of the use of each production input used on soybean farming production. The data analyzed is free from deviations and is normally distributed using the Kolmogorov-Smirnov technique, where data is said to be normally distributed if the number is sig. > 0.05. Based on the analysis results, a sig value was obtained. of 0.200, which means the sig value. data (0.200) is greater than 0.05 so it can be seen that the variable is normally distributed.

Furthermore, the data has also been tested by carrying out a multicollinearity test to find out whether the regression model formed has a high correlation between independent variables with a tolerance value > 0.01 and a VIF value < 10. Based on the results of this analysis, all variables have a tolerance value > 0.1 and VIF value < 10 so it can be concluded that in the data distribution there are no symptoms of multicollinearity. Then a Heteroscedasticity Test was carried out to determine whether there were differences in the variance of the residuals for all observations in the regression model which was carried out using the Glejser Test technique with a significance value (Sig) between the dependent variable and the absolute residual > 0.05. Based on the results of the analysis, it was found that there were no symptoms of heteroscedasticity in the data. Next, a model evaluation was carried out consisting of the coefficient of determination test (R-Square), F test and T test [18].

The coefficient of determination (R2) test was carried out to determine the percentage of each production factor variable in the regression field estimation model. The analysis results obtained that the Adjusted R2 value was 0.626. This shows that the variables land area (X1), seeds (X2), urea fertilizer

(X3), NPK phonska fertilizer (X4), organic fertilizer (X5), pesticide (X6), and labor (X7) together - the same can explain soybean farming production of 62.6% while the remaining 37.4% is influenced by other factors outside the model. The F Statistical Test (F Test) is carried out to find out whether the independent variables have a joint effect on the dependent variable. The F test result is 7.096 with a significance value of 0.000. This shows that all independent variables have a real effect, marked with a significance value of 0.000 <alpha = 0.05.

To find out the influence of the independent variable which has a real effect separately on the dependent variable, it can be seen by looking at the t-value of each independent variable obtained from the Maximum Likelihood Estimation (MLE) method. Maximum Likelihood Estimation (MLE) method to estimate all production factor parameters and variances of the two error components Vi and Ui. MLE parameters are used to describe the relationship between maximum production that can be achieved using existing production factors. The input variables used are land area, seeds, urea fertilizer, NPK phonska fertilizer, organic fertilizer, pesticides, and labor. Estimation of the production function of soybean farming in the research area using the MLE method in 2023 can be seen in Table 1.

Tabel 1 Production Function Estimation Soybean Farming in Research Area using MLE Method

Variable	**Parameter**	**Coefficient**	**T-calculate**
Constant	α_0	5.269	11.733
Land area	α_1	-0.016	-1.254ns
Seed	α_2	-0.058	-1.327ns
Urea fertilizer	α_3	-0.116	-1.157ns
NPK phonska fertilizer	α_4	0.270	5.997***
Organic fertilizer	α_5	0.701	2.948***
Pesticide	α_6	0.083	1.592ns
Labor	α_7	0.088	5.422***
Sigma-Squared		0.005	3.603
Gamma		0.999	13.96
$\Sigma\ \alpha_j$		0.528	
LR Test Of The One-Sided Error			20.93
Log-Likelihood Function MLE			73.89
Log-Likelihood Function OLS			63.42
R^2		0.626	

Source Frontier Processing Data, (2023); Remarks = *** (significant at 1%); ns (no significant)

Table 1 is the result of data processing using the Frontier 4.1 application which is used to use the production function using the Maximum Likelihood Estimation MLE method). The table shows the R2 value of 0.626, which means that the independent variables (land area, seeds, fertilizer, organic fertilizer, pesticides and labor) together can explain the dependent variable (productivity) by 62.6%, while the remaining 37.4 % is determined by other factors outside the model.

The value of $\Sigma\alpha i = 0.949 < 1$, meaning that the use of production factors in the research area is in region II of the production curve or the decreasing return to scale region, which means that every increase in the same proportion of production input will result in an additional decreasing output. This can be said by adding production input in the same proportion of 1%, it will result in additional output decreasing by 0.949.

Input variables used in farming will be analyzed in the frontier productivity function model. The results of estimating the frontier productivity function with the following equation:

$$\text{Ln } Y= 5.269 - 0.016 \ln X1 - 0.058 \ln X2 - 0.116 \ln X3 + 0.270 \ln X4 + 0.701 \ln X5 + 0.083 \ln X6 + 0.088 \ln X7 \ (0.01 - 0.99) \quad \ldots\ldots (4)$$

The influence of the use of production factors on soybean production can be partially seen from the t- ratio value for each independent variable. It can be seen that the variable production factors for NPK phonska fertilizer, organic fertilizer and labor partially have a real positive effect on soybean production, while the pesticide production factor has a positive effect but not a real effect. Meanwhile, the production factors of land area, seeds and urea fertilizer partially do not have a significant effect on soybean production and it can also be seen that the parameter Ui is 0.99 and the variable Vi is 0.01 on soybean production in the research area. The influence of each independent variable on the dependent variable in detail can be seen in the description below.

3.1.1 *Effect of Land Area (X1) on Production*

The analysis results in Table 1 shows that the elasticity value of land area has a negative sign, namely 1 = -0.016 and has no real effect on production. This can be seen from the t-count value of 1.255 ns < t-table, meaning that the land area variable is not one of the factors. which affects soybean productivity in the research area.

This is thought to be because tidal land conditions are a crucial problem in the research area. Based on information obtained from respondent farmers, it is said that tides always come in almost every soybean planting season, thus affecting crop yields and even resulting in crop failure. Land conditions that are exposed to tidal water reduce the nutrients in the soil to support soybean growth. The results of these different studies are in accordance with research conducted by [19] where the results of their research state that land area has a real and positive effect on soybean production, where every 1% increase in land area will increase soybean production by 0.306%.

3.1.2 *Effect of Seeds (X2) on Production*

The analysis results in Table 1 shows that the seed elasticity value has a negative sign, namely $\alpha 2$ = 0.058 and has no real effect on production. This can be seen from the t-count value of 1.327 < t-table, meaning that the seed variable has no real effect on soybean production in the area. study. Apart from land conditions that influence soybean growth are seed production factors. Partially, each additional seed in one unit will reduce productivity by 0.058. Seed use in the research area is still below the recommendation, namely only 49.38 kg/ha, where the recommended use is 50 kg/ha. This shows that adding seeds is still able to increase productivity. This is in accordance with research by [20] said that seeds have a real and significant effect on soybean production.

3.1.3 *Effect of Urea Fertilizer (X3) on Production*

The analysis results in Table 1 shows that the elasticity value of urea fertilizer has a negative sign, namely $\alpha 3$ = 0.116, and if viewed from the correlation of the table value and the calculated value of the fertilizer variable it has no real effect on soybean production in the research area, this is proven by the t-calculated value of 1.157 < t- table. From the results of this analysis, it can be said that the fertilizer variable is not one of the factors that influences soybean production in research area. Assuming the other variables remain constant (ceteris paribus), it can be concluded that every additional input for Urea fertilizer production will have an impact on decreasing production by 0.116.

3.1.4 *Effect of Phonska NPK Fertilizer (X4) on Production*

The results of the analysis in Table 1 shows that the elasticity value of urea fertilizer has a positive sign, namely $\alpha 4$ = 0.270, and if viewed from the correlation of the table value and the calculated value of the phonska NPK fertilizer variable, it has a significant effect on production soybeans in the research area, this is proven by the t-count value of 5.997> t-table. From the results of this analysis, it can be said that the phonska NPK fertilizer variable is one of the factors that influences soybean production in Tanjab Timur Regency. Assuming the other variables remain constant (ceteris paribus), it can be concluded that every additional input for Urea fertilizer production will have an impact on decreasing production by 0.270.

3.1.5 *Effect of Organic Fertilizer (X5) on Production*

The results of the analysis in Table 1 shows that the elasticity value of fertilizer has a positive sign, namely $\alpha 5$ = 0.701 and if viewed from the correlation of the table value and the calculated value of the organic fertilizer variable, it has a real effect on soybean production in the research area, this is proven by the t-calculated value of 2.948> t -table. This means that for every 1% addition of organic fertilizer with ceteris Paribus assumptions, there will be an addition of 0.701. From the results of this analysis, it can be said that the organic fertilizer variable is one of the factors that influences soybean production in research area. Consistent with research by [21] said that the use of organic fertilizer has a positive and significant impact on production. The elasticity value of organic fertilizer is 0.0713, this shows that with the addition of 1% organic fertilizer, lowland rice production will increase by 0.0713%.

3.1.6 Effect of Pesticides (X6) on Production

The analysis results in Table 1 show that the seed elasticity value is positive, namely α6 = 0.083, but it has no real effect on production, this can be seen from the t-count value of 2.069 > t-table. This means that every time pesticides are added to one unit, there will be an increase of 0.083, that the pesticide variable affects soybean production in the research area. The pesticides that are the variables in this research are the types of herbicides and insecticides. In line with research by [22], it is said that the use of pesticides has a real and positive effect on soybean production. The pesticide elasticity value is 1.1636, meaning that increasing pesticide use by 1% will increase production by 1.1636.

3.1.7 Effect of Labor (X7) on Production

The analysis results in Table 1 show that the seed elasticity value has a positive sign, namely α7= 0.088 and has a real effect on production, this can be seen from the t-count value of 5.422 > t-table. This means that for every 1% increase in pesticides there will be an increase in output of 0.088. This indicates that the Labor variable influences soybean production in the research area. The results of this research are in line with research by [23] which states that labor variables have a real and positive effect on soybean production. The labor coefficient value is 0.0116, this shows that every additional one percent of labor will increase soybean production by 0.0116 percent.

3.2 Analysis of Technical Efficiency of Soybean Farming

Technical efficiency describes the ability of farming to obtain maximum output from a certain amount of input use. A farm is said to be technically efficient if the efficiency index value is ≥ 0.7. The MLE method describes the best performance (best practice) of farmers at the existing technology level. The results of the estimated level of technical efficiency in soybean farming can be seen in Table 2 below.

Table 2 Technical Efficiency Soybean Farming in Research Area

Frontier Technical Efficiency	Frequence (People)	Percentage (%)
0,586-0,623	9	7.5
0,624-0,661	11	9.2
0,662-0,699	11	9.2
0,700-0,737	22	18.3
0,738-0,775	25	20.8
0,776-0,813	24	20.0
0,814-0,851	9	7.5
0,852-0,889	9	7.5
Total	120	100.0
Minimum value	0.586	
Maximum value	0.885	
Mean	0.767	

Source : Frontier Processing Data, (2023)

Based on Table 2, it can be seen that all soybean farmers in the research area are technically efficient. This can be seen in the technical efficiency range from 0.586 to the highest value of 0.885 with the average technical efficiency achieved by soybean farmers being 0.767. This shows that the average productivity achieved by farmers in the research area is 76.7%. This means that soybean farmers are quite efficient but there is still a 23.3% chance of achieving maximum production.

3.3 The Influence of Socio-Economic Factors on Technical Inefficiency of Soybean Farming

Based on the results from Table 2, it is explained that the technical efficiency results are 0.767. It can be said that the problems caused by technical inefficiency in soybean production in the research area are only around 23.3% of the problems caused by inefficiency factors. One of the factors that influences technical inefficiency is the socio-economic factor of farmers. The following are the estimation results of sources of technical inefficiency presented in Table 3.

Table 3 Regression Estimation of Factors Affecting Technical Inefficiency on Soybean Farming

Variable	Parameter	Coefficient	T-count
Constant	β_0	-0.150	-0.156
Age	β_1	0.098	0.434ns
Education	β_2	0.039	0.405ns
Experience	β_3	-0.005	-0.087ns
Family member	β_4	-0.015	-1.61ns
Extension	β_5	-0.063	-1.62ns
Sigma-Squared		0.005	3.603
Gamma		0.009	13.968
ΣBi		0.528	
R^2		0.626	

Source : Frontier Processing Data, (2023); Remark: ns (no significance)

Based on the information in Table 3, it is explained that there are no variables that have a real and significant effect or have a real effect on the inefficiency of soybean production techniques. According to [20], the negative sign on the technical inefficiency parameter in the Frontier 4.1 software processing results indicates that this variable reduces technical inefficiency or increases technical efficiency and conversely the positive sign indicates that increasing this variable will increase technical inefficiency or reduce technical efficiency.

The following is an estimate or estimate of the sources of technical inefficiency in soybean production in the research area as follows:

3.3.1 Farmer Age

The analysis results in Table 3 show that the farmer's age elasticity value is positive, namely β_1 = 0.098, and has no real effect on technical efficiency where the t-value is 0.434 < t-table. This shows that the increasing age of farmers will increase inefficiency, but it is not significant for production. This is because as farmers age, farmers try to increase their skills and knowledge, but tend not to want to take on greater risks. This is different in line with research by [24] who said that farmer age is positively correlated and has no real effect on the level of technical inefficiency of soybean farming.

3.3.2 Farmer Education

The results of the analysis in Table 3 show that the elasticity value of farmer education is positive, namely β_2 = 0.039, meaning that every additional farmer education will increase inefficiency or reduce technical efficiency. When viewed from the correlation with t-count, where the t-count value is 0.405 < t-table, this means that farmers' formal education has no real effect on soybean production in Tanjab Timur Regency. Educational conditions do not have a significant effect on soybean farming in the research area because farmers' education levels tend to be the same, namely elementary school graduates. Apart from that, soybean farming activities do not use complicated or modern equipment or technology so it is suspected that the education variable has no effect on soybean farming activities.

This is in line with research by [25] who found that education had a positive effect on the technical efficiency of rice farmers. However, different from the research of [23] who said that farmers' education levels were negatively correlated, namely -0.0079 and were significantly influenced by the α = 1% level. This means that increasing farmers' formal education will reduce the effects of technical inefficiency in farming operations. So, the higher the formal education of farmers, the higher the technical efficiency of soybean production.

3.3.3 Experience

The results of the analysis in Table 3 show that the elasticity value of the Experience variable has a negative sign, namely ⍰3 = 0.05, and this variable is not significant or has no real effect on the effects of technical inefficiency. This can be seen in the t-count value, where the t-count is 0.008< t-table. This can happen because the conditions for soybean cultivation in the research area are tidal areas which makes farmers innovate to continue to survive in these conditions. Farmers' long experience will certainly increase efficiency, although it is not significant because farmers with several years of experience still tend to use the same methods.

This is consistent with research conducted by [25] who said that experience is negatively correlated and has no real effect on the technical inefficiency of soybean farming. This condition is in accordance with initial expectations, that the experience variable will reduce the level of technical inefficiency in soybean farming. The longer the farmer's experience in soybean farming, the lower technical inefficiency and increase the efficiency of soybean farming.

3.3.4 Family Members

The results of the analysis in Table 3 show that the elasticity value of the variable number of family members has a negative sign, namely ⍰4 = -0.159, but this variable is not significant or has no real effect on the effect of technical inefficiency. This can be seen in the t-count value, where the t-count is 1.618

< t-table. This means that the variable number of family members results in a decrease in inefficiency or an increase in the level of technical efficiency. This is different from the editorial hypothesis where every increase in the number of family members will increase inefficiency. The number of family members is thought to reduce the technical inefficiency of farming because the number of family members is a proxy for the availability of labor in the family. Rational farmers will divert the savings in labor costs outside the family to purchasing other higher quality inputs.

The results of this research are in line with research by [23] where it is explained that the variable number of family members (Z4) in soybean farming has a negative but not significant effect on technical inefficiency. This means that the greater the number of dependents of farming families, the more the technical inefficiency of soybean farming will decrease.

3.3.5 Extension

The results of the analysis in Table 3 show that the elasticity value of the extension variable has a negative sign, namely ⍰5 = 0.063, but this variable is not significant or has no real effect on the effects of technical inefficiency. This can be seen in the t-count value, where the t-count is 1.622 < t-table. This means that the addition of extension variables results in a decrease in inefficiency or an increase in the level of technical efficiency. This is different from the editorial hypothesis where every additional extension activity will increase inefficiency. This can happen because the extension program that farmers participate in is quite effective and significant for the respondent farmers' soybean farming. This is also supported by the distribution of sufficient extension workers in each research village.

The results of this study are different from the research of [26] where it is explained that Extension is positively correlated and has no real effect on the technical inefficiency of soybean farming. This condition is also not in line with expectations, where the more frequently respondent farmers participate in extension, the more inefficiency will increase.

4 Conclusion

Based on the research objectives, the conclusions that can be drawn from this research are

- Tidal land conditions have an impact on disrupting soybean farming production in the research area. Farmers have done several things, but have not been able to stem the volume of water that inundates the land when high tide occurs. Productivity or average production produced by farmers in the research area is 1,039 kg/ha.
- The production factors of land area, seeds, fertilizer, organic fertilizer, pesticides and labor simultaneously influence soybean production. Meanwhile, production factors that have partial influence are NPK phonska fertilizer, organic fertilizer and labor. Farming in the research area is technically efficient with an efficiency of 0.767 or 23.3%.
- Socioeconomic factors such as age, education, experience, number of family members and simultaneous and partial extension have no real effect on soybean production.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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