

## ESTIMATION MODEL OF POTATO FARMING PRODUCTION FUNCTION IN KERINCI REGENCY, JAMBI PROVINCE INDONESIA

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### ABSTRACT

This study aims to estimate the model of potato farming production function in Kerinci Regency, Jambi Province. The estimation of the production function model uses the Cobb-Douglas production function model, the transcendental production function model, and the log-log inversion production function model. The best production function model of the analysis that is able to explain the physical relationship between inputs and potato farming output is the Cobb-Douglas production function model with the value of the determination coefficient  $\text{adj-R}^2 = 0.8566$  [85.66 %] for granola and for cipanas varieties the determination coefficient  $\text{adj-R}^2 = 0.8972$  [89.72 %]. The Cobb-Douglas production function model was chosen as the best function because it showed a high  $\text{adj-R}^2$  value and a t-test of each significant predictor variable. The estimation of the production function model of the Cipanas potato farming function is only a Cobb-Douglas production function model that is able to explain the logical, factual and theoretically acceptable technical relationship to explain the influence of production inputs on production. The sum of all input parameters for granola potato farming production was obtained  $\sum\beta_i = 0.9689 < 1$ . Indicates that granola potato farming is in area I (Decreasing Return to Scale). In the cultivation of cipanas potato varieties,  $\sum\beta_i = 0.9669 < 1$ . It indicates that the cultivation of cipanas potato varieties is in area II (decreasing Return to Scale). The technical efficiency of both potato varieties is relatively low, which means there is still great potential for increased productivity.

**Keywords:** Estimation model, Productions, Function, Potatoes farming.

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### INTRODUCTION

The agricultural sector in 2021 was able to contribute 2,115,086 billion rupiah or 13.70% of Indonesia's total *Gross Domestic Product* (GDP) or an increase of 0.95 from 2021 which only contributed 2,012,742 billion rupiah or 12.71% of Indonesia's total *Gross Domestic Product* (GDP) (Kementan, RI, 2023). The contribution of the agricultural sector is inseparable from the increase in food crop products which experienced a growth of 10.47%. The pagan commodity that is experiencing increasing demand is the potato commodity reaching 6.5-11.3% per year. Jambi Province is one of the regions that has the potential and center for the development of potato cooditas. Jambi Province has climatic conditions that are in accordance with the growing and developing conditions needed in potato farming, this can be seen from the development of land area, potato production and productivity in Jambi Province in 2016-2023 (Diperta and Horticulture, 2023).

For Jambi province, the food agriculture sub-sector is an integral part of economic policy in the government's efforts to realize food self-sufficiency and sustainable agriculture, especially potato production. The average planting area of potatoes in Jambi Province for the 2015-2022 period is 8,960 ha per year and 68.3% is in Kerinci Regency. Potato farming production during the period 2013 – 2022 averaged 96,888 tons per year with a production of 11.5 tons/ha/MT (BPS Kerinci, 2023).

Somantri (2014) and Maryanto (2018) Optimal and sustainable potato production cannot only be realized by improving the quality of farmers, but must be supported by the availability of sufficient production factors and can be used as optimally as possible. (Sahara (2023), Nuryana (2017) and Rozandy (2013) The adoption of this technology will affect the productivity produced. Differences in technology adoption between farmers will result in differences in farmers' productivity and income.

In the research area, potato productivity of 11.5 tons/ha/MT is very low compared to the best potato farming management with productivity that can reach 22.3 tons/ha (*BPS Kerinci 2020*). With optimization of the use of production factors; land area, seeds, fertilizers and tashapen production of potato farming can reach 23.1-31.5 tons/ha Sahara, (2023] and Rozandy (2013) Efforts that can be made are to pay attention to and optimize the adoption of technologists, especially plant maintenance. Other factors are land area, potato prices and means of production. These three variables influence economic decisions in farming. Institutional access factors affect the adoption and innovation of the use of new technologies. Institutional access factors that affect the adoption of new technologies are access to credit, access to counseling, and access to the availability of production facilities. Rozandy (2013) and Ali, RM (2020) argue that the greater the access of farmers to these institutions, the more it will affect the scale of production and adoption of potato farming technology and in turn will affect the high and low productivity and guaranteed success of potato farming.

Productivity is inseparable from the role of farmers in allocating various production inputs used. If the use of production inputs is not timely and in the right amount, it will not cause an increase in production so that the use of production inputs becomes inefficient. The use of production inputs such as land, seeds, fertilizers, medicines, labor, and other inputs will affect the high and low productivity produced. The more optimal the production inputs used, the higher the productivity will be Tasman, A (2008), Daniel. M, (2004) and Nainggolan, S, Ririn Oktari, U (2018) With an efficient combination of one production input and another production input, it is expected to be able to provide optimal production. Therefore, it is necessary to carry out an "Analysis of the Estimation of the Production Function Model of Potato Farming in Kerinci Regency, Jambi Province".

## RESEARCH METHOD

This research was conducted in Kerinci Regency with a research locus in Kayu Aro District. This research was conducted in three villages, namely Sungai Asam Village, Kebun Baru Village and Giri Mulyo Village. The sample size was determined purposively as many as 60 farmers with details of 30 farmers who cultivated *granola* varieties potatoes and 30 farmers who cultivated *cipanas* varieties Sampling was carried out by *the Simple Random Sampling Method* using a random number table.

To analyze the production response to changes in the use of production factors, the *Cobb-Douglas*, *Transcedental*, and *Inversion log-log* production function models were used using *the Ordinary Least Square (OLS) method*. As for the production function model of Tasman, A (2008) (Soekartawi, 2014) Nainggolan et al. {2024} can be stated as follows:

1. Cobb-Douglas production function model

$$Y = A \prod_{i=1}^n X_i^{\beta_i} \dots \dots \dots (3.1)$$

This model of mathematical equations is transformed into:

$$\text{Log} Y = \text{Log} A + \beta_1 \text{log} X_1 + \beta_2 \text{log} X_2 + \beta_3 \text{log} X_3 + \beta_4 \text{log} X_4 + \beta_5 \text{log} X_5 + \beta_6 \text{log} X_6 + \beta_7 \text{log} X_7 + \beta_8 \text{log} X_8 + \mu \dots \dots \dots (3.2)$$

2.  $Y = A \prod_{i=1}^n X_i^{\beta_i} e^{\mu}$  .....(3.3)

This mathematical equation model is transformed into:

$$\text{Log} Y = \text{log} A + \beta_1 \text{log} X_1 + \beta_2 \text{log} X_2 + \beta_3 \text{log} X_3 + \beta_4 \text{log} X_4 + \beta_5 \text{log} X_5 + \beta_6 \text{log} X_6 + \beta_7 \text{log} X_7 + \beta_8 \text{log} X_8 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \alpha_8 X_8 + \mu \dots \dots \dots (3.4)$$

3.  $Y = A \prod_{i=1}^n X_i^{\beta_i} e^{\mu/n}$  .....(3.5)

This mathematical equation model is transformed into:

$$\text{Log} Y = \text{log} A + \beta_1 \text{log} X_1 + \beta_2 \text{log} X_2 + \beta_3 \text{log} X_3 + \beta_4 \text{log} X_4 + \beta_5 \text{log} X_5 + \beta_6 \text{log} X_6 + \beta_7 \text{log} X_7 + \beta_8 \text{log} X_8 + \alpha_1 X^{-1} + \alpha_2 X_2^{-1} + \alpha_3 X_3^{-1} + \alpha_4 X_4^{-1} + \alpha_5 X^{-1} + \alpha_6 X_6^{-1} + \alpha_7 X_7^{-1} + \alpha_8 X^{-1} + \mu_8$$

Information:

Y = Total potato production(kg)

X1 = Potato farming area (ha)

X2 = Number of potato seedlings (kg)

X3 = Total Urea Fertilizer

- (kg)  $X_4$  = Fertilizer Usage SP
- 36 (kg)  $X_5$  = Fertilizer
- Usage K (kg)
- $X_6$  = Drug use (ml)
- $X_7$  = Labour used (HOK)  $X_8$  = Organic fertilizer (kg)
- A = Constant
- $\beta_i$  = Regression Coefficient;  $i = 1,2,3, \dots 8$
- $\alpha_i$  = Coeficin Regresi;  $i = 1,2,3, \dots 8$
- $\mu$  = Disruptive Error

## RESULTS AND DISCUSSION

Real Conditions of Potato Production Input Use For granola *potato farming* with a land area ranging from 0.25-1.20 ha, an average of 0.65 ha with a coefficient of variation of 18.3%. For *cipanas potato farming*, the area of land cultivated ranges from 0.21-1.10 ha, an average of 0.58 ha with a coefficient of variation of 15.7%, the potato seeds used are 720-1200 kg, an average of 950 kg with a coefficient of variation of 18.4% for *granola varieties*, For *potato farming of the cipanas variety use* seeds as much as 650-860 kg, an average of 815 kg with a coefficient of variation of 14.6%.

Granola potato farming; fertilizer use, urea ranges from 115-155 kg, SP36 ranges from 90-125 kg, and KCl ranges from 70-115 kg. The total use of this fertilizer is only 55.5%; 50.2% and 55.5% of the recommended dose. For potato farming of *the cipanas* variety of potatoes use; urea 95-115 kg; SP36 85-100 kg and KCl 75-95 kg. The allocation of this fertilizer dose is only 65.2%, 60.3% and 62.3% of the recommended dose for *granola* potato farming. the use of organic fertilizers is 185 – 320 kg, the average is 220 kg; the coefficient of variation is 18.3 %; For *cipanas* potato farming, the use of organic fertilizer is 150-215 kg; with an average of 172.5 kg; and a coefficient of variation of 20.5%;

### Estimation of Granola Potato Farming Production Function Model

The results of the Anova test model of the production function of *granola potato farming* with the three approaches of the production function model show that the Cobb-Douglas production function model with Prob.  $F(0.00034 < f \text{ tab } \alpha (0.01)$ . Transcedental with  $P. F(0.00005 < f \text{ tab } \alpha (0.01)$  and Log-log inversion with Prob.  $F(0.000071 < f \text{ tab } \alpha (0.01)$ . All three function models show that they have a statistically significant level of precision. This means that the three production function models are suitable for use in estimating the production function of potato farming.

Results Estimation of the parameters of the production function of *granola potato farming* with the three approaches of the production function model can be seen Table 1.

**Table 1. Results of Estimation of Granola Variety Potato Farming Production Function Model in the 2024 Research Area**

Variabel	Production Function				
	Cobb-Douglas		Transcendental	Inversi Log-log	
	$B_i$	$\beta_i$	$A_i$	$B_i$	$A_i$
Land( $X_1$ )	0,1143 <sup>a</sup>	0,2215 <sup>a</sup>	0.1134	0.4233 <sup>b</sup>	0.0392
Seed( $X_2$ )	0,1856 <sup>a</sup>	0.1627 <sup>a</sup>	-0.0035	0.1001	0.1246
Urea ( $X_3$ )	0.1745 <sup>b</sup>	0.1211 <sup>a</sup>	-0.01243 <sup>a</sup>	-0.3334 <sup>a</sup>	0.1495 <sup>a</sup>
SP 36 ( $X_4$ )	0.0751		0.075 0.1211	0.0136	0.0092
		6 <sup>c</sup>			
KCl ( $X_5$ )	0.0256 <sup>a</sup>	0.0542	0.0346	0.0283	-0.1243
Organic ( $X_6$ )	0.2185	0.1047	0.0115	0.0451	0.3146
Pesticides( $X_7$ )	0.0961 <sup>b</sup>	0.0818 <sup>c</sup>	-0.0014 <sup>c</sup>	0.2437	-0.3674
Labors( $X_8$ )	0.0792	0.0752 <sup>c</sup>	0.0835	0.0836	0.0941
Konstanta	1.2544		0.1263	0.0986	
Adj-R <sup>2</sup>	0.8566		0.9135	0.7145	

Description: a,b,c is significant at 0.01, 0.05, and 0.10

Table 1 shows that the result parameters of the Cobb-Douglas production function model estimation are obtained the determination coefficient  $\text{Adj.R}^2 = 0.8566$  Log-log inversion with  $\text{adj-R}^2 = 0.7135$ , and the Transcendental production function model with  $\text{adj-R}^2 = 0.9135$ . For all three types of production function models, it shows that

land area, urea fertilizers, seedlings and organic fertilizers are among the determining factors for potato production at the level of 99%. Although *the transcendental* production function model showed the highest adj-R2, the t-test of each explanatory variable showed a marked difference in *the Cobb-Douglas* function. Thus, the estimation of the appropriate production function model for *granola potato farming is the Cobb-Douglas production function model*.

Based on the results of the summation of all the values of the regression coefficient  $\sum \beta_i = 0.9689 < 1$  (one). This shows that *granola potato farming* is in the production area of phase II (*Decreasing Return to Scale*) or is experiencing an increase in the scale of yields that are decreasing and production has become close to technically efficient. Thus, an increase in the use of inputs in the same proportion by 10% will increase production (*output*) by 9.69%.

### Estimation of Fungsi Model of Cipanas Potato Farming Production

The results of the third Anova test approach of the production function model show : that in *the Cobb-Douglas* Prop.F-hit.0.0062 function  $< F$  tab.  $\alpha$  (0.01). *Transcendental Prop* function model.F-hit.0.0000  $< F$  tab.  $\alpha$  (0.01). Prop *Log-log Inversion function model*. F-hit. 0.0000  $< F$  tab.  $\alpha$  (0.01) . The results of the anova test were very significant with zero for all three function models showing that statistically the precision of the model was very high. Variations in the use of production inputs simultaneously affect the variation in potato production very significantly This means that the three production function models are suitable for use in the estimation of the production function of *potato farming of the cipanas variety* Results Estimation of the parameters of the production function of the potato varieties *cipanas* with the three production function approaches can be seen Table 2

**Table 2. Results of Estimation of Parameters of Three Production Functions of Cipanas Potato Farming in the Research Area in 2024**

Variabel	Production Function				
	Cobb-Douglas		Transcendental	Inversi Log-log	
	B <sub>i</sub>	B <sub>i</sub>	A <sub>i</sub>	B <sub>i</sub>	A <sub>i</sub>
Land(X <sub>1</sub> )	0,2216 <sup>a</sup>	0,1215 <sup>a</sup>	8.4261 <sup>a</sup>	0.4333 <sup>b</sup>	0.3476 <sup>b</sup>
Seed(X <sub>2</sub> )	0.1627 <sup>a</sup>	0.1627 <sup>a</sup>	-0.1982 <sup>a</sup>	-0.2310 <sup>b</sup>	-0.0983 <sup>b</sup>
Urea (X <sub>3</sub> )	0.1211 <sup>a</sup>	0.1211 <sup>a</sup>	0.0043	0.2670	0.1030
SP 36 (X <sub>4</sub> )		0.0756 <sup>c</sup>	0.0828	0.0875	0.0007
		0.0756 <sup>c</sup>			
KCl (X <sub>5</sub> )	0.0542	0.0542	-0.03825	0.0764	0.0018
Organic (X <sub>6</sub> )	0,1047	0,0431	-0.3012	0.0913	0.0024
Pesticides(X <sub>7</sub> )	0.0818 <sup>c</sup>	0.0816 <sup>c</sup>	-0.0435 <sup>b</sup>	-0.0761 <sup>c</sup>	0.0263 <sup>c</sup>
Labors(X <sub>8</sub> )	0.0752 <sup>c</sup>	0.0752 <sup>c</sup>	-0.6320 <sup>b</sup>	-0.6335	0.0078

Description: a,b,c is significant at 0.01, 0.05, and 0.10

Table 2 shows that the results of the parameter estimation of *the Cobb-Douglas production function model* with the determination coefficient adj-R2 = 0.8566. A model of a transcendental function with a determination coefficient of adj. R2 = 0.8961, Log-log Inversion function model with a determination coefficient adj-R2 = 0.9143 . Although the model of transcendental functions and log-log inversions provides a higher value of the adj-R2 determination coefficient than the Cobb-Douglas function model, the algebraic form of such production functions cannot be accounted for because it is unable to explain the logical economic relationship between production inputs and production. Thus, the best and theoretically correct model of production function that is able to describe the farming of *the Cipanas variety potato* is the Cobb-Douglas production function model.

By summing all the values of the  $\beta_i$  regression coefficient,  $\sum \beta_i = 0.8969, < 1$ . It indicates that the cultivation of the *Cipanas variety of potatoes* is in the production area of phase II (*Decreasing Return to Scale*). Increasing the allocation of simultaneous input use in the same proportion by 10% is able to increase potato production by 8.97%. In other words, the cultivation of *the Cipanas variety potato* is experiencing a decreasing scale of production.

### Estimation of Potato Farming Production Function Model With or Without Variety Dummy

The estimation of the production function model of *granola* and *cipanas varieties* shows that the most suitable function model is the Cobb-Douglas production function model, so that in the analysis of the combined production function model estimation without *a dummy* and with *a dummy*, the estimation is carried out with the

Cobb-Douglas production function approach. The results of the Anova test show that in *granola* potato farming Prob.F  $0.0062 < F \text{ tab } \alpha (0.01)$ , this shows that statistically the model is very valid as a predictive model. In the cultivation of potatoes of the *cipanas* variety Prob.F  $0.0006 < F \text{ tab } \alpha (0.01)$  which shows that statistically the variation in the use of production inputs simultaneously affects the variation in the production of potatoes of the *cipanas* variety. In the cultivation of combined potatoes without *dummy* or without differentiating the potato varieties cultivated by the sample farmers shows Prop. F-hit.  $0.00003 < F.\text{tab. } \alpha (0.01)$

Likewise, potato farming combined with *dummies* showed Prop. F-hit.  $0.0000 < F.\text{tab. } \alpha (0.01)$ .

Results Estimation of production function parameters for the production function of *granola potato farming*, *cipanas potato farming*, combined without *dummy* and combined with *dummy* with the Cobb-Douglas production function model approach is presented in Table 3:

**Table 3. Results of Estimation of Potato Farming Production Function Model with Cobb-Douglas Production Function Model Approach in the 2024 Research Area**

Variable Input	Varietas <i>granola</i>	Varietas <i>cipanas</i>	Combinations non- <i>Dummy</i>	Combination with <i>Dummy</i>
nd(X1)	0,2143 <sup>a</sup>	0,2216 <sup>a</sup>	0.1835	0.1354
Seed(X2)	0,1856 <sup>a</sup>	0.1627 <sup>a</sup>	0,1283 <sup>a</sup>	0.1461
Urea (X3)	0.1745 <sup>b</sup>	0.1211 <sup>a</sup>	0,1082 <sup>a</sup>	0,1632 <sup>a</sup>
SP 36 (X4)	0.1954	0.0756 <sup>c</sup>	0,0894	0,1893 <sup>b</sup>
KCl (X5)	0.0256 <sup>a</sup>	0.0542	0,0651	0.0571
Organic (X6)	0.2185	0,1047	0.1284	0.0816 <sup>b</sup>
Pesticides(X7)	0.0961 <sup>b</sup>	0.0818 <sup>c</sup>	0.0530 <sup>a</sup>	0.0758 <sup>a</sup>
Labors(X8)	0.0792	0.0752 <sup>c</sup>	0.0705 <sup>c</sup>	0.0611
D1				0.4281 <sup>a</sup>
Konstanta	0.7763	0.6782	0.9135	0.9632
Adj-R <sup>2</sup>	0.8561 <sup>a</sup>	0.7854 <sup>a</sup>	0.88457	0.9563

Description: a,b,c is significant at 0.01, 0.05, and 0.10

Table 3 results Estimation of combined production function parameters with *potato variety dummy* with the Cobb-Douglas production function model approach yields a determination coefficient adj-R<sup>2</sup> = 0.9563, indicating that 95.63 % variation in potato production can be explained by variation in production input usage. While the rest is explained by other factors that are not included in the analysis model.

The model of the production function of potatoes combined with *dummy* shows that the production function is well formed with the magnitude of the determination coefficient adj-R<sup>2</sup>= 0.9257. The results of this estimate illustrate that the diversity of potato production can be explained by the diversity of production input allocation of 92.57%. The variables that have a real effect on average production are land area, seeds, SP 36 Urea fertilizer (X3), and organic fertilizer at a 99% confidence level. The variables of KCl fertilizer, drugs (X6) and labor (X7) were at a confidence level of 95% with a positive sign. Meanwhile, *the dummy* variable (D1) had a real effect at the level of 99% with a positive sign.

The land area variable (X1) has a positive and significant effect on potato production. This variable has a production elasticity value of 0.1354. It indicates that if the area of land cultivated by farmers increases by 10%, it will increase production by 1.354%, assuming that the conditions of using other inputs are considered constant. Consistent with Tasman, A (2008) that area is a determining factor for increasing production. Nainggolan et.al (2023), that the area of land cultivated by farmers determines competitiveness reviewed from comparative advantages.

The seed variable (X2) has a positive and significant effect on potato production. This variable has a production elasticity value of 0.1461. Indicating an increase in the use of seedlings by 10% will increase production by 1.461% assuming the conditions of other input variables are constant. Consistent with the research of Nainggolan (2011), that the use of seeds has a real effect on potato production with an elasticity value of 0.125 with a positive sign, In this relationship Rukmana, R (1994) and Deras and Sinulingga (2021) that the use of seeds not only affects the productivity of potatoes but also affects the quality of the potatoes produced. Furthermore, Maryanto (2018) said that in order to increase productivity, we must pay attention to the size and quality of seeds.

Urea fertilizer variables (X3), Rukmana, R (1994), Zulkarnian and Yusdiana (2022) that urea fertilizer is classified as a determining factor for the high and low productivity of the potato tami business. Soemantri, R (*et. Al (2914)*) the application of urea fertilizer in the right dose and on time is able to increase the productivity of potato farming business very significantly. The results of this study show that urea fertilizer has a positive and very significant effect on production with a production elasticity of 0.1632 Indicating that the addition of urea fertilizer by 10% will increase production by 1.632% assuming that the conditions of using other inputs are considered constant, consistent with the Sahara research, S *et.al* (2023) that urea fertilizer has a very significant effect on the productivity of potato farming businesses. In this regard, Maryanto (2018) the determining factor in potato farming is the provision of urea fertilizer, therefore for the purpose of achieving maximum production, the use of urea fertilizer must be optimized.

Fertilizer Variable SP 36 (X4), (Rukmana, R 1994), Nuryana, M (2017), and Zulkarnian and Yusdiana (2022) that the application of SP 36 fertilizer in the right dose and on time is classified as a determining factor for the high and low productivity of potato farming businesses. Deras and Sinuningga (2021) that the productivity of potato farming is determined by the efficiency of using SP 36 fertilizer. The results of this study show that SP 36 fertilizer has a positive and significant effect with a coefficient of production elasticity of 0.1893 Indicating that the development of the use of SP36 fertilizer by 10% will increase potato production by 1.893%. Consistent with Yanuar Fitri (2023), Maulidia *et.al* 2024, and Maryanto (2018), the application of SP 36 fertilizer not only has a significant effect on the productivity of potato farming businesses, but also determines the quality of the production produced.

Fertilizer variables KCl (X5), Rukmana, R (1994), Maryanto (2018), Soemantri, R *et.al* (2014). KCl fertilizer affects vegetative growth and plant resistance to pests and diseases. The application of this fertilizer has a positive and significant effect on the productivity of potato farming. Consistent with the results of this study, the application of KCl fertilizer has a positive and significant effect on potato farming production with a production elasticity of 0.0571. It indicates that the use of KCl fertilizer by 10% will increase potato production by 0.571%. Consistent with Ali, RM (2020), Zulkarnian and Yusdiana (2022), and Maryanto (2018) that the application of KCl fertilizer is classified as a determinant factor for the productivity of potato farming. In this regard, Sahara, *et.al* (2023), optimizing the use of KCl fertilizer is one of the main requirements for maximizing the productivity of potato farming.

The variable of organic fertilizer (X6), Soemantri, R *et.al* (2018) that organic fertilizers usually receive less attention in the allocation of their use by farmers. This organic fertilizer with the best management will improve the soil structure which allows for better plant growth. The application of organic fertilizers is appropriate and timely in addition to increasing productivity and also improving the quality of production produced. The results of the study were obtained that the use of organic fertilizers was positive and had a significant effect on production with a production elasticity of 0.0816. Indicating that an increase in the allocation of organic fertilizers of as much as 10% will increase production by 0.816% assuming the use of other input factors is in a constant state. Consistent with Maulidia *et.al* (2024), Maryanto (2018) that the production response of potato farming businesses is significantly influenced by the allocation of organic fertilizers.

The use of drugs and labor will increase potato production. The drug variable (X7) showed an elasticity value of 0.0758 Labor use (X8) with a production elasticity value of 0.0611. This means that an increase in the use of drugs and labor by 10% will increase potato production by 0.758% and 0.611%, respectively. This is in line with the research conducted by Nainggolan (2011) which shows that labor has a real effect on increasing potato production in Kerinci Regency with a production elasticity value of 0.1032. Meanwhile, research by Ahmad (2004), Maryanto (2018) and Ali RM (2020) found that the use of drugs and labor was positive but had no real effect on increasing potato production with an elasticity value of 1.087.

In the estimation of the combined production function model with a *dummy* value  $\sum \beta_i = 0.9096 < 1$  (one). The production stage is in area II, which is the decreasing return to scale area. It indicates that potato farming is experiencing a decreasing scale of production increase. Indicating that an increase in the use of inputs by 10% will increase production (*output*) by 9.091%.

### Technical Efficiency Level of Potato Farming

Technical efficiency describes the performance of farmers in achieving productivity produced by farming (Nainggolan et.al 2024). The estimated level of technical efficiency of potato farming can be seen Table 4.

**Table 4. Efficiency Level of Potato Farming in Research Areas in 2024**

Potato Farming	Actual Production (Y)	Produksi <sub>ET</sub>	Potensial (Y <sub>Pot</sub> )
Varietas <i>granola</i>	15.560,64	25.751,43	0.6042
Varietas <i>cipanas</i>	13.876,32	20.627,75	0.6727
Combinations non <i>Dummy</i>	14.453,85	20.835,16	0.6937
Combination with <i>Dummy</i>	14.453,85	22.614,28	0.6391

Table 4 shows that the level of technical efficiency of potato farming is relatively low. The level of technical efficiency of a farming is said to be efficient when approaching *the frontier* (TE-1) and the magnitude of the TE is > 0.70 (Nainggolan, 2023). The low level of technical efficiency reflects the farmer's managerial skills are quite low. The low level of engineering efficiency means that the opportunity to increase its productivity is even greater because the productivity gap that has been achieved with the maximum productivity that can be achieved is huge.

The value of technical efficiency of potato farming of *granola* varieties TE = 0.6042 or a production achievement of 60.42% of frontier production. Indicates an opportunity to increase productivity by 39.58%. Frontier production can be achieved by optimizing the use of potato farming production inputs. Research conducted by Yanuar, F and Nainggolan, S (2022) with the DEA model "showed that the average TE value achieved was 0.8918 with the lowest TE value of 0.7708 and the highest TE value of 0.9698, indicating that all farmers relatively reached the maximum TE value. The efficiency figure of 89.18% means that the average farmer can achieve a non-89% of the production potential obtained from a combination of sacrificed production inputs and the opportunity to increase potato production by 11%.

The value of technical efficiency of potato farming of *the Cipanas* TE variety = 0.6722 or a production achievement of 67.22% of frontier production. Indicates an opportunity to increase productivity by 32.78%. Frontier production can be achieved with optimal use of production inputs. The rest is needed for new technological innovations to increase the productivity of potato farming. According to research conducted by Ahmad (2010) on "Factors Affecting Technical Efficiency" shows that the average farmer in the study location has been technically efficient with an average technical efficiency of 0.920 and the factors that affect technical efficiency are the age of the farmer and the farmer's education, but the effect is not significant.

When viewed from combined farming, the value of technical efficiency in potato farming in the research area with dummy varieties being cultivated, the level of potato farming efficiency obtained TE = 0.6391 or a production achievement of 63.91% of frontier production. Indicating an opportunity to increase productivity by 36.09%. Meanwhile, the level of technical efficiency without differentiating the type of variety that farmers are trying to achieve TE = 0.6932 or a production achievement of 69.12% of frontier production. Indicating an opportunity to increase productivity by 30.88% Nainggolan et.al (2023), that although technical efficiency is relatively low, potato farming still has high competitiveness both in terms of comparative advantage and in terms of competitive advantage

### CONCLUSION

The best functional model among the three Cobb-Douglas, Transcendental, and Inversion-log models of production functions that is able to describe the physical relationship between inputs and outputs of potato farming is logically, factually, and theoretically correct is the Cobb-Douglas model of production functions. The value of the determination coefficient of adj-R2 = 0.8566 [85.66 %] for *granola* potato farming and the determination coefficient of adj-R2 = 0.8972 [89.72 %] for *cipanas* variety farming. The value of the determination coefficient of the production function model with the variety type dummy was obtained with a high adj-R2 value and the t-test of each significant predictor variable. The production response of potato farming for the two types of *granola* and *cipanas* varieties is significantly influenced by changes in land use, seeds, urea fertilizers, SP 36 fertilizers, KCl fertilizers and organic fertilizers. The level of technical efficiency of the two groups of *granola* and *cipanas* potato farming varieties is still relatively low, indicating that the potential or opportunity to increase productivity is still very large.

To improve the technical efficiency of potato farming, it is necessary to use production inputs proportionately by paying attention to the results of the estimated parameters of the production function model used. Increasing productivity with technological innovation through an Integrated Management approach which includes allocation, use of seedlings with adaptive and quality varieties, balanced fertilization, and integrated pest and disease control.

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