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Estimation of the profit function of Trans log and the elasticity of input demand in rice farming in Jambi province

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Abstract

This study aims to analyze the development of input and output prices, the translog profit function, and the elasticity of demand for lowland rice farming inputs in Jambi Province. The function model used is the Transcendental Logarithmic (Translog) profit function. The study results show that

- The development of input prices has increased significantly every year.
- The production input factors that affect the profitability of lowland rice farming are the price of seeds, TSP fertilizer, and other chemical fertilizers (KML). Other production factors such as urea fertilizer prices, pesticide prices, labor wages, and land rental costs are determinant factors.
- The value of the elasticity of demand for inputs to their prices is elastic.

All cross-price elasticity of demand is complementary and elastic. The value of the elasticity of input demand which is influenced by the price of rice shows a positive and elastic value. From the results of the study, it is expected that there will be capital assistance for farmers so that farmers can allocate optimal use of inputs.

Keywords: Elasticity; Trans log Profit Function; Demand; Paddy Rice

1. Introduction

The food crop sector is a producer of strategic commodities in the form of rice which is the staple food for most of Indonesia's population. Food crops are one of the agricultural sub-sectors that are a priority for Jambi Province to be developed regularly to increase production and income of the agricultural sector. One of the food crop commodities that are still a mainstay for Jambi Province is rice. Jambi Province is one of the national rice production centers with a contribution of 5 percent in 2010 and 5.8 percent in 2020 (Central Bureau of Statistics, 2021). When viewed from the productivity of Jambi Province, Bungo Regency has the fifth largest productivity in 2015 and in 2020 it will be the third largest after Kerinci and Sungai Penuh districts. Increased production and productivity of lowland rice farming in Jambi Province are expected to increase farmer profits in Jambi Province (Central Bureau of Statistics, 2020).

In Indonesia, rice is cultivated by about 18 million farmers and accounts for 66 percent of the Gross Domestic Product (GDP) of food crops. In addition, rice farming provides employment and income opportunities for more than 21 million households with a contribution of 25-35 percent of income. Therefore, rice remains a strategic commodity in the economy and national food security, so that it becomes the main basis for future agricultural revitalization (BALITBANG, 2020). Research on lowland rice states that the productivity of lowland rice in Indonesia reaches 7 tons per hectare (Hasibuan, 2018). However, the productivity of lowland rice in Jambi Province has not yet reached that number. The

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low productivity rate occurs because of the alleged use of input factors that have not been optimal so which will affect farmers' profits.

A factor of production is "demanded" because it is needed in a production process. The production process is carried out for a reason, namely because there is a demand for the resulting output. So the demand for input arises because of the demand for output. Demand for inputs is a derivative demand because these inputs will be used in producing a certain output, so the number of input requests depends on the output scale to be used. The factors that affect the demand for inputs are the price of the input itself, the cross price, the price of the output, and the elasticity of the profit function. The factor of input prices, cross prices, and grain output prices are factors that are always faced by farmers in various regions, both nationally and regionally, including in Jambi Province which affect input demand and will have an impact on the farmer's profit function, so that the use of production factors must be carried out efficiently.

2. Research methods

This research was conducted within the scope of Jambi Province using time series data on the development of input and output prices for rice farming, from 1979 to 2020. The analysis model uses the Transcendental Logarithmic Profit Function (Translog).

In general, the form of the Transcendental Logarithmic (Translog) function introduced by Christiansen, Jorgenson, and Lau (1973) as quoted by Agustian & Hartoyo (2012) is as follows:

$$\text{In } \pi^* = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \text{ In } P_i^* + 0{,}5 \sum_{i=1}^{n} \sum_{k=1}^{n} y_{ik} \text{ In } P_i^* \text{In} P_j^* + \sum_{i=1}^{n} \sum_{k=1}^{n} \delta_{ik} \text{ In } P_i^* \text{In } Z_k + \sum_{k=1}^{m} \beta_k \text{In} Z_k + 0{,}5 \sum_{k=1}^{m} \sum_{j=i}^{n} \emptyset_{kj} \text{ In} Z_k \text{In} Z_j$$

Information:

In = Natural logarithmic.
π* = Profit = (TR-TC), which is normalized to the price of rice output (Py).
Pi* = Variable input prices (price of seed, price of urea fertilizer, price of TSP fertilizer, price of other chemical fertilizers (KML), pesticide prices, and labor wages) normalized by rice output prices (Py), with i=1,2 ,3,4,5,6, respectively, namely the price of seeds, the price of urea fertilizer, the price of TSP fertilizer, the price of other chemical fertilizers (KML), the price of pesticides and the wages of labor.
Z_k = Fixed input (ki-k) in this case the fixed input is the cost of land rent.
α_0 = Constant.
α_1, βij, δik, ρk, δkl = Parameter input variable to the expected profit.
βij = ij for all I and j, and the function is homogeneous with degree one concerning input prices (price of seed, price of urea fertilizer, price of TSP fertilizer, price of other chemical fertilizers (KML), pesticide price, labor wages, and land rent costs) and rice output.

The elasticity of input demand (price of seed, price of urea fertilizer, price of TSP fertilizer, price of other chemical fertilizers (KML), pesticide prices, labor wages, and land rental costs) to own price (Eii):

$$E_{ii} = -S_i^* - 1 - \frac{\beta_{ii}}{S_i^*}$$

The elasticity of demand (cross) for inputs (price of seed, price of urea fertilizer, price of TSP fertilizer, price of other chemical fertilizers (KML), pesticide prices, labor wages, and land rental costs) to other input prices (Eij):

$$E_{ij} = -S_j^* - 1 - \frac{\beta_{ij}}{S_j^*}$$

The elasticity of input demand (price of seed, price of urea fertilizer, price of TSP fertilizer, price of other chemical fertilizers (KML), pesticide prices, labor wages, and land rental costs) to the price of rice output (Eiy):

$$E_{iy} = \sum_{i=1}^{n} S_i^* + 1 + \sum_{j=1}^{n} \frac{\beta_{ij}}{S_j^*}$$

3. Results and discussion

3.1. Development of Input and Output Prices of Rice Farming

The development of input and output prices for lowland rice farming in Jambi Province during the period 1979 to 2020 always increases every year. Based on the data, it can be seen that the highest average price of grain occurred between 2009 and 2020, which was Rp. 4761 per kg. Technical factors that affect the selling price of farmers' grain are labor wages and fertilizer costs. Non-technical factors that affect the selling price of farmers' grain are weather conditions, agents, and harvest time. The price policy instruments are the floor price policy for grain and the ceiling price for grain, with the consequence that the government will incur whatever costs are needed to implement the price policy.

The price of rice seeds from 2009 to 2020 is an average of Rp. 8340 per kg. According to BALITBANGTAN (2021), two factors cause changes in the price of paddy rice seeds. First, the demand for seeds increases every growing season and results in a shortage of seed stocks at the merchant level. Second, due to the lack of labor to produce rice seeds, most farmers prefer to produce rice and not produce rice seeds. Fertilizers are divided into three types of fertilizers, namely urea fertilizer, TSP fertilizer, and other chemical fertilizers (KML). The price of urea fertilizer from 2009 to 2020 continues to increase. The average increase in the price of urea fertilizer every year is 8.84 percent. The average price of urea fertilizer from 2009 to 2020 is Rp. 2610. For the development of TSP fertilizer prices from 2009 to 2020, it is Rp. 2648. The price development of chemical fertilizers other than urea and TSP is no different from the price development of urea and TSP fertilizers and continues to increase every year. The highest average price occurred from 2009 to 2020 at Rp.2789. The three types of fertilizers are subsidized fertilizers.

Pesticides are substances used to control various pests. The development of pesticide prices will determine the difference in the ratio between rice output prices and pesticide input prices. The development of pesticide prices from 1979 to 2020 increased by 9.5 percent. The development of labor wages will determine the cost component in the total cost of farming. . In Jambi Province, wages increased by 4.52 percent per year. The development of land rental costs in the form of a profit-sharing system will determine the cost of the input component of lowland rice farming.

3.2. Overview of Farmers' Characteristics in Research Area

The identity of the farmer is seen from several aspects, namely the age of the farmer, the number of dependent family members, education level, farming experience, land area owned, type of irrigation, main occupation, and side work are some of the factors that influence farmers' decisions in managing their farming business. From the results of research on 60 lowland rice farmers in the study area, the age of farmers ranged from 30 to 72 years. The majority of farmers who cultivate lowland rice in the study area are farmers who are of productive age. This statement is supported by the statement of Hernanto (2006), productive age is the age of 15-60 years. The number of family members will affect the level of work productivity associated with the amount of use (contribution) of labor to farming production activities. Based on the results of the study, it is known that the respondents have an average of five members in one family head. Based on the level of formal education, most farmers attend elementary school (SD) as much as 61.66 percent, farmer's education equivalent to junior high school (SLTP) as much as 26.66 percent, while for senior high school (SLTA) as much as 13.33 percent.

The decision of farmers in the study area to use local rice seeds is a decision that has been considered both from an economic point of view. Lowland rice farmers choose to use local varieties because the selling price of paddy rice seeds at the production and production shop is quite expensive, which is around Rp. 8000 per kg. The average use of urea fertilizer by farmers in the study area for lowland rice plants is 74.47 kg per 0.89 ha or equivalent to 83.67 kg/ha. According to the Center for Rice Research (2015), the average use of urea fertilizer is around 60-110 kg/ha, so the use of urea fertilizer in the research area is still relatively low. The average use of labor in lowland rice farming in the study area per planting season is 94 HOK/ha. Based on the average use of labor in lowland rice farming above, a lot of labor is devoted to land processing activities with a percentage of 50.85 percent.

3.3. Profit Function Estimation Results

Estimation of the profit function can be done directly through the translog profit function (transcendental logarithm) and indirectly through the share function of the output and input variables. A direct estimation can be made if the number of observations is more than the number of predicted parameters, on the other hand, indirect estimation is carried out if the number of observations is smaller than the number of predicted parameters. The number of parameters estimated in this study is less than the number of observations, so the estimation of the profit function can be done directly. To find out the factors that affect the profitability of lowland rice farming in the study area, the translog profit function (transcendental logarithm) is used. In this study, the factors that are thought to affect the profits of

lowland rice farming are the price of seeds, the price of urea fertilizer, the price of TSP fertilizer, the price of other chemical fertilizers (KML), the price of pesticides, labor wages, and land rent costs.

Table 1 Result of analysis of coefficient of determination of profit function of rice farming by using translog profit function (Transcendental Logarithm)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.825	0.8367	0.829	0.1463	1.357
Predictors: (Constant), Inx1, Inx2, Inx3, Inx4, Inx5, Inx6, Lnxz, Inx1x2, Inx1x3, Inx1x4, Inx1x5, Inx1x6, Inx1z, Inx2x3, Inx2x4, Inx2x5, lnx2x6, lnx2z, lnx3x4,lnx3x5, lnx3x6, lnx3z, lnx4x5, lnx4x6, lnx4z, lnx5x6, lnx5z, lnx6x6, lnx6z					

Dependent Variable: InY

Table 1 shows that the coefficient of determination Adj.R2 is 0.8293. The precision of the estimated model is 82.93 percent. This value illustrates that 82.93 percent of the dependent variable (profit) can be explained simultaneously by independent variables (seed prices, urea fertilizer prices, TSP fertilizer prices, prices for other chemical fertilizers (KML), prices for pesticides, labor costs, and land rent) are included in the equation at the 99 percent confidence level. While the remaining 17.07 percent is caused by the influence of other factors outside the model

In this study, because the profit function starts from the center point (transcendental properties), the coefficient of determination used is the value of Adj.R2. The value of coefficient b uses Unstandardized Coefficients because the variables used are mostly partially significantly different and very significant. While the value of the coefficient b based on the Standardized Coefficients (β) is not quite different.

Estimation of parameters in this study using the profit function equation output unit price (OUP) which is estimated based on the method of Zellner (1962). The Durbin Watson (DW) test was performed to test the presence or absence of autocorrelation. The results of processing (Table 1) on the profit function obtained a DW value of 1.408. The significance limit of the null hypothesis that there is no autocorrelation at the 1 percent confidence level is between 1.06 and 2.94. This means that in the profit function equation there is no autocorrelation. The results of the profit function of the output unit price (OUP) of lowland rice farming in Jambi Province are presented in Table 2.

Table 2 Result of estimation of profit function of rice farming with translog profit function approach (Transcendental Logarithm)

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	4.258	1.943		2.191	0.032
Lnx1	1.236	1.500	0.121	0.824	0.413
Lnx2	-3.477	1.236	0.203	-2.813	0.001
Inx3	-4.832	1.528	-0.844	-3.163	0.002
Inx4	-4.278	1.972	1.172	-2.170	0.034
Inx5	-4.217	1.578	-1.901	-2.673	0.010
Lnx6	-2.832	1.343	1.763	-2.108	0.037
Lnxz	-2.633	1.211	-1.832	-2.174	0.016
Inx1x2	-0.306	1.490	-0.055	-0.205	0.838
Lnx1x3	-0.987	1.235	0.852	-0.799	0.054
Lnx1x4	-2.665	0.964	-1.874	-2.766	0.000
Lnx1x5	-2.763	0.823	-1.856	-3.357	0.000
Lnx1x6	-2.776	0.954	1.334	-2.909	0.000

Lnx1z	-0.876	0.215	0.877	-4.074	0.000
Lnx2x3	-0.665	1.112	-0.123	-0.598	0.468
Inx2x4	-0.554	1.691	-0.152	-0.328	0.744
Lnx2x5	-1.742	0.435	-1.626	-4.004	0.000
Lnx2x6	-0.335	1.032	-0.343	-0.324	0.126
Lnx2z	-0.615	1.362	-0.572	-0.451	0.435
Lnx3x4	-0.965	0.183	-0.952	-5.273	0.000
Inx3x5	3.312	1.273	1.212	2.601	0.012
Inx3x6	-1.604	0.326	-1.357	-4.914	0.000
Inx3z	0.848	0.359	1.162	2.362	0.022
Inx4x5	-2.978	0.714	-1.821	-4.171	0.000
Inx4x6	0.987	0.229	0.960	4.312	0,000
Inx4z	0.458	0.356	0.822	1.289	0.202
Inx5x6	0.864	0.299	1.135	2.886	0.005
Inx5z	-0.565	0.108	-1.928	-5.228	0.000
Inx6x6	0.195	0.086	0.521	2.273	0.027
Inx6z	-0.000310	0.056	-0.001	-0.006	0.996

Table 2 shows that the constant value c = 0.556 indicates the value of technical efficiency and is classified as low because of ET < 0.7. Opportunity to increase profits by 44.4 percent The regression coefficient Lnx1 is -1.236, meaning that every 10 percent increase in seed prices will reduce profits by 12.36 percent. On the other hand, every 10 percent decrease in seed prices will increase profits by 12.36 percent, assuming other variables are ceteris paribus. Likewise other variables such as the price of TSP fertilizer, the price of other chemical fertilizers (KML), the price of pesticides, and a combination of other inputs. Every one percent increase (decrease) in input prices will decrease (increase) the profit percentage by the value of the regression coefficient. Based on Table 2, the profit function shows the effect of the input price itself on profits whose coefficient is negative, and is as expected. The negative sign means that an increase in the allocation of input costs due to an increase in the price of the input itself will reduce profits. Production input factors, especially the price of urea and SP 36 fertilizers are the determinants of productivity and production risk, (Nainggolan et al., 2021) and Nainggolan (2019..b)., Alfiati, S (2011).

3.4. Estimated Result of Input Demand Elasticity

Debertin (1981), that the demand for variable inputs can vary depending on the price of the input itself or the price of other variable inputs. The percentage change in quantity demanded due to a change in the price of an input is called the elasticity of demand for the input price. This elasticity occurs on own price elasticity (own elasticities) and cross-price elasticity (cross elasticities). From the use of six input variables, namely seeds, urea fertilizer, TSP fertilizer, other chemical fertilizers, pesticides, and labor, 42 values of the elasticity of demand were produced, consisting of 6 self-price elasticity and 36 cross elasticity. Based on the estimation results, the elasticity of input demand can be seen in Table 3.

Table 3 Input demand elasticity value

	P-Seeds	**P-Urea**	**P-TSP**	**P-KML**	**P-Pest**	**P-Labor**	**P-Rice**
Seeds	-1.972	-1.683	-2.756	-1.953	-13.521	-1.223	3.862
Urea	-4.572	-62.321	-1.231	-4.563	-21.452	-2.223	3.675
TSP	-3.521	-3.235	-5.617	-5.825	-19.750	-0.935	4.362
KML	-3.463	-3.567	-5.326	-4.347	-25.153	-1.162	2.223
Pest	-0.635	-0.762	-0.715	-0.768	-5.264	-0.112	3.112
Labor	-0.825	-0.836	-0.532	-0.541	-4.35	-9.632	3.423

Table 3 shows that the elasticity of demand for inputs of seeds, urea fertilizer, TSP fertilizer, other chemical fertilizers (KML), pesticides, and labor wages to the input price itself is all negative, this is following the theory of the law of demand, namely the higher the price, the higher the price. demand for these inputs will decrease. The value of the elasticity of demand to own prices for seeds, urea fertilizer, TSP fertilizer, other chemical fertilizers (KML), pesticides, and labor is elastic. This means that the effect of changes in input prices is very influential on the demand for the input itself. By looking at the response of the input demand itself to the price, it can be seen that the elasticity of demand for urea fertilizer shows the highest number, which is 93.5. This means that changes in urea fertilizer prices are more responsive to farmers, followed by labor wages, TSP fertilizer prices, pesticide prices, other chemical fertilizer prices (KML), and seed prices.

The cross-price demand elasticity values caused by changes in the prices of other inputs as shown in table 3 are all elastic. Complementary and significantly different relationships were also found in Diana's (2000) study, namely between seeds, urea fertilizer, TSP fertilizer, pesticides, and labor, but other chemical fertilizers (KML) were substituted. This is also in line with Fauzia's (2006) research which found that most of the cross-elasticity values were complementary, except for labor and TSP fertilizers which were substitutes.

The value of the elasticity of input demand due to changes in output prices is elastic, this means that the effect of changes in lowland rice output prices is large on input demand. All signs of elasticity of input demand due to changes in output prices are positive as expected, meaning that rising rice prices tend to stimulate farmers to use more inputs. The biggest influence due to changes in rice prices is the demand for urea fertilizer following TSP fertilizer, pesticides, seeds, other chemical fertilizers (KML), and labor at 2.33; 2.10; 2.06; 1.70; 1.36; and 1.34. Farmers are very responsive to input demand due to changes in rice prices, especially for urea fertilizer. This means that if there is an increase in rice prices, farmers will increase spending to buy urea fertilizer in the production process. The high estimation value is probably because urea fertilizer is an important component in lowland rice farming to increase production yields.

This research is in line with the research conducted by Diana (2000) which results in the elasticity of input demand due to changes in rice prices for seed input of 1.131; urea fertilizer of 1.12; other chemical fertilizers amounted to 0.975; and pesticides by 2.5. Fauzia (2006), obtained the value of the elasticity of demand for the largest input at the price of seed, which is 1.497; other costs of 1.125; workforce of 1,071; urea fertilizer of 1.046; and 1,030 TSP fertilizer.

4. Conclusion

The development of input and output prices for lowland rice farming in Jambi Province has increased significantly every year. Production inputs that affect the profit function of lowland rice farmers are the price of seeds, TSP fertilizer, and the price of other chemical fertilizers (KML). Other production factors such as urea fertilizer prices, pesticide prices, labor wages, and land rental costs based on the regression results are in the exclude variable table, which means that the level of input prices will not affect the demand for these inputs. The elasticity value of input demand (price of seed, price of urea fertilizer, TSP fertilizer, price of other chemical fertilizers (KML), pesticide prices, labor wages, and land rental costs) to own prices is elastic which means that the effect of changes in input prices is very influential to the input request itself. All of the cross-price demand elasticity values show complementary and elastic properties. The value of the elasticity of input demand (price of seed, price of urea fertilizer, TSP fertilizer, price of other chemical fertilizers (KML), pesticide prices, labor wages, and land rental costs) which is influenced by rice prices shows a positive value and is elastic. The policy scenario is an increase in farmers' rice prices so as to motivate farmers to use more production inputs according to the optimal line and capital assistance.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest available for this research.

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