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Economic Efficiency and Determinations; Rice Production in the Karo Regency

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The purpose of this study to find out if the factors of production could contribute to production or income, and the cost of rice production, the economic efficiency of rice production. It is hoped that the result of this study could give information to farmers and local government in the Karo Regency, about the contributions of the factors of production to the production or income and the cost of rice farm operation production. From the study, it is shown that the characteristics of the model of production, the using of the factors of production, and the cost of production opportunity is increasing returns to scale or decreasing cost industries. The economic scale of rice production describes that the estimated cost of rice farm production. The analysis of economic efficiency from rice production was taken from the condition that the production's marginal cost is lower than the corn scale. From the contributions of field, seed, fertiliser, and labour toward rice production, it can be explained that rice production can be raised by increasing the field, seed, fertiliser, and labour.

Key words: *Rice Production, Rise Cost Production, Efficiency of rice production.*

Introduction

The main objective of Indonesian development is to provide welfare and wealth for all Indonesian people (Tanjung, et al, 2017; Tanjung, et al, 2019). One indicator to see the achievement of these objectives is the value of a country's gross domestic product (GDP). A country's economy is said to be in good condition if it has a high GDP value. In Indonesia, one of the biggest contributors to forming gross domestic product is the agricultural sector (Pudaka, et al. 2018). Indonesian agricultural commodities make a positive contribution to the trade balance index (Ervani,2013). One area that is very famous for its agriculture is the Karo

Regency, North Sumatra Province. Agriculture is an important sector in the Karo Regency. The sector contributed about 56,90% of the GDP by industrial origin at current market prices for 2012-2016 (Statistics of Karo Regency, 2017). Agriculture is divided into some sub-sector such as food plants, plantations, fisheries, and forestry sectors. The scope of the food crops sub-sector includes paddy maize and horticulture such as cassava, sweet potatoes, peanuts, and soybeans. Paddy production in 2006 noted dry land paddy is 33.812 tons it and increases if compared with the result in 2015 is 22.952 tons. Wetland paddy production is 110.175 in 2016, which increases if compared with the result in 2015 about 106.436.

Table 1: Production and Productivity Wetland Paddy in Karo Regency year 2011-2016

Year	Wetland Paddy		
	Area (Ha)	Production (Ton)	Productivity
2011	14298	79738	55,77
2012	16997	95447	56,17
2013	15407	87118	56,54
2014	17227	88831	52,94
2015	17920	104668	58,41
2016	19479	110175	56,56

Source: Agriculture Service of Karo Regency

The classical problem of agricultural systems in general is the limited capital of farmers in developing their farming. Likewise, rice farming requires a certain amount of capital from land rent, seed, labour, fertiliser, medicines, maintenance, and harvest. The size of the capital obtained by the farmers affects the area of rice farming farms managed. In addition to the availability of capital for the way rice farming is done, the management is not optimal. Therefore, the general problem in rice production is the efficiency of farming that can give benefits to farmers. The efficiency of rice farming will ultimately affect rice investment in rice cultivation.

Efforts to increase rice production can be done through increased use of production technology and planting area expansion. The use of technology in the form of fertilisation, medicines, superior seeds, and expansion of planting areas will accelerate rice self-sufficiency. The important questions related to the rice production centre of the Karo Regency is; is rice farming in the Karo Regency efficient and profitable for the farmers? The answer to this question requires a scientific study.

Concerning the above issues, the authors are interested in analysing the efficiency of rice farming in the Karo Regency with the problem: (i) How does the contribution of production factors to the production or income of rice farming, (ii) How is the contribution of input costs to total rice production costs and (iii) is rice farming in the Karo Regency efficient?

Literature Review

The Concept Of Farm Efficiency

Efficiency is a very important factor in productivity growth. The efficiency of rice farming is determined by factors of production and technology cultivation. The factors of production of rice farming consist of land, seed, fertiliser, medicine, and labour. The combination of production factors and rice cultivation technology will determine how much rice production or income will be. At the minimal cost condition of rice farming and production price, the price of production factors, and the price of certain cultivation technology, the farmer will get maximum profit. In other words, rice farming with minimal cost also means maximum profit or rice farming with maximum profit also means minimal cost.

Then the profit-maximisation problem facing the farm can be written as $\max_{x_1} pf(x_1, \bar{x}_2) - w_1 x_1 - w_2 \bar{x}_2$. The condition for the optimal choice of factor 1 is not difficult to determine. It x_1^* is the profit-maximising the choice of factor 1, then the output price times the marginal product of factor 1 should equal the price of factor 1. In symbols, $pMP_1(x_1^*, \bar{x}_2) = w_1$ In other words, the value of the marginal product of a factor should equal its price (Varian, 2010).

The function of rice production is a production process technology with a combination of cultivation technology (nursery, land preparation, planting, maintenance) with production factors (land, seed, fertiliser, medicine, and labour). The rice production function specification is assumed to follow the Cobb-Douglas production function. The important properties of the Cobb-Douglas production function are; the marginal rate of marginal substitution, diminishing returns of production factors and rice cultivation technology. The production of rice uses a variety of factors of production so that the Cobb-Douglas production function is formulated in the form of technological diffusion (Spence, 1976; Dixit and Stiglitz 1977; Ehtier 1982; Romer 1986: 1990)

$$Q_j = A \; L_J^{\;1-\beta} \; \sum_{j=1}^{Nom} K_j^{\;\beta} \qquad (1)$$

Where:
Qj= quantity of rice product,
A = productivity parameters of rice cultivation technology,
Lj = labour quantity of rice farming,
Nom = variability of rice production factors,
Kj = quantity of j - a factor of production,
j = 1, 2, ..., N, and 0 < β < 1.

If (NOM) is a type or variety of rice production factors available at a certain price then rice farmers are motivated to use all factors of production. The use of all factors of production will produce a balance Kj = Kj, so the production function (1) changes to:

$$Q_j = A\ L_j^{\ 1-\beta}\ (NOM\ \ K_j)^{\ \alpha}\ \ NOM^{\ 1-\beta} \qquad (2)$$

The production cost of rice farming is the sum of the cost of cultivation technology and the cost of production factors, namely:

$$C_j = FC + W \times L_j + PFB \times (NOM \times K_j) \qquad (3)$$

Where Cj (the cost of rice farming), FC (fixed cost of cultivation technology), W(wage rate or labour income), and PFB(factor prices of production).
To minimise production cost, the production cost function in the form of Lagrange function (Chiang and Wainwright, 2005), namely:

$$C_j = FC + W \times L_j + PFB \times (NOM \times K_j) + \lambda[Q_j - A\ L_j^{\ 1-\beta}(NOM \times K_j)^{\beta}\, NOM^{1-\beta}] \qquad (4)$$

The necessary condition of minimum cost (4) is

$$\frac{\partial Cj}{\partial Lj} = W - [(1-\beta)A\ Lj^{-\beta}(NOM \times Kj)^{\beta}\, NOM^{\ 1-\beta}]\ \lambda = 0 \quad \frac{\partial Cj}{\partial Kj} = PFB \times NOM - [\alpha A\ Lj^{1-\beta} Kj^{\beta-1} NOM]\ \lambda = 0$$

From the equation is obtained the balance so that the optimal conditions of use of factors of production are:

$$Lj = \frac{(1-\beta)PFB \times NOM \times Kj}{\beta\ W} \qquad (5)$$

Equation (5) is called the expansion line of production that is the combination of labour (LUJ) with other factors of production under minimal cost conditions (Pindyck and Rubinfeld, 1995).

Substitution (5) to (2) will result in optimal use of various factors of production, namely:

$$Kj = \frac{1}{A}\left[\frac{1-\beta}{\beta}\right]^{\beta-1} PFB^{\ \beta-1}\ W^{\ 1-\beta} NOM^{\ 2-\beta} Qj \qquad (6)$$

Substitution (6) to (5) will result in optimal labour usage conditions, namely:

$$Lj = \frac{1}{A}\left[\frac{1-\beta}{\beta}\right]^{\alpha-1} PFB^{\ \beta}\ W^{\ -\beta} NOM^{\ 3-\beta} Qj \qquad (7)$$

The optimal conditions of labour utilisation (Lj)] and factors of production (Kj) will ensure the minimal cost of rice farming. Substitutions (6) and (7) to (3) will result in a minimum production cost condition for rice farming, namely:

$$Cj = FC + \frac{2}{A}\left[\frac{1-\beta}{\beta}\right]^{\beta-1} W^{1-\beta} PFB^{\beta} NOM^{3-\beta} Qj \qquad (8)$$

From (8) it is shown that the efficiency of rice farming is indicated by the large coefficient (β) and coefficient (1-β). This means that the cost-efficiency of rice farming is achieved if the coefficient (0 <β < 1), but the overall efficiency of rice farming if the rice farming produces profit in the short term.

Assuming that the price of rice product, the price of cultivation technology and the price of production factors are given to the farmers, the efficiency of farming is formulated as follows:

Revenue : $Rj = Pj \times Qj$ (9A)

Cost : $Cj = FC + \frac{2}{A}\left[\frac{1-\beta}{\beta}\right]^{\beta-1} W^{1-\beta} PFB^{\beta} NoM^{3-\beta} Qj$ (9B)

Maximum profit is achieved when marginal revenue (MRj) equals the marginal cost (∂Cj / ∂Qj),

$$Pj = \frac{2}{A}\left[\frac{1-\beta}{\beta}\right]^{\beta-1} W^{1-\beta} PFB^{\beta} NOM^{3-\beta} \qquad (10)$$

if

$$Pj \succ \frac{2}{A}\left[\frac{1-\beta}{\beta}\right]^{\beta-1} W^{1-\beta} PFB^{\beta} NOM^{3-\beta}$$

Then farmers will increase rice production by increasing the rice production area so that the marginal cost of rice production rises to reach the market price of rice product, and if

$$Pj \prec \frac{2}{A}\left[\frac{1-\beta}{\beta}\right]^{\beta-1} W^{1-\beta} PFB^{\beta} NOM^{3-\beta}$$

then farmers will experience losses and will reduce the area of rice production.

Methodology

The research was conducted using a survey method in the Karo Regency. Sampling was conducted by a purposive sampling method on 138 farmer respondents. The data was analysed qualitatively and quantitatively. Qualitative analysis was used to describe the circumstances related to the research problems that cannot be described quantitatively. Quantitative analysis was performed with the Cobb-Douglas function and analysis of the efficient use of factors of production.

Mathematically, the Cobb-Douglas equation can be written as follows:

$$Q_R = Q_R[HA, S, F, L] \qquad (11)$$

Where:

Q_R (Total rice production [kg]), HA (Harvest Area, Ha), S (Seed, Kg), F (Fertilizer, kg), and L (Labor, People).
As for the model of production cost analysis used model as follows:
C_R = CB [PFB, W, QB] (12)
Where, C_R (Total production cost of rice farming, Rp), PFB (average price of production factors, the ie total cost of land, seeds, fertilizers, and medicines divided by 3) and W (a price or average wage of labour, that is the amount of labour cost divided by kindergarten, Rp / hours)

Both models are used by the Cobb Douglas model and further elaborated in the econometric analysis model as follows:

$$LNQ_R = \beta_0 + \beta_1 LNHA + \beta_2 LNS + \beta_3 LNF + \beta_4 LNL + \varepsilon_T \quad (13)$$
$$LNC_R = \delta_0 + \delta_1 LNPFB + \delta_2 LNW + \delta_3 LNQ_R + \varepsilon_T \quad (14)$$

Meanwhile, to see how the efficiency of rice is used as follows:

1) Rice farming is said to be efficient if $P \geq \partial C_R / \partial Q_R$,
2) Rice farming is said to be inefficient if $P < \partial C_R / \partial Q_R$.

Result and Discussion

The results showed only 3 types of factors of production used by rice farmers outside of labour, namely land, seeds, and fertilisers. Table 1 shows the variations in land use [HA], seed [S], fertilizer [F], and labour for land processing [L].

Table 2: Average Values and Variances of Production Factor Use

Variable	N	Average	ST. DEV	VARIANCE	MIN	MAX
HA	138	1.6357	0.4645	0.1626	0.3	3.2
S	138	11.545	6.3346	6.5875	3.5	60
F	138	33.270	132.18	21231	97	710
L	138	3.9887	1.3443	3.5591	2.5	5.6

Source: Results of Data processing

Based on table 2 it can be seen that the average land use is 1.6357 with a variation of 0.1626, while the average seed use is 11.545 with a variation of 6.5875, the average fertiliser use is 33,270.

Table 3: Mean value and variance of production factors as well as land and labour

Variable	N	Average	ST. DEV	VARIANCE	MIN	MAX
FPB	138	52211	3253,2	1.34029	3324	25511
W	138	4437.3	879.54	8.080292	2432	7235
Q_R	138	3358.7	3071.5	9.33326	1543	13200

Source: Results of Data processing

Based on table 3 it can be seen that the average FPB is 52211 with a variation of 1.34029, while the average labour wage is 4437.3 with a variation of 8.080292.

The cost of production of rice farming is the sum of land rent, seed, fertiliser, labour for land processing, labour for planting and maintenance, and labour cost for harvest. Rice production costs rice is an opportunity cost because farmers do not necessarily rent land and hire labour to manage rice farming. Revenue of rice farming is the amount of production multiplied by the selling price of rice farmers. The profit of rice farming is the revenue less the opportunity cost of production so that the profit of rice farming is an economic profit.

Results of the Estimation Model

The production function model formulated in the Cobb-Douglas type. Partially, all coefficient of production [Q_R] such as Harvest Area (HA), Fertiliser (F), and Labour (L) is significant at level α = 1 percent except seed (S). Globally also all coefficients are significant at the rate of α = 1 percent because the coefficient of determination [R^2] is quite high. Results Data Processing using Eviews program shown in the following table: Table 4.

Table 4: Results of Production Function Estimation

Dependent Variable: LNQ_R				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.18982	0.4355	57.8411	0.0000
LNHA	0.65543	0.0912	6.00761	0.0000
LNS	0.05431	0.0498	1.09056	0.6580
LNF	0.16539	0.0431	3.83735	0.0000
LNL	0.35432	0.0623	5.68732	0.0000
R-squared	0.97520	F-statistic		438.1533
Durbin-Watson stat	1.435922	Prob(F-statistic)		0.000000

Source: Results of Data processing with Eviews

The coefficient of elasticity of production [Q_R] on the use of land production factors, seeds, fertilisers, and labour utilisation respectively 0.65543 for HA, 0.05431 for seeds, 0.16539 for fertiliser and 0.35432 for labour according to theoretical expectations.

Partially all observed variables were significant at level α = 1% with the degree of confidence 99%, except for seed variable not significant which can be seen from t statistics or P-Value. Similarly, simultaneous factors of production are determined by the four factors, namely harvest area or land, seeds, fertilisers, and labour, which is shown by the value of Test F.

The coefficient determinant of 0, 9752 indicates that the rice production variables can be explained by land, seed, fertiliser, and labour factors of 97.52 percent while the rest of 2.48 percent is explained by other factors that are not applied into the analysis model.
Thus the equation for the rice production function can be formed as follows:

$$LNQ_R = 25{,}19 + 0.6554LNHA + 0.0543LNS + 0.1654LNF + 0.3543LNL$$ or

$$Q_R = \exp[25,.19]HA^{0.6554}\ S^{0.05431}F^{0.1653}L^{0.35432}$$

The total production cost model of rice farming [Rp] (C_R) is determined by the average price of production factors, such as the total cost of land, seeds, fertiliser, and medicines divided by 3 (PFB) and the price or average wage of labour ie the number of labour costs divided by labor [Rp / hours] (W) formulated in Cobb Douglas type. Partially, all coefficient of total production cost (C_R) that is PFB and W significant at level α = 1.

Globally also all coefficients are significant at the rate of α = 1 percent because the coefficient of determination [R^2] is quite high. Results of Data Processing using Eview programs shown in the following table:

Table 5: Results of Cost Function Estimation

Dependent Variable: LNC_R				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNPFB	3.35490	0.1015	33.0532	0.0000
LNW	0.45562	0.0354	12.87062	0.6580
LNQ_R	0.68335	0.0236	28.95551	0.0000
R-squared	0.99101	F-statistic		8532.243
Durbin-Watson stat	1.322922	Prob(F-statistic)		0.000000

Source: Results of Data processing with Eviews

The coefficient elasticity of production cost [C_R] to the average price factor of production factors, namely the total cost of land, seeds, fertiliser, and medicine divided by 3 (PFB) of 3.3549 and the price or wage of the average worker, labour cost divided by labour [Rp /hours] (WAG) equal to 0.45562 and factor of production equal to 0,99101 according to theoretical expectation. Partially, all observed variables were significant at level $\alpha = 1\%$ with a degree of confidence 99% which can be seen from t-test or P-Value. Similarly, simultaneously the factor of production cost is significantly determined by the three factors shown by the value of Test F.

The coefficient determinant of 0, 9901 indicates that the variable cost of rice production can be explained by the factor of the total cost of land, seeds, fertiliser, and medicine divided by 3 (PFB) and the price or wage of the average labour, ie the amount of labour costs divided by labor [Rp / hours] (W) and production factor (Q_R) of 99,01 percent while the rest of 0,99 percent is explained by other factors not included in the model. Thus the equation for the production cost function of rice can be formed as follows:

$$[LNCB = 3.355 LNPFB + 0.455 LNW + 0.683 LNQ_R + e_t]$$

or

$$C_R = PFB^{3.355} W^{0.455} Q_R^{0.683}$$

Analysis of the Economic Efficiency of Rice Farming

An analysis of the economic efficiency of rice farming is achieved under conditions of marginal cost less than or equal to the selling price of rice. In this case, the assumed rice commodity market is the competition market, so maximum profit from rice farming is obtained at condition P >= MC. From the opportunity cost model of rice production obtained marginal cost, that is:

$$\mathbf{MC_R = \partial CB / \partial Q_R}$$
$$\mathbf{= 0.683\ PFB^{3.355}\ W^{0.455}\ Q_RS^{0.317}}$$

From the calculation of the marginal cost of rice production in the Karo Regency are:

$$\mathbf{MCB = 0.683\ PFB^{3.355}\ W^{0.455}\ Q_RS^{0.317}}$$
$$\mathbf{= 0.683\ [11.088]^{3.355}\ [9.5033]^{0.455}\ [8.2345]^{0.317}}$$
$$\mathbf{= Rp\ 11.887,57\ per\ kilogram}$$

The calculation results explain that the marginal cost of rice production [Rp 11.887,57 per kilogram] is much lower than the selling price of rice [Rp 12.000 per kilogram]. In other words, rice farming in the Karo Regency is efficient. The marginal cost of production lower than the selling price of rice explains that the potential of economies of scale can still be exploited.

Conclusions

Analysis of the economic efficiency of rice farming in the Karo Regency, the results of research are the characteristics of the production model, the use of production factors and the production opportunistic cost is decreasing returns to scale or decreasing cost industries, which contributes to the costs of production factors, such as land, and fertiliser and labour to the production opportunity cost respectively 35,55 percent and 45,50 percent. While the production contribution to production opportunity cost is 99,20 percent. The economic scale of rice farming explains that the average cost per unit of rice production tends to decrease as rice production increases.

The analysis of the economic efficiency of rice farming is shown by the marginal cost condition of production is less than the selling price of rice, where the marginal cost of rice production per kilogram is Rp 11.887,57 with the selling price of rice production of Rp 12.000 per kilogram.

Recommendations of this research are:
(1) from the contribution of land, seed and fertiliser and labour to rice production, it is explained that the increase of rice production can be done by increasing the use of land, seeds, fertiliser, and labour;
(2) increased land use, seedlings, fertilisers, and labour will result in increased production or higher revenues from increased production opportunity costs, so that the profitability of rice farmers increases; and,
(3) increasing the variety of rice production factors will also result in increased production or higher revenue from increased production opportunity costs, resulting in higher rice profit or profit.

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