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ECONOMIES OF SCALE AND ALLOCATIVE EFFICIENCY OF RICE FARMING AT WEST SERAM REGENCY, MALUKU PROVINCE, INDONESIA

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ABSTRACT

Economies of scale and allocative efficiency of rice farming has been conducted in technical irrigated field at Kabupaten Seram Bagian Barat – SBB (West Seram Regency), Province of Maluku. This study has the objectives to analyze production factors that affecting production and farming scale level, also technical efficiency and input utilization allocation in rice farming at West Seram Regency, by using linear regression from Cobb-Douglas production function. Result of this study showed that there were three independent variables that has significant effect toward production (Y), that is labor bulk (X6), urea fertilizer (X2) and NPK Pelangi fertilizer (X3) with consecutive elasticity 0,55; 0,19 and 0,11 which means that technical efficiency of this farming has been achieved. Value in return to scale (RTS) with 0,88 showed that increase rate for rice farming at West Seram Regency tend to decrease or decreasing return to scale (DRS), but still within rational production area. Result in allocative efficiency test toward farming input showed ratio MVPxi/Pxi>1, which means allocative efficiency of this farming still not achieved.

Keywords: Rice, Economies of scale, Production function, Allocative efficiency, West Seram, Indonesia.

INTRODUCTION

Arinigsih (2008) suggested that until now, rice is the main food that has greatest contribution (55%) in calories consumption. Irawan *et al*. (2003) and Irawan (2005) also stated that 90% national rice production produced from rice farming. Lots of efforts has been done by the government to secure food production particularly rice through protection toward irrigated wet field, intensification quality improvement, and agricultural optimalization and extensification. This huge step for the government was poured into Agriculture Ministry agenda, that is unhulled paddy (gabah) production targeted 70,6 million ton GKG and rice surplus for 10 million ton in 2014 (IAARD., 2011).

Amount of rice area in the Province of Maluku is not as vast as those in Java, Sumatra, Bali and West Nusa Tenggara. However, rice farming performance in the Province of Maluku was showing a very positive *trend*. Based on BPS data in Province of Maluku within periods of 2001-2011, harvest increase rate is reaching 22,5%/year, production rate 30,1%/year and productivity reaching 4,12%/year. Harvest area for rice in Province of Maluku for year 2011 is 17.779 ha and total production reaching 77.532 ton with productivity average 4,36 GKG t/ha (BPS Maluku, 2011). Four region in rice production center at the Province of Maluku were Central Maluku Regency with 8.439 ha, Buru with 7.053 ha, West Seram Regency with 1.237 ha and East Seram Regency with 1.050 ha. Thus wet field in Maluku has important role in providing food production for food security program, labor absorption and farmer income source.

Problems faced by rice farmer at West Seram Regency at this moment include capital limitation, also low profit caused by inefficient production factor allocation particularly in fertilizer production factor under suggestion and average in pesticides input utilization that tend to be excessive. This has caused production cost for farmer become quite large. High production cost would reduce farmer’s profit. Through management refinement, such as production factors reorganization, it is expected that input utilization efficiency could improved thus farmer’s profit from rice farming could also increasing. The objectives of this study were to (1) analyze production factors that affecting production and scale level of rice farming; and (2) analyzing technical efficiency and production input utilization allocation in rice farming at West Seram Regency.

METHOD

Study Area

Study was conducted at Waimital village, sub district Kairatu, West Seram Regency in the year 2012. This location is a location of integrated plant and resource management rice with main input in implementation of location-specific nutrient management and irrigation water efficiency. Respondent farmer involved in this study were irrigated rice farmer who has done rice farming for about 10 to 40 years.

Sampling Techniques and Data Collection

The sampling technique used Simple Random Sampling. Sample farmers as the primary data source was 40 respondents. Primary data obtained through interview and discussion, using participative and selected rural comprehension method, discussion method was emphasized on technology component input which implemented by farmer in rice farming. Data collected focused on used production facility data, production cost, physical production and price of production per physical unit. As complementary data, secondary data collection was done from Agriculture Department, National Bureau of Statistic, and Local Government Institution.

Analysis Method

Data analysis conducted to obtained qualitative and quantitative description of rice farming in West Seram Regency. Quantitative analysis would covers production function, production elasticity, farming scale, technical and allocative efficiency. Method used for each function were as follows:

Production Function Analysis

Main objectives in production process generally was to obtain maximum profit. Profit would reach maximum condition if production runs efficiently (Fousekis *et al.*, 2001). Ferson *et al.* (2003) and Suresh *et al.* (2008) suggested that production efficiency determination could be done after production function was known. Production function described physical relationship between *input* and *output* through the equation of *Y=f(x)*.

Cobb-Douglas production function was used to explained the relationship of *input* and *output*. Cobb-Douglas function was used with the reason solution of this function could easily transferred into linear. Besides, lines hypothesizing result through Cobb-Douglas function would resulting regression coefficient which also act as elasticity quantity. Cobb-Douglas production function model used in this study is;

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e^u$$

Where;

Y = production per season per hectare (kg),

X_1 = amount of seed per hectare (kg),

X_2 = amount of urea fertilizer per hectare (liter),

X_3 = amount of NPK Pelangi fertilizer per hectare (kg),

X_4 = amount of pesticide per hectare (liter),

X_5 = amount of herbicide per hectare (liter),

X_6 = labor bulk per hectare (working hours/day (HOK)),

a = constant (intercept),

e = nature figure (2,7182),

u = error (remains),

$b_1, b_2, b_3, b_4, b_5, b_6$ = production factor regression coefficient of $X_1, X_2, X_3, X_4, X_5, X_6$.

Hypothesizing of Cobb-Douglas model was done by conversing production function model into linear and becoming:

$$LnY_i = a + b_1 \ln X_{1i} + b_2 \ln X_{2i} + b_3 \ln X_{3i} + b_4 \ln X_{4i} + b_5 \ln X_{5i} + b_6 \ln X_{6i} + u \ln e$$

Testing toward model accuracy was conducted using t-test, F-test, determination coefficient and multi co-linearity test.

Technical Efficiency Analysis

Technical efficiency could by viewed through its elasticity value. Elasticity value is output change percentage as a result of input change percentage. Regression coefficient in Cobb-Douglas production function would also showed elasticity quantity. If farmer was producing at areas with elasticity value more than one, technical efficiency still haven't achieved. Technical efficiency would be achieved if farmer producing at areas with elasticity value between zero until one (O'Neill *et al.*, 2006; Perez *et al.*, 2007; Suresh *et al.*, 2008).

Allocative Efficiency Analysis

Efficiency analysis in production facility utilization was conducted by allocative efficiency testing or price efficiency. Price efficiency analysis has been used by Umoh (2006), Goni *et al.* (2007), Kareem *et al.* (2008), Oniah *et al.* (2008), Omonona *et al.* (2010), Nwaru and Iheke (2010) to see allocation level of input utilization, since efficiency level eventually would show maximum profit for farmer.

Nicholson (1995) and Soekartawi. (2002) suggested that production facility utilization allocation could be said efficient if marginal value product for i^{th} input (MVPxi) is equal with its input price (Pxi), it means that production facility allocation has reach optimal point or has been efficient. Mathematically, allocative efficiency could be written as,

$$MVPx_i = Px_i \quad \text{or} \quad \frac{MVPx_i}{Px_i} = 1 = k_i$$

Where,

$$MVPx_i = MPx_i . py$$

$$MPx_i = b \cdot \frac{y}{x}$$

If k_i=1 means that input utilization has been efficient, k_i>1 means that input utilization still not efficient and need to be added, while k_i<1 means that input utilization is no longer efficient and need to be reduced.

RESULT AND DISCUSSION

Statistic Description of Variables

Variables description of rice farming at study site could be seen in Table 1.

Table-1. Statistic Description for Production Factors and Rice Farming Production at West Seram Regency for year 2012

Variables	Average	Minimum	Maximum	Standard Deviation	Average value (IDR)
Production (kg)	4.217,00	3.000,00	5.000,00	1.059,76	16.608.620,69
Seed (kg)	27,17	20,00	50,00	5,52	135.833,33
Urea (kg)	177,50	100,00	400,00	68,34	319.500,00
NPK Pelangi (kg)	136,98	0	300,00	101,37	315.042,50
Pesticide (liter)	7,68	1,00	25,50	7,43	605.843,28
Herbicide (liter)	2,59	0	6,00	1,52	214.255,84
Labor (HOK)	96,00	58,0	119,00	13,51	4.800.000,00

Source: processed primary data, October 2012

Average in rice farming production at West Seram Regency is 4.217 kg/ha GKG with value IDR.16.608.620,69,- from rice selling price IDR.6.500/kg, if converted into the selling price of paddy IDR.3.900/kg with sucrose content 60%. Lowest production gained by farmer is 3.000 kg/ha GKG and highest production is 5.000 kg/ha GKG with standard deviation of 1.059,76. Wide productivity gap between farmers, is an opportunity for farmer with minimum production to improve his productivity if farmer could manage farming more efficiently.

Average seed utilization is 27,17 kg/ha with value IDR.135.833,33 with minimum value 20 kg/ha and maximum value 50 kg/ha. Seed utilization at study site is in accord with suggestion that is between 20-25 kg/ha for transplanting system and 30-50% kg/ha for direct seed planting system. Average in urea fertilization utilization is 177,50 kg/ha with IDR.319.500,00; with range 100 kg/ha- 400 kg/ha and standard deviation of 68,34. Average in urea fertilization rate at study site is still below general suggestion, N component as met from urea fertilizer was also met from complex fertilizer NPK Pelangi.

Fulfillment of P and K component was obtained from complex fertilizer utilization that is NPK Pelangi and NPK Ponska. In order to ease calculation in production function, Ponska utilization would be converted into NPK Pelangi. Average in NPK Pelangi utilization is 136,98 kg/ha with value IDR.315.042,50; minimum 0 utilization (not fertilized with NPK Pelangi) and maximum 300 kg/ha. Average in input utilization of NPK Pelangi at study site is still far below suggestion.

Average in pesticide input utilization 7,68 liter/ha worth IDR.605.843,28; with range 1-25,50 liter/ha. Pesticide utilization rate would depend on pest and disease attack and anticipation factor conducted by farmers. Pesticides used is quite vary such as *Montap, Rudal, Furadan, Mitorban, Dursban, Sidopadrin* and *Resotin*.

Weed control by farmers at study site usually conducting herbicide spraying since it is assumed as more efficient by farmers, since labor provision is highly limited. Average in herbicide utilization is 2,59 liter/ha that worth IDR.214.255,84; with range from 0-6 liter/ha.

Average in labor utilization for one season is 96,00 HOK that worth IDR.4.800.000,00; with range 58,00-119,00 HOK. If viewed from total input value expends by farmer per hectare thus expenditure for labor is the highest component with proportion reaching 75 percent.

Production Function Analysis and Technical Efficiency of Rice Farming

Regression analysis result for all variables hypothesized in production efficiency of rice farming at West Seram Regency was shown in Table 2. Production function for rice farming produced in this site is,

$$Y = 4{,}3816 X_1^{-0{,}047} X_2^{0{,}194} X_3^{0{,}111} X_4^{0{,}051} X_5^{0{,}017} X_6^{0{,}551}$$

With determination coefficient value (R^2) 0,656. This coefficient value means that there's about 65,5% rice production affected by variables within model, such as amount of seed, urea fertilizer, NPK Pelangi fertilizer, pesticide, herbicide and labor, while the remain 34,4% was affected by other factors outside model such as rain fall, humidity, water temperature and others. VIF < 10 value showed fulfillment of assumption that there is no multi co-linearity between variables within model. This analysis was presented in Table 2.

Table-2. Regression analysis result of all variables hypothesized in production efficiency of rice farming at West Seram Regency for year 2012

Hypothesized variables	Regression coefficient	Standard error	t-calculated	Significance	VIF
Constant	4,381	1,878	2,334**	0,024	
Seed (X_1)	-0,047	0,218	-0,216	0,831	1,879
Urea (X_2)	0,194	0,097	2,075*	0,052	1,766
NPK Pelangi (X_3)	0,111	0,044	2,539**	0,018	2,788
Pesticide (X_4)	0,051	0,041	1,222	0,234	2,510
Herbicide (X_5)	0,017	0,026	0,664	0,513	1,562
Labor (X_6)	0,551	0,275	2,074*	0,052	2,471
R^2	0,656				
F-calculated	7,296***			0,000	

Source: processed primary data

*** Significant at α=1%, ** Significant at α=5%, * Significant at α=10%, VIF=*variance inflating factor*

F-test in analysis result as shown in Table 2, could be used to determined production factors effect in overall toward production (Y). F-calculation value 7,296 and significant at level α=1% showed that independent variables in this production function has very significant effect toward rice production. While t-test could be used to see the effect of each independent variable in partial toward production. T-test analysis result showed that urea fertilizer, NPK Pelangi fertilizer and labor bulk has each significant effect toward production in level α=10%; 5% and 10% while seed, pesticide and herbicide did not give significant effect toward production.

Technical efficiency could be viewed from its elasticity value. Regression coefficient value produced in production function model as shown in Table 2 would show technical efficiency condition (elasticity >0). Regression coefficient in urea fertilizing has value 0,194 which means that if urea fertilizer increase by 10 percent, it would cause rice production to increase by 1,94 percent. On the contrary, if urea fertilizer decrease by 10 percent, rice production would also decrease by 1,94 percent (*ceteris paribus*). Complex fertilizer utilization such as NPK Pelangi as the source for P_2O_5 and K_2O had significant effect toward production with coefficient value 0,11. It means that if NPK Pelangi fertilizer is increasing by 10 percent, rice production would also increase by 1,11 percent, vice versa.

Labor variable also has significant effect toward production with coefficient value 0,551; this means that if labor utilization increase by 10 percent, rice production would also increase by 5,51 percent. If labor utilization decrease by 10 percent, rice production would also decrease by 5,51 percent. Elasticity values for both above variables that is urea, NPK Pelangi and labor were positive between zero and one (technical efficiency achieved), in which amount addition by farmers would increase production and could improve farmer's profit.

Pesticide and herbicide variable utilization were also within technical efficiency condition with positive coefficient value between zero and one, but this is not significant toward production which means addition or reduction in herbicide and pesticide variable has no means toward production, while seed variable has negative coefficient which means that seed addition would lowered production though not significantly.

Farming Scale or Return to Scale (RTS)

Farming scale (return to scale) described response of an output toward its proportional change from input in overall, RTS index was showed in Table 3.

Table-3. Elasticity and Farming Scale (*return to scale*) in rice farming at West Seram Regency for year 2012

Hypothesized variables	Elasticity
Seed (X_1)	-0,047
Urea (X_2)	0,194
NPK Pelangi (X_3)	0,111
Pesticide (X_4)	0,051
Herbicide (X_5)	0,017
Labor (X_6)	0,551
Return to Scale (RTS)	0,877

Source: processed primary data, 2012

Analysis result obtained RTS value 0,877. This showed that rice farming conducted by farmers at study site is in *Decreasing Return to Scale* (DRS) which means that all input addition by 1 percent would increase output by 0,877 percent or output additional proportion is smaller than input additional proportion. This RTS value also describes that farmers has already operated in rational production area that is area with value $0 \leq RTS \leq 1$ to reach Constant Return to Scale (CRS) or RTS=1 in which farmers should reallocate their input utilization that has significant effect toward production.

Efficient Use of Production Facilities (Allocative Efficiency)

Lots of farmers conduct their farming activities based on habit and experience therefore rationality is mostly neglected. This might be caused by several problems in farmer environment, such as capital limitation and difficulties in obtaining production facilities thus affecting farmers in making any decision. Thus, viewing farmer' rationality in farming to increase their income we conduct efficiency test for production facility utilization allocation. Result of this allocative efficiency test toward production facility utilization was showed in Table 4.

Production factors to be evaluated in efficiency would only covers factors that has significant effect toward rice production, such as urea fertilizing, NPK Pelangi and labor bulk. Value in allocative efficiency could be seen from ratio between marginal value product for ith input ($MVPx_i$) with ith input price (Px_i). $MVPx_i$ was obtained from multiply result of product price and production result addition.

Table-4. Marginal value product (MVP_{Xi}), Input price (Pxi) and ratio of MVPxi and Pxi for rice farming at West Seram Regency for year 2012

Production Factors	Regression coefficient	Average input	Marginal product (MP)	Marginal value product (MVP)	Input price (Px)	Ratio MVP-Px
Urea	0,19	177,50	4,49	17.083,94	1.800,00	9,49
NPK Pelangi	0,11	136,97	3,37	12.816,93	2.300,00	5,57
Labor	0,55	96,00	24,10	91.603,75	50.000,00	1,83

Source: processed primary data, 2012

Based on Table 4, we could conclude that there is no input allocatively within efficient condition. This could be seen from ratio $MVPx_i$-Pxi which is far above one. Ratio MVPx-Px obtained for urea, NPK Pelangi and labor consecutively were 9,49; 5,57 and 1,83 which means amount of all three input variables above is on the level 177,5 kg/ha for urea, 136,97 kg/ha for NPK Pelangi and 96 HOK/ha for labor per season by inefficient farmer. Farmer still could raise the amount of input utilization at current price level since proportion addition in input used could increase production proportion thus significantly would increase profit for farmer. Related with limited labor input provision at study site, labor input reallocation could be done through agricultural mechanization particularly for planting and harvesting activities.

CONCLUSION

Rice farming at Waimital village, sub district Kairatu, West Seram Regency has achieved technical efficiency which means that technically, management in farming is worth to try since it is able to achieve maximum output by focusing on production factors, particularly urea fertilizer, NPK Pelangi fertilizer and labor bulk. Economically, rice farming at Waimital village has not yet able to give maximum profit because average in input allocation level by farmer still not yet optimal. Maximum profit achievement is possible by reorganizing input utilization allocation in farming such as by increasing the amount of urea fertilizer, NPK fertilizer and labor bulk utilization, however for labor input there should be agricultural mechanization given limited labor existed at study area.

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