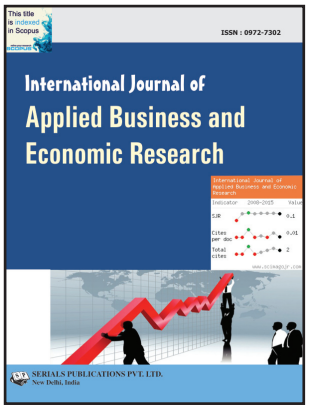

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Resources Economic Efficiency for Sustainable Agriculture: Case on Rice Farm in Yogyakarta, Indonesia

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ABSTRACT

An integrated analysis approach of a farm needs to be formulated to assist in decision making by policy makers. This study aimed to analyze the as one of determinant factor of sustainable agriculture. Survey was conducted on rice farmers in 25 locations of the observation of the 8 river irrigation sources are scattered in Yogyakarta. Estimated economic efficiency using frontier cost function analysis involving independent variables rice production and input prices of rice farm resources. The result showed that the overall value of the economic efficiency of rice production is still low. Frontier inefficiency effects model showed that experience, rent and profit-sharing system in terms of land ownership, credit availability and active participation in a group can encourage farmers to manage farm resources more efficiently.

Keywords: Economic, Efficiency, Rice Farm.

1. INTRODUCTION

Sustainable agriculture are key issues in developing countries. It is important because a developing country with limited natural resources and technology available should try to increase agricultural production to meet the needs of the ever increasing population. Therefore, innovation aggressively pursued to maintain and improve the productivity of agriculture, especially food crops.

Efforts to increase agricultural productivity has been done through technology innovation experience barriers reduced hectarage (paddy) and the decline in the carrying capacity of the land and the environment due to intensive use of chemicals cause pollution. The development of industrial sector, services and

property in the era of economic growth has put pressure on the agricultural sector, especially rice fields. Therefore, in a state of technology, improved efficiency is the right effort to increase productivity and is expected to be a solution for the sustainability of farm. However, the development of industry and services provide opportunities for people to allocate its available resources on a wide selection of work including the allocation of resources in agriculture. It certainly can have an impact on the performance of the farm, including the efficient use of agricultural resources.

Much of the research on farm performance has been done based on the efficiency and sustainability of farm. Research on the technical efficiency has been done by (Tchale and Sauer, 2007) and (Tchale, 2009). Bozoglu and Ceyhan (2007){Please_Select_Citation_From_Mendeley_Desktop}, Obare, et. al., (2010) conducted a study to see the level of allocative efficiency of resources. (Abedullah, et. al., 2006)andMsuya, et. al., (2008) using the stochastic frontier production function, Hasandan Islam (2010) use cross section data with Cobb Douglas production function approach. Wadud (2003) research results showed that the age of farmers, land fragmentation, irrigation infrastructure and land degradation significant positive effect on economic efficiency in rice farm in Bangladesh.

Sustainability analysis conducted by Castoldi & Bechini (2010) is a sustainability assessment using indicators of agro-ecology and economy. Ceyhan (2010) assess the sustainability indicator by dividing the three components of the economic, social, and ecological (environmental). Sustainable agriculture research in terms of efficiency have been conducted by Tyteca (1999), Callens and Tyteca (1999), Reinhard et. al., (1999) and Reinhard et. al., (2002), Koeijer et. al., (2002), Abay et. al., (2004), Okike et. al., (2004), Sauer and Abdallah (2007)andVan Passel et. al., (2009).

Tyteca (1999) shows that the economic principles of production can be used to describe the indicators of sustainability at farm level. Callens and Tyteca (1999) uses indicators based on the concept of cost-benefit analysis and the principle of productive efficiency. Furthermore Callens and Tyteca (1999) stated that the efficiency of the economic, social, and environment is an imperative requirement (but not sufficient) towards sustainability. Development efficiency is an important step towards more sustainable because it can tolerate conflict economic and environmental objectives can be achieved simultaneously. Sustainability can be enhanced by strategies that encourage the efficient use of resources in the economic system (Van Passel et. al., 2009). Precisely, efficiency form the key policy, planning and business approach to sustainable development, including agricultural development.

The following study takes the case of rice farm in the area of Yogyakarta (Indonesia). Paddy rice farm centers in Yogyakarta, scattered in Sleman and Bantul. Geographically, the two regions have different characteristics. Rice fields in Sleman located upstream relatively close to the source of irrigation, whereas wetland Bantul Regency is located in the south that are susceptible to pollution that may have an impact on farm in the downstream area. In general, the two regions mentioned above directly bordering the city of Yogyakarta were vulnerable to conversion of agricultural land. Community characteristics of peri urban area directly adjacent to urban areas experienced a change that makes an impact on the behavior of doing business in agriculture.

Production and productivity of rice in Yogyakarta has fluctuated in the period 2009-2013. The significant increase in production in 2012 at 12.25%. The increase in production is attributable to increased productivity and an increase in harvested area. However, in 2013 the production and productivity of rice decreased significantly despite an increase in harvested area (CBS, 2014a). Socio-economic conditions of

farmers and farm physical environment (agro-ecosystem) deserve supposed to influence the allocation of costs and efficiency of rice farm run by farmers. Under these conditions, it needs to be studied on the level of economic efficiency along with the factors that influence it and the level of sustainability of rice farm in Yogyakarta.

However, we have not found a research that considerate natural resources like water irigation and organic fertilizer as part of sustainable agriculture. There for we tried to analize the following research by considering natural resources including water irigation and organic fertilizer.

2. METHODS

This research was conducted in Yogyakarta focused on districts that have the widest wetland Sleman and Bantul amounted to 67.64 percent of the total rice area in Yogyakarta (CBS, 2014b). In addition, the two regions also have different agro-ecosystem based on the distance to the source of irrigation namely Sleman located in the upstream region close to the source of irrigation and Bantul are in downstream areas far to the source of irrigation.

Determination of sampling sites based on irrigation streams passing through Sleman and Bantul. Of the eight irrigation flow stream that passes through the two districts specified locations in irrigated areas upstream, midstream and downstream as much as 25 points sampling sites. Each sample locations taken five samples of farmers by simple random sampling. Thus the number of samples in this study were 125 farmers. Data farm in the capture is data farm in the rainy season and the dry year 2014-2015, so the total observation is about 250.

This study uses of cost efficiency of frontier analysis. Frontier cost function analysis by the inefficiency effects model (Coelli, 1996) can be written as follows:

$$\begin{aligned} LnC = {} & \beta_0 + \ln y + \beta_1 \ln p_1 + \beta_2 \ln p_2 + \beta_3 \ln p_3 + \beta_4 \ln p_4 + \beta_5 \ln p_5 + \beta_6 \ln p_6 + \beta_7 \ln p_7 \\ & + \beta_8 \ln p_8 + \beta_9 \ln p_9 + \beta_{10} \ln p_{10} + \beta_{11} \ln p_{12} + d_1 D_{season} + d_2 D_{loc} + \delta_0 + \delta_1 age \\ & + \delta_2 educ + \delta_3 experc + \delta_4 fmly + d_3 D_{area} + d_4 D_{credt} + d_5 D_{status} + d_6 D_{active} \\ & + (v_i + u_i) \end{aligned} \quad (1)$$

With:

C = total farm production costs (Rp)

y = rice production (kg)

p_1 = seed price (Rp/kg)

p_2 = N fertilizer price (Rp/kg)

p_3 = NPK fertilizer prices (Rp/kg)

p_4 = Organic fertilizer price (USD/kg)

p_5 = Pesticides price (USD/kg)

p_6 = labor costs (USD/HKO)

p_7 = plow land costs (USD/m^2)

p_8 = planting costs (USD/m^2)

p_9 = harvesting costs (USD/kg)

p_{11} = irrigation costs (USD/m^2)

D_{season} = dummy cropping season (wet season = 1; dry season = 0)

D_{loc} = dummy district location (Sleman = 1; Bantul = 0)

age = age of farmers (score)

educ = education of farmers (score)

experc = experience of farmers (score)

fmly = number of family members of farmers (people)

D_{rural} = dummy arable land area (rural = 1: sub-urban = 0)

D_{status} = dummy status of arable land (belonging = 1; do not belong = 0)

D_{credt} = dummy access to credit (available access = 1; not available access = 0)

D_{active} = dummy participation in groups (active = 1; inactive = 0)

β_0 = constants of parameter estimation of the frontier cost function on rice farm

β_i = parameter estimation of the frontier cost function on rice farm

δ_0 = constant inefficiency effects of parameter estimation of the frontier cost function on rice farm

δ_i = parameter estimation of the effects of the inefficiency frontier cost function on rice farm.

Jondrow, et. al., (1982) defines economic efficiency as the ratio between the total minimum cost was observed (C^*) by total actual production cost of farm (C), so that the economic efficiency equation becomes:

$$EE = \frac{C^*}{C} = \frac{E(C_i \mid u_i = 0, Y_i, P_i)}{E(C_i \mid u_i, Y_i, P_i)} = E[\exp.(U_i/\varepsilon)] \quad (2)$$

Based on the analysis of the cost efficiency of frontier cost function, then the economic efficiency can be calculated as the inverse of the cost efficiency frontier:

$$EE = \frac{1}{\text{Cost Efficinency (CE)}} \quad (3)$$

Based on the analysis of the cost efficiency of frontier cost function, then the economic efficiency can be calculated as the inverse of the cost efficiency frontier:

3. RESULTS AND DISCUSSION

Frontier Cost Function of Rice Farm

The role of agricultural resources is very important in determining the success of rice farm. In general, agricultural resources are human resources, capital, natural resources and environment. Human beings with

all its potential is a resource that is quite unique and complex because it contains roles as managers, workers and community members who have a social role. Thus human beings can be regarded as a social resource in the farm, especially rice plant. In addition to land, water is a natural resource that plays an important role in the process of farm production. While the weather conditions and the season is also an important environmental resource on farm production process. Capital resources is the cost of capital used for the provision of inputs and labor on farm production process.

Table 1
Estimation Coefficient of the Cost Function Frontier of Rice Farm

Variable	*Parameter*	*Expected Sign*	*Coefficient*	*T-Ratio*
Intercep	β_0	+/−	2.9672*	1.8045
Rice production	β_1	+	0.9657***	22.6673
Seed price	β_2	+	−0.1911***	−2.8632
N fetilizer price	β_3	+	0.0245	0.4377
NPK fertilizer prices	β_4	+	0.1732	0.9772
Organic fertilizer price	β_5	+	−0.4503***	−4.6193
Pesticides price	β_6	+	0.1336***	3.0208
Labor costs	β_7	+	0.0454	0.7736
Cost of land plowing	B_8	+	0.0618	0.6738
Costs of Planting	β_9	+	0.0872	1.3789
Costs of Harvesting	β_{10}	+	0.0978**	2.4883
Costs of Irrigation	β_{11}	+	0.2034***	5.4436
Dummy cropping season	d_1	+/−	0.0560	1.1312
Dummy district location	d_2	+/−	0.0059	0.0799
Sigma-squared	α^2		0.0143***	12.7715
Gamma	γ		0.9999***	11.7532
Log likelihood function	LLF		108.5122	
LR Test of the one-side eror			124.6584	

*Significant at 10%; **significant at 5%; ***significant at 1%.

Allocation and management of agricultural resources in of the rice farm has been linked with the allocation of costs and economic efficiency of the farm. In the model the cost function farm illustrates that total cost is influenced by the production, input prices, labor cost, cropping season (weather) and location. Based on the application of the model of frontier cost function in equation (1), then the result of the estimated cost function by stochastic frontier approach on the rice farm provide some basic overview in the form of scale, as well as the level of significance on the parameter estimates. Results frontier cost function estimation using maximum likelihood method can be seen in Table 8.1.

Based on estimates stochastic frontier cost function, this model has a parameter value γ of 0.9999. The estimated parameters γ is the ratio between the deviation inefficiency (u_i) against deviations that may be caused by random factors (v_i). Statistically, the value of 0.9999 has meaning 99.99% of errors in the cost function describes the efficiency of farm costs or due to their inefficiency, while the rest (0.01%) due

to random error variables (risk). It is clear that all of the variation in the output from the cost frontier can be considered as a result from the level of achievement of cost efficiencies related to menajerial issues in farm management. Value $\alpha 2$ show significant diversity at the 99% confidence level.

The result of the calculation, the value of likelihood ratio (LR) of 124.66 is greater than the value of chi-square ($\alpha 1\%$: at 27.69). This means that the independent variables are jointly significant effect on the dependent variable. Thus rice production, seed price, N fertilizer price, NPK fertilizer price, organic fertilizers price, pesticides price, labor cost, cost of land plowing, costs of planting, costs of harvesting and costs of irrigation and dummy cropping season and district location together significantly influence the cost of rice farm.

Partially, there are several variables that significantly influence the cost of of rice farm. Variable production, pesticide prices, the cost of harvesting and irrigation costs a positive influence on the cost of of rice farm. This indicates that if there is an increase in each of these variables, it will have an impact on the increase in farm costs. Such conditions are common, that every happened increases in the prices production inputs, then it will have an impact on the increase in production costs.

The results estimated coefficient of the variable of seeds price and organic fertilizer prices showed unusual conditions. Variable cost of seeds and organic fertilizer prices negatively affect farm production costs. The coefficient of the variable cost of seeds and fertilizers are negative, indicating that if the price increase of seeds and organic fertilizer prices will impact on the production costs. Such conditions can occur because farmers have its own way of managing their farm. If the seed price increases, then the farmers will look for alternative seed with a cheaper price or they will use a portion of grain production in the previous season to meet the needs of the seed. Based on observations in the field are 37.5 percent of rice farm using seed from the previous harvest at a cheaper price. This condition will reduce the overall cost of rice production during high seed prices. It so happens when organic fertilizer prices high, farmers will reduce purchases of organic fertilizer for farmers thought that organic fertilizers only as a fertilizer supplement and farmers can produce their own from livestock waste that they have. This will reduce production costs.

The results of the analysis of cost efficiency frontier provides information on the economic efficiency of rice farm. The use of equation (3), which is the inverse of the cost efficiency frontier will generate economic efficiency. Based on the distribution of economic efficiency values (Table 8.2) it can be seen that most of the economic efficiency values of less than 0.50. Thus we can say that the overall economic efficiency of rice production is still low. The highest efficiency was 0.93 in the rainy season and 0.97 in the dry season.

Table 2
Distribution of Economic Efficiency estimation of Rice Farm

Economic Efficiency	*Wet Season*		*Dry Season*	
	Number of Farmer	*Persentase (%)*	*Number of Farmer*	*Persentase (%)*
0.10 – 0.19	50	40	49	39.2
0.20 – 0.29	29	23.2	31	24.8
0.30 – 0.39	16	12.8	14	11.2
0,40 – 0.49	14	11.2	19	15.2
0.50 – 0.59	10	8	6	4.8

Economic Efficiency	*Wet Season*		*Dry Season*	
	Number of Farmer	*Persentase (%)*	*Number of Farmer*	*Persentase (%)*
0.60 – 0.69	2	1.6	2	1.6
0.70 – 0.79	3	2.4	3	2.4
0.80 – 0.99	1	0.8	1	0.8
Number of Observation	125	100.0	125	100.0
Mean	0.29		0.29	
Minimum	0.10		0.10	
Maximum	0.93		0.97	

Inefficiency effects model show that the efficiency of rice farm is influenced by experience, arable land status, access to credit and participation in the group. These four factors negatively affect the inefficiency of rice farm. It can be said that the higher the experience of farmers, the farm costs more efficiently. While the costs of farm on non-owned arable land (rent and profit sharing) is more efficient than the costs of farm on their own land. Sharecroppers and tenants have to think rationally in order to keep profit from his efforts, then they will allocate production inputs more efficiently. Meanwhile farmers who have access to credit and is active in the group, the costs of farm more efficient than other farmers.

Table 3
Estimated Coefficient Inefficiency of Rice Farm

Variable	*Parameter*	*Expected Sign*	*Coefficient*	*T-Ratio*
Intersep	δ_0	+/–	1.9090***	8.2389
Age	δ_1	+/–	0.0009	0.2991
Education	δ_2	+/–	0.0051	0.7238
Experience	δ_3	+/–	–0.0040**	–2.4686
Number of family	δ_4	+/–	–0.0003	–0.0185
Dummy area	d_1	+/–	–0.0163	–0.2450
Dummy arable land status	d_2	+/–	–0.6439***	–11.5766
Dummy access to credit	d_3	+/–	–0.1449***	–2.7876
Dummy participation in group	d_4	+/–	–0.1724***	–2.9756

4. CONCLUSION

Based on the results of frontier cost function analysis can be concluded that all the variable independent which tend to have higher costs of farm resources, economic resources, social and environmental jointly significant effect on the cost of rice farm. Prices of seeds and organic fertilizer prices negatively affect the cost of rice farm. Farmers have always tried to take advantage of the resources that he has like seeds and organic fertilizers, especially when the price is high. But the quality of these resources is still low so it can impact on the low efficiency of rice farm.

The results of estimation of economic efficiency of rice farm shows that most of the rice farm is not economically efficient. Frontier inefficiency effects model showed that experience, rent and profit-sharing system in terms of land ownership, credit availability and active participation in a group can encourage farmers to manage farm resources more efficiently.

Increasing the efficiency and sustainability of rice farm can be done through increasing resource productivity, namely the allocation of resources efficiently. This can be done through training and assistance for farmer groups as well as providing access to farm credit. Training and assistance for farmer groups will provide additional experience for the farmers so that farmers have a way of thinking that is rational in farm. Farm management skill development will enhance the ability of farmers to manage farm resources more efficiently. Managerial capacity building of farmers is expected to increase the productivity of agricultural resources.

Relating to the management of agricultural resources is necessary for the provision of quality resources in the form of farm production inputs of seeds and organic fertilizer at an affordable price. Quality improvement of service facilities and irrigation infrastructure and the provision of harvesting technology that cheap is expected to save costs of farm. Management of these resources can be done through assistance for farmer groups and increase the participation of members of the group.

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