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Investigation of production efficiency and socio-economic factors of organic rice in Sumber Ngepoh District, Indonesia

Bunga HIDAYATI[1], Naoyuki YAMAMOTO[2] (✉), Hideyuki KANO[2]

[1] University of Miyazaki, Interdisciplinary Graduate School of Agriculture and Engineering, Gakuenkibanadai-nishi-1-1, Miyazaki 889-2192, Japan

[2] University of Miyazaki, Faculty of Agriculture, Gakuenkibanadai-nishi-1-1, Miyazaki 889-2192, Japan

✉ Corresponding author: nyamamoto@cc.miyazaki-u.ac.jp

ABSTRACT

Recently, environmental preservation and the back-to-nature approach to living have become a great lifestyle. The conditions for making organic rice have received a significant amount of attention in the rice market. The study of production efficiency will become substantial to the improvement of organic rice farming to fulfill rice demand. This study investigates the relevant variables which affect the production efficiency of organic rice. The Sumber Ngepoh is one of the largest districts in the rice-producing province of Indonesia. The production stochastic frontier function and the cost stochastic dual frontier is utilized to analyze the data. The technical, economic and allocative efficiency is analyzed to determine the significant variables. Moreover, the socio-economic variables are also investigated. The averages of the technical, allocative and economic efficiencies are 54.3%, 52%, and 31.3%, respectively, which are categorized as inefficient production. The averages indicate that organic rice farming in the Sumber Ngepoh District is not optimal and needs to be optimized. The results show that land, seed, organic fertilizer, organic pesticide, and hand tractor variables have a significant effect on organic rice production. The socio-economic variables which significantly affect all efficiency levels are farm size, experience, and family member.

Keywords: allocative efficiency, economic efficiency, organic rice, socio-economic, stochastic frontier factor, technical efficiency

INTRODUCTION

Indonesia has the potential to expand its organic farming production. Since 2001, Indonesia has promoted organic agricultural development with the slogan 'Go Organic 2010' (Jahroh, 2010). Moreover, the growth of the organic agriculture market will create opportunities to improve farmers' or peasants' income and welfare in rural areas of Indonesia (Hidayat and Lesmana, 2011). Indonesia also has the potential to expand the application of organic farming methods due to Indonesia being ranked seventh out of the ten countries with the highest increment of organic land (Organic World, 2016).

The prospects of organic farming in developing countries include attaining consumer acceptance and environmentally friendly production methods (Bello, 2008). Consumers are now turning to organic food because they believe it to be tastier and healthier, for both themselves and the environment. Furthermore, organic farming is environmentally friendly because an organic farmer's primary strategy for controlling pests and diseases is the use of prevention methods. The increase in organic soil matter gained through organic farming has the added benefit of improving soil quality and thereby enhancing the long-term sustainability of agriculture (Laird et al., 2001).

Organic farming not only has the potential to grow in the future but is also subject to several constraints. Jouzi et al. (2017) describe that the primary challenge of organic farming in developing countries as being the limited yields gained thereof. According to Bello (2008), most organic farmers are faced with constraints, such as limited knowledge of technical practices and production methods. The problems surrounding the use of technical and production methods have a negative impact, causing low production efficiency and low productivity (Mariyono, 2014). One of the main reasons for low productivity in Indonesia is the inability of the farmer to fully exploit the available technologies, resulting in low efficiency of production. The analysis of efficiency is associated with the possibility of farms producing the optimum level of output from a given bundle of resources, or a certain level of output at the least cost (Galawat and Yabe, 2012).

Kalirajan (1991) states that socio-economic attributes have a roundabout effect on production, and, hence, should be indirectly incorporated into an analysis (Bravo and Pinheiro, 1997; Sharma et al., 1999). First, farm size, which is inseparable from the main features of Indonesian agriculture, has always been small-scale and subsistence-based (the land ownership average is around 500 meters). Second, age is a crucial factor in the adoption rate of technologies and the performance of a farmer, the case being that younger people tend to adjust faster and better to new technologies than the elderly, who are conservative (Ngeywo, 2015). Third, human capital development, particularly the technical farming skills of farmers, is still low and most of Indonesia's farmers have only received an elementary education. Based on the research background, this study purposes of investigating the organic rice production efficiency through technical, allocative, and economic efficiencies, as well as other factors that influence efficiency.

MATERIALS AND METHODS

Production efficiency measurement

Production efficiency relates to the degree to which a farmer produces the maximum feasible output from a given bundle of inputs (an output-oriented measure), or uses the minimum feasible level of inputs to produce a given level of output (an input-oriented measure) (Galawat and Yabe, 2012). A producer's performance can be measured by its economic efficiency (EE) (Coelli et al., 2005). This concept mainly comes from Farrell (1957), who distinguishes technical efficiency (TE) and economic efficiency (EE). The efficiency is technically significant when the number ratio of output to input is excellent. The input viewpoint is entirely different for production. A production that only requires a few inputs and provides an extensive output can be categorized as an efficient production, but the production will become inefficient if the price of the few inputs is higher than that of the output.

The most popular approach to efficiency measurement is the Stochastic Frontier Production Function (Rahman, 2003; Coelli et al., 2005). Therefore, to identify the factors which affect rice yield and assess the efficiency of organic rice farming in Indonesia, the Stochastic Frontier Production Function is applied. A Cobb-Douglas Stochastic Frontier Production model is assumed to be an appropriate production model, and is described as follows:

$$\ln(Y_i) = \beta_0 + \sum_{i=0}^{n} \beta_i \ln(X_{ij}) + (v_{ij} - u_{ij}) \quad (1)$$

Where Y_i is an output production of *i*th farm, X_{ij} is a *j*th input of ith farm, and β_0 are unknown parameters to be estimated. The two components v_{ij} and u_{ij} are assumed to be independent of each other. The v_{ij} represents random errors or variations in output that are assumed to be independent and identically distributed as $N(0, \sigma_v^2)$ due to factors outside the control of farmers, as well as the effects of measurement error in the output variable, left out explanatory variables from the model, and stochastic noise (Galawat and Yabe, 2012).

The u_{ij} is a non–negative random variable, associated with the technical inefficiencies of production, which are assumed to be independently distributed such that uij is obtained by the truncation of the half normal distribution (u~|N (0, σ_u2|) (Battese and Coelli, 1995). The maximum likelihood estimation of equation (1) yields consistent estimators for β, γ and σv², where β is a vector of unknown parameters, $\gamma = \sigma_u^2/\sigma^2$ and $\sigma^2 = \sigma_v^2 + \sigma_u^2$. Jondrow et al. (1982) have further shown the formula as follows:

$$E(u_i|\varepsilon_i) = \sigma^* \left[\frac{f^*(\varepsilon_i\lambda/\sigma)}{1 - F^*(\varepsilon_i\lambda/\sigma)} - \frac{\varepsilon_i\lambda}{\sigma}\right] \quad (2)$$

Where F^* and f^* are the standard normal density and distribution functions, respectively, which are evaluated at $\varepsilon i\lambda/\sigma$, and $\sigma^{*2} = \sigma_v^{\,2}+\sigma_u^{\,2}/\sigma^2$. Subtracting v from equation (1), the output in the model (1) may be different from the farm's observation output Yi^*. By moving the output error to the left-hand side of (1), a relationship between actual output and the estimated model is obtained as follows.

$$\ln(Y_i^*) = \ln(Y_i^*) - v_{ij} = \beta_0 + \sum_i \beta_j \ln(X_{ij}) + u_{ij} \quad (3)$$

The technical efficiency is derived from the observation output (3) to its input. By solving the equation (3), the technical efficiency (TE) can be the calculation of the ratio of the observed output (Y) to the corresponding frontier output (Y^*), as conditional on the levels of inputs used by the farmer. In the context of the stochastic frontier production function equation (1), a technical efficiency formula (based on Chiona et al., 2014) is given by:

$$TE = \frac{Y_i}{Y_i^*} = \frac{\exp(X_i\beta + V_i - U_i)}{\exp(X_i\beta + V_i)} = \exp(-U_i) \quad (4)$$

The Cobb-Douglas production function in (1) is a self-dual; therefore, the dual cost frontier can be derived as follows.

$$\ln(C_i) = \beta_0 + \sum_i \beta_j \ln(P_{ij}) + \gamma \ln(Y_i^*) \quad (5)$$

Where C_i is the minimum cost of production per *i*th farm, P_{ij} is the price of the *j*th input, and β_j and γ are the parameters from the estimation of (1). The cost of production can be calculated by solving equation (5). Based on Jondrow et al. (1982), the economic efficiency (EE) can be derived from the ratio of the observed total minimum cost (C^*) to the actual cost production total as follows:

$$EE = \frac{C^*}{C} = \frac{E(C_i|u_i = 0, Y_i, P_i)}{E(C_i|u_i, Y_i, P_i)} = E\left[\exp\left(\frac{U_i}{\varepsilon}\right)\right] \quad (6)$$

The EE introduces that, besides the number of the input, the price of the input should be considered. Then, the production efficiency can be assigned as an allocative efficiency (AE), which comes from the multiplication of TE and EE (Farrell, 1957), as follows.

$$AE = \frac{EE}{TE} \quad (7)$$

Where AE value $0 \leq AE \leq 1$ and EE value $0 \leq EE \leq 1$.

Tobit regression model

The Tobit regression model is frequently used to analyze data with left-censored responses (outputs) in many fields (Ding et al., 2017). The Tobit regression model, which models dependent variables with censored data, is an appropriate technique for modeling excess speed data (Tobin, 1958). In the Tobit model framework, the observations of compliant drivers can be clustered at a threshold value of zero, and those of non-compliant drivers can be retained as continuous data to represent the magnitude of non-compliance (Liu et al., 2017). The Tobit model, as based on Liu et al. (2017) can be expressed as follows:

$$Y_i^* = \beta X_i + \varepsilon_i,\ i = 1, 2, ..., N \quad (8)$$

$$Y_i = Y_i^* \text{ if } Y_i^* > 0 \quad (9)$$

$$Y_i = 0 \text{ if } Y_i^* \leq 0 \quad (10)$$

where Y_i is the dependent variable measured using a latent variable Y_i^* for positive values, β is a vector of estimable parameters, X_i is a vector of explanatory variables, ε_i is a normally and independently distributed error term with zero mean and constant variance σ^2, and N is the number of observations (Washington et al., 2011; Liu et al., 2017).

Data collection

According to an agricultural census held by Statistic Indonesia every ten years, Jawa Timur Province has the most significant number of rice producers in Indonesia (Statistic Indonesia, 2013). The Sumber Ngepoh District of Malang Regency is the first area adapted to organic rice farming. The transformation from conventional to organic rice farming methods was caused in 1998 by the high cost of chemical fertilizer due to the economic crisis. The region's farming became purely organic in 2000, and an organic certificate from the Indonesian Organic Certification Body was obtained in 2004. The land conversion organic certification process requires at least four planting periods (two years) to neutralize the toxicity of the soil. The farmers have to designate a specific area for water contamination control from their conventional fields. Based on this fact, the primary data was collected in the Sumber Ngepoh District by interview. Forty farmers, as a representation of farmers in the district, were interviewed in June 2017. The collected data was analyzed to extract critical information about organic rice farming.

RESULTS AND DISCUSSION

The general background of respondents

Table 1 explains the respondents' general information for one dry planting season. The yield variable represents the output variable of production. The ownership of land area starts from 0.25 ha to 1.6 ha, which constitutes subsistence and small-scale farmers. The average seed usage in this sample is around 30 kg per 0.77 ha. Most of the farmers cultivate the seed themselves to achieve high-quality local seed. The average number of hired laborers is 25.15 persons per crop season. The usage of labor is intensive as a large amount of labor is required when both the planting and harvesting time comes. Low wages also inform farmers' preference for using labor instead of machines. The average wage for farm laborers ranges from IDR 35,000 (USD 2.45) to IDR 50,000 (USD 3.5) per day. The cost of renting a hand tractor is around IDR 700,000 (51.5) USD per day. Other production inputs are organic pesticide and organic fertilizer, which have an average usage of around 13.2 liters and 81.75 kg, respectively.

Production efficiency

The comparison between the Ordinary Least Square (OLS) and Maximum Likelihood Estimation (MLE) of common production functions from equation (1) is shown in Table 2. All the estimated coefficients except labor had the expected positive signs and were statistically significant at levels of 0.1, 1, and 5%, respectively, in both the OLS and MLE. The estimated coefficient of land area is statistically significant (at the 5% level of significance estimation). Therefore, rice production can be increased by 0.206% with a 1% increase in land area, *cateris paribus*. Organic seeds are a crucial factor for high determinant

Table 1. General information of variables (n=40)

Variables	Unit	Min	Max	Mean	Standard deviation
Yield	t	2	7	3.425	1.089
Land area	ha	0.25	1.6	0.765	0.42
Organic seed	kg	15	55	30.375	10.277
Labor	person	15	35	25.15	12.033
Organic pesticide	L	6	36	13.2	8.348
Hand-tractor	h	24	48	27	8.038
Organic fertilizer	kg	50	200	81.75	43.138

production, as the use of quality seeds can affect an increase in rice production. Based on the results of the regression, organic seed indicates a significantly positive relation to production. If the number of seeds is increased by 1%, organic rice production will increase by 0.05%, with a significant level of 5%.

The estimation results show that the usage of labor is not significant in both OLS and MLE. The result could be explained by the fact that labor is subject to a contract system. Kauffman (1999) describes "de facto" working farmers as contract workers who often work in a highly intensive (over the period) and high extensive (unpaid household member) manner. Low-rate wages cause the dissipation of labor employed during planting and harvesting. The dissipation indicates that the utilization of labor reaches a saturation point. At this point, there is no increment or decrement in production. A one percent increment in organic pesticide, hand tractors, and organic fertilizers has a significant positive effect on organic rice production (0.24%, 0.09%, and 0.15%, respectively). The coefficient R^2 shows that the input variables explain 82% of the total sample variation in the output variable. The maximum likelihood estimation (MLE) can derive gamma (γ), which is associated with the variance effects in the stochastic frontier and estimated to be 0.787. It represents 78.7% of the total of the variability of organic rice production for the sample farmers.

Table 2. The OLS and MLE of the stochastic frontier production function

Variables	Parameters	Coefficient	Standard error	Coefficient	Standard error
		OLS		MLE	
Constant	β0	0.445**	0.857	0.09*	0.23
		(0.007)		(0.044)	
Land area	β1	0.206*	0.094	0.158*	0.154
		(0.035)		(0.047)	
Organic seed	β2	0.05*	0.145	0.067**	0.167
		(0.033)		(0.003)	
Labor	β3	-0.07	0.099	-0.061	0.151
		(0.487)		(0.188)	
Organic pesticide	β4	0.236**	0.081	0.225**	0.167
		(0.003)		(0.007)	
Hand tractor	β5	0.093*	0.154	-0.114*	0.156
		(0.041)		(0.034)	
Organic fertilizer	β6	0.15***	0.07	0.149**	0.134
		(0)		(0.007)	
R^2		0.82			
Model Variance	σ			0.007***	7.309
Gamma	γ			0.787**	3.02
Log-likelihood				61.9	

OLS - Ordinary Least Square; MLE - Maximum Likelihood Estimation. *P<0.05; **P<0.01; ***P<0.001

The dual cost frontier calculation, which is derived from equation (5), is given as follows:

$$\ln(Ci)=1.162+(0.092)\ln(PLand)+(0.083)\ln(PSeed)+(0.047)\ln(PLabor)+(0.186)\ln(PPesticide)+(0.067)\ln(PHand\_tractor)+(0.017)\ln(PFertilizer)+(0.017)\ln(Y^{*}) \quad (11)$$

Where *Ci* is the minimum cost of rice production per i[th] farm. PLand is the price of land area in IDR/hectare. PSeed is the price of organic seed in IDR/kg. PLabor is the wage rate of labor in IDR/day. PPesticide is the price of organic pesticide in IDR/liter. *Phand_tractor* is the rental cost of tractor IDR/day. *PFertilzer* is the price of organic fertilizer in IDR/kg and Y^{*} is the farm output adjustment for any statistical noise.

The summary statistics for all efficiency are presented in Table 3. The mean level of the overall technical efficiency (TE) is 54.3%, and the efficiency ranges from 38.6% to 83.8% for the farms in the sample. The mean of overall technical efficiency explains that farmers can potentially reduce their input by 46.7% (100%-54.3%) on average, and can still achieve the same level of output via the use of the existing technology. The mean AE of the samples in the study area is 52%, ranging from 39.3% to 64.5%. The combined effect of technical and allocative factors showed the average economic efficiency (EE) level to be 31.3%. The average score of AE and TE reveals the potential effects of overall cost-minimizing behavior. If the average farm in the sample set reached the EE level of its most efficient counterpart, the average farmer could experience savings of up to 45% (i.e., 1– [31.3/57.1]). This means that farmers are currently employing the incorrectly given input prices, meaning that average costs are 45% higher than the cost-minimizing level. In other words, the low EE scores suggest that there is still some scope to reduce the cost of input without decreasing output. The farmers can reduce the cost of production by 68.7% (100% - 31.3%) while still producing the same level of output. The same calculation for the most economically inefficient farmer suggests a potential reduction in EE of about 62% EE (i.e. 1– [21.5/57.1]).

Table 3. Frequency and percentage of technical, allocative and economic efficiencies

Efficiency level (%)	TE		AE		EE	
	Number of farmers	Percentage of total farmers	Number of farmers	Percentage of total farmers	Number of farmers	Percentage of total farmers
<10	0	0	0	0	0	0
11-20	0	0	0	0	0	0
21-30	0	0	0	0	29	72.5
31-40	1	2.5	1	2.5	6	15
41-50	18	45	10	25	3	7.5
51-60	12	30	27	67.5	2	5
61-70	4	10	2	5	0	0
71-80	3	7.5	0	0	0	0
81-90	2	5	0	0	0	0
>90	0	0	0	0	0	0
Means	54.3		52		31.3	
Minimum	38.6		39.3		21.5	
Maximum	83.8		64.5		57.1	

TE - technical efficiency; AE - allocative efficiency; EE – economic efficiency

Socio-economic factors affecting farmer's efficiency

The socio-economic variables should be incorporated directly into the production frontier model because such variables may have a direct impact on efficiency (Galawat and Yabe, 2012). A description of the socio-economic variables is presented in Table 4.

Table 4. Socio-economic variables for efficiencies

Variables	Minimum	Maximum	Mean	Standard deviation
Farm size	0	1	0.375	0.49
Age	42	65	55.075	5.534
Education	0	1	0.575	0.5
Conventional experience	4	21	10.375	5.12
Organic experience	2	15	7.825	1.5
Family member	1	7	4.175	1.43
Off-farm income	0	1	0.225	0.422

Some points in Table 4 are worth discussing. First, Farm size acreage is defined in hectares where 1 means more than one hectare and 0 is for otherwise. Second, AGE is defined as the age of the main farmer in organic farming. The average age of respondents is 55.07 years (ranging between 42-65 years), and most of them are retirees. Third, Education variable will be explained as a dummy variable. If a farmer has ever attended elementary school the value is 0, and 1 represents post-elementary school education. Fourth, Conventional experience variable is the number of years the farmers were involved in conventional rice farming before the change to organic farming. The average for conventional farm experience is ten years. The Organic experience variable is the number of years that the farmers have been involved in organic rice farming. Fifth, the Family member variable is defined as the total number of persons in the farmer's home. Last, the Off-farm income variable is farmers' income from jobs other than organic rice farming, where 1 means yes and 0 is for otherwise.

Based on the equation (8), the model uses a two-limits Tobit procedure, which bounds the efficiency between 0 and 1. The model can be written as follow.

$$\text{Efficiency} = \delta_0 + \delta_1 \text{Farm\_size} + \delta_2 \text{Age} + \delta_3 \text{Education} + \delta_4 \text{Conventional\_experience} + \delta_5 \text{Organic\_experience} + \delta_6 \text{Family\_ member} + \delta_7 \text{Off\_farm\_income} \quad (12)$$

Where Efficiency is the technical inefficiency, allocative efficiency, or economic efficiency of farmers calculated in the previous frontier functions. The variables used in this study have been adopted in many stochastic frontier studies.

Table 5 presents the results of the two limits Tobit from equation (7), which was used to estimate socio-economic factors that affect efficiency. According to the results, the estimated coefficient of Farm size shows a robust and positive relationship with TE and EE. The result of Farm size indicates that farmers with a middle-farm (more than 1 ha) tend to have a TE and EE advantage compared to small-farms (less than 1 ha). The proposition suggests that those large farms are more efficient than small ones, namely as economies of scale. The large-scale farm usually uses modern technology to cultivate and harvest.

The analysis finds that Age has an insignificant statistical connection with technical efficiency and economic efficiency. Based on the survey, the majority age of respondents is between 50-60 years' old (60% of respondents). 25% of respondents are under 50 years old, and 15% of respondents are over 60 years old. Based on the data, 75% of the respondents are over 50 years old. This condition explains that older farmers may find it difficult to learn how to use organic technology, which thus results in a farm's technical inefficiency. The Age variable also has a significant negative relationship to allocative efficiency, as a higher age will decrease the ability of farmers to learn. Douglas (2008) also reveals the same result: farmers' creativity becomes lower when they become older. This fact is reinforced by the research of Supan and Weiss (2016) into the correlation between productivity and age, the result of which being that large-scale productivity declines from the age of 60. Labor

Table 5. Tobit equation to estimate technical, allocative, and economic efficiencies

Variables	Parameters	Technical efficiency		Allocative efficiency		Economic efficiency	
		Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Constant	δ0	-3.696***	0.66	-0.232	0.485	-2.438***	0.472
		(0)		(0.635)		(0)	
Farm size	δ1	0.032**	0.015	0.006***	0.011	0.011**	0.011
		(0.048)		(0.005)		(0.024)	
Age	δ2	-0.079	0.09	-0.075**	0.066	0.001	0.064
		(0.382)		(0.044)		(0.986)	
Education	δ3	-0.001*	0.016	0.008	0.011	-0.002**	0.011
		(0.053)		(0.481)		(0.031)	
Conv. experience	δ4	-0.028**	0.018	-0.013*	0.013	-0.022*	0.013
		(0.029)		(0.036)		(0.043)	
Organic experience	δ5	0.011**	0.022	0.008*	0.016	0.002**	0.016
		(0.004)		(0.041)		(0.007)	
Family member	δ6	0.02*	0.019	-0.016**	0.014	-0.02*	0.013
		(0.045)		(0.008)		(0.04)	
Off-farm income	δ7	-0.04***	0.019	0.011	0.014	-0.016***	0.014
		(0)		(0.265)		(0)	
Log-likelihood		62.042		83.264		78.65	

* P<0.05; **P<0.01; ***P<0.001.

productivity will affect a farm's production. Based on the productive Indonesian age, which is between 20 to 45 years old, productivity will stagnate and decrease from the age of 55 years old.

The Education factor is negatively significant for both technical efficiency and economic efficiency. The negative means less educated farmers are more productive than more educated farmers. Most of the educated farmers have an alternative income source and are not very attentive to their farming. In that case, they tend to rely on fixed laborers in the form of people who have received either minimum education or no education at all. The other reason, regarding the labor theory of leisure choice, is that farmers with a higher education prefer leisure time to work.

Kauffman (1999) described such people as "laidback"; that is, someone who wants to increase leisure by one hour but has to forego the opportunity of earning income (wage per hour). Such changes occur when the income effect is higher than the substitution effect. Education is insignificant regarding the influence it had on allocative efficiency because the majority of the respondents were elementary school graduates (44%). Around 56% of respondents had been educated to a higher level than elementary school. This condition does not guarantee that farmers are willing to apply new technology but occurs because, in the research area, rice cultivation is still a hereditary profession

The coefficient of Conventional experience has a negative statistically significant connection with all efficiency category. The negative result means that more experienced conventional farmers tend to be more reluctant to apply the organic farming system. Also, farmers with more conventional experience will be more accustomed to using chemical fertilizers and pesticides. If a farmer has not yet mastered the techniques of organic fertilizers and pesticide production, there is often a reluctance to implement such methods because they are perceived as a troublesome. The other reason, as stated by Douglas (2008), is that experience has a positive correlation with age. When a farmer becomes older, their experience exceeds their creativity, which declines. In the process of organic farming, the farming experience is not enough: it takes creativity to protect crops from pests without the use of chemical pesticides. Based on the results of the intensive interviews conducted with the sample of organic farmers, problem-solving is required when dealing with pests such as mice, *orseolia orizae* (wood mason), and the brown plant hopper. They use natural ingredients, such as a local spice blend. Thus, it requires the creativity to produce effective pest extermination, which, in turn, effects efficiency.

The estimated coefficient of Organic experience has a positive contribution to all efficiency categories. It indicates that farmers with more farming experience tend to be more efficient than inexperienced farmers. Farmers with more experience tend to become more efficient through "learning by doing" than a farmer with less experience (Shehu et al., 2007). In other words, experienced organic farmers can manage and allocate inputs more efficient than inexperience farmers. Based on the survey interviews, there are some things that a farmer should do when farming organic rice. First, the organic farmer must be able to make organic seeds. Second, the organic farmer must protect their crop by using the natural enemies of plants, which means the use of a "barrier crop," and natural ingredient pesticides. Third, make biodynamic organic fertilizer from the stone meal, manure, and crop dung. Last, the farmer cannot burn rice straw to preserve the environment and diversity of the ecosystems in the field.

The Family member variable is significant to farming management because the lower the number of family members, the higher the farmer's responsibility for jobs that need fulfilling. Based on the sample data, the average number of family members is four. The lowest member is two, and most are seven family members. The coefficient Family member has a positive impact on technical efficiency because a higher number of family members means more help when farming organic rice. However, the family number is negative with allocative and economic efficiency because a large number of family members means a higher rate of consumption. Besides at the level of subsistence agriculture and small scale farmers, most of the rice production is used to meet consumption needs (Galawat and Yabe, 2012). These findings are consistent with research by Girei et al. (2013), which states that the number of family members increases the level of technical efficiency.

The Off-farm income variable accounts for farmers receiving an income besides that of their organic rice revenue. Based on the survey data, 25% of the farmers engaged in other activities, such a building, cattle breeding, and mercantile pursuits. Based on the Tobit equation, the Off-farm income variable is negatively significant for technical efficiency because such farmers have to handle more than one job at the same time. Also, farmers who have other forms of income are not dependent on their organic rice income, and consequently do not attain optimal farming efficiency. The Off-farm income is insignificant with regards to allocative and economic efficiency because the smaller income attained from off-farm activities is exhausted by daily needs and thus cannot be invested in modern technologies.

CONCLUSIONS

There are three conclusions about efficiency levels in organic rice farms when the analysis is integrated with production function and socio-economic factors. First, organic pesticides, land area, and organic fertilizer are substantial variables. An investment in these three variables can be significant to the improvement of organic rice production. However, the labor variable is not significant to production (due to the dissipation of labor during planting and harvesting).

Second, this study also reveals the average levels of technical, allocative, and economic efficiencies, which are equal to 54.3%, 52%, and 31.3%, respectively. The efficiency scores suggest that substantial gains in output or a decrement in cost could be attained through the use of existing technologies. The technologies that need to be improved are not only exogenous technologies (machine) but also the endogenous technologies (human capital).

Third, the socio-economic point of view is that farm size, experience, and family members are significant to all efficiency levels. The implication of farm size is one of an "economy of scale," with the cost per unit of output decreasing with an increasing scale. Finally, the improvement of significant input factors and socio-economic factors is suggested to boost production efficiency.

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