American Journal of Applied Sciences

Original Research Paper

Socio-Economic and Technical Efficiency Level of Organic Rice Farming with System of Rice Intensification: A Case Study in Morowali Regency Indonesia

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Article history
Received: 27-02-2015
Revised: 26-05-2015
Accepted: 02-06-2015

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Abstract: This research aimed to (1) analyze technical efficiency level of rice farming with System of Rice Intensification and non-System of Rice Intensification and (2) analyze the factors that affected technical efficiency of rice farming. The research was conducted in Morowali Regency Indonesia. The populations in this research were farmer associations of water users, who membered as many as 104 household heads. Sampling was done by census. The number of samples that were used as many as 104 household heads, 47 household heads of rice farmers with System of Rice Intensification and 57 household heads of farmers with non-System of Rice Intensification. The result showed rice farming with System of Rice Intensification had a higher technical efficiency level when compared with rice farming with non-System of Rice Intensification. This was due to rice farming with System of Rice Intensification had more farmers who used organic fertilizers. The usage of organic fertilizers, age of farmers, education of farmers, frequency of following extension and System of Rice Intensification affected toward the technical efficiency of rice farming. Farmers could increase organic rice production with System of Rice Intensification.

Keywords: Rice, System of Rice Intensification, Organic Fertilizers

Introduction

Rice is one of the important food crops in Indonesia. The dependence on food crops, especially rice is still very large. Total calories consumed by the community in Indonesia are almost 60% that satisfied by rice (Pirngadi *et al*., 2002; Makarim and Suhartatik, 2006).

The achievement of rice self-sufficiency in Indonesia in 1984 was the transition of traditional farming technique (organic farming) to non-organic farming. Rice produced is the result of modern agriculture by using fertilizers and chemical pesticides. The techniques create negative impact of excessive chemicals usage. Excessive chemicals will affect the health of farmers as farming actors and farmers will have difficulty in fulfilling the input.

One of alternatives farming systems that can resolve the problem is organic farming (Sumardi *et al*., 2007). This alternative is very important in facing the issue of food safety. When the community became increasingly aware of the dangers of fertilizers usage and pesticides made by chemical then farming that produced healthy organic food was expected could be a solution.

Farming system that used organic materials is the System of Rice Intensification (SRI). In 1991, SRI began to be tested and applied to Asia region, this method was used to improve the state of soil fertility and rice productivity due to the saturation of the usage of fertilizers and chemical pesticides. This was proved by the results that were enough positive, namely rice that produced were about 8 tons/hectare were higher when compared with the results of national average (Pirngadi, 2009). SRI is method of rice crops cultivation by intensively, efficient and environmental friendly. SRI method is water-saving and do not use an-organic fertilizers (Ferdinan and Harmailis, 2007; Sumardi *et al*., 2007).

SRI technology is one of rice crops cultivation of water-saving, high yield and cost efficiency. Rice crops cultivation by organically with the usage of SRI on rice fields, will be obtained some advantages such as the usage of more efficient seeds per hectare and productions achieved will increase by 50% (Marlina *et al*., 2012).

SRI had been tested in more than 18 countries in the world, such as China, Cambodia, Philippine, Myanmar, Bangladesh, India, Nepal, Cuba, Indonesia and the others with results that were achieved between 7-12 tons/ha. This system had been developed in a number of regions in Indonesia and was proved could increase rice production (Pirngadi *et al*., 2002; Anugrah *et al*., 2008).

The application of rice crop cultivation by using SRI is basically intended to obtain high production. SRI also includes cultivation system of water-saving, so it is very suitable to be applied in the irrigation area which always has a shortage of water, especially during the dry season. Rice cultivation method on SRI was expected to give a significant contribution toward production increasing and profits.

Besides the method of cultivation, the efficient of production input usage also very determines the production of rice farming (Hormozi *et al*., 2013; Ojogho and Alufohai, 2010; Wen *et al*., 2011; Maruyama *et al*., 2014; Watkins *et al*., 2014). The effort of rice production increasing through the efficiency of input usage became the right choice. Rice production is affected by agricultural land, labor, capital and management, but in practice, the factors that affect rice production can be divided into two groups, namely biological factors, such as agricultural land and fertilizers and socio-economic factors such as labor. This research aimed to (1) analyze technical efficiency level of rice farming with SRI and non-SRI and (2) analyze the socio-economic factors that affect technical efficiency of rice farming.

Research Methods

The research was conducted in Wita Ponda Sub-Regency Morowali Regency Indonesia. It was done because Wita Ponda Sub-Regency had applied SRI pattern in organic rice farming. The populations in this research were farmer associations of water users in Wita Ponda Sub-Regency. Associations of water users had members as many as 104 Household Heads (HH), but from all of associations of water users members were not entirely applied SRI pattern in their farming. Considered the condition, then the determination of respondent in this research was done by census method. Farmers of associations of water users members amounted 104 HH that consisted of 47 HH who applied SRI and 57 HH who applied non-SRI.

The stochastic frontier production function was used to answer the first objective. This function is based on the model that developed by Coelli *et al*. (2005):

$$\ln Y_i = \lambda_0 + \sum_{j=1}^{k} \lambda_j \ln X_{ji} + (V_i - U_i) \quad (1)$$

The production function was assumed to have a Cobb-Douglas form who transformed into natural logarithm form:

$$\begin{aligned} \ln Y &= \lambda_0 + \lambda_1 \ln BNH \\ &+ \lambda_2 \ln PUK + \lambda_3\, Pest + \lambda_4 \ln TK + (V_i + U_i) \end{aligned} \quad (2)$$

Where :
Y = Rice production (kg)
BNH = Seed (kg)
PUK = Fertilizers (kg)
Pest = Pesticides (liter)
TK = Labor (HOK)
V_i = Error of random model
U_i = Random variable that presented the inefficiency of i sample technical

Technical efficiency level of rice farming was estimated by the formula of (Coelli *et al*., 2005):

$$TE_i = \frac{y_i}{y_i^*} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} = \exp(-u_i) \quad (3)$$

Where:
y_i = Actual production
y_i^* = Alleged of frontier production

Multiple linear regression model was used to answer the second objective:

$$TE_i = \delta_0 + \delta_1 X_1 + \delta_2 X_2 + \delta_3 D_1 + \delta_4 D_2 + \delta_5 D_3 + \mu_i \quad (4)$$

Where:
TE_i = Technical efficiency that was estimated;
δ_1-δ_5 = Regression coefficient
X_1 = Age of respondent
X_2 = Frequency of following agricultural extension;
D_1 = Dummy education
D = 0 for farmers who did not graduate from elementary school
D = 1 for other farmers
D_2 = Dummy organic
D = 0 for farmers without organic
D = 1 for farmers used organic
D_3 = dummy SRI
D = 0 for non-SRI farmers
D = 1 for SRI farmers
μ_i = error term

Results

Technical Efficiency Level

Technical efficiency of rice farming in this research used the stochastic frontier production function. This analysis was used to measure the technical efficiency level of rice farming with SRI and non-SRI. The form of production function that used was Cobb Douglas Stochastic Frontier. This production function is taken on the grounds: (1) homogeneous, (2) a simpler form, (3) could be made in form of additive linear and (4) rarely caused problems (Debertin, 1986).

The analysis results of technical efficiency level of organic rice farming are seen on Table 1.

Technical efficiency level of rice farming with SRI ranged from 0.4804 to 0.9604 with average value of 0.8432 and rice farming with non-SRI ranged from 0.3819 to 0.9390 with average value of 0.7463.

The Effect of Farmers Socio-Economic toward Technical Efficiency Level

Multiple regression analysis was used to analyze the effect of farmers socio-economic toward technical efficiency level of rice farming. Farmers socio-economic in this research were age of farmers, education of farmers, frequency of following extension, usage of organic fertilizers and SRI cropping. The results of multiple regression analysis of farmers socio-economic effect toward technical efficiency level of rice farming are seen on Table 2.

Adjusted R Square 0.677 shows that variation of technical efficiency level of rice farming could be explained by the independent variables of age of farmers, education of farmers, frequency of following extension, usage of organic fertilizers and SRI cropping simultaneously amounted 67.70%, while its remaining 32.30% were explained by the other factors.

Discussion

Table 1 shows SRI organic rice farming had a higher technical efficiency level when compared with non-SRI organic rice farming. This was due to SRI rice farming had more farmers who used organic fertilizers. SRI farming in the research area was semi-organic agriculture, where farmers used organic materials as one of the inputs that served as soil and supplement of synthetic chemical fertilizers (Las *et al*., 2006). Pesticides were used selectively and limited. The main cornerstone was a modern agricultural system Good Agricultural Practices (GAP) that prioritized productivity, efficiency of production system, security and preservation of natural resources and environmental.

Table 2 shows F statistic = 44.185 significant at α 1%, it meant simultaneously independent variables of age of farmers, education of farmers, frequency of following extension, usage of organic fertilizers and SRI cropping affected toward technical efficiency of rice farming. Partially can be explained as following.

Age of farmers affected positive and significant toward technical efficiency level of rice farming at confidence level 99%. Age of farmers could reduce inefficiencies of farmers in rice farming. This was consistent with the research of (Islam *et al*., 2012; Balde *et al*., 2014; Ogundari *et al*., 2010; Piya *et al*., 2012). Age of farmers correlate with farming experience if farming was done continuously. The older age of farmers then tended the more experiences they had, in this case knowledge and ability in rice farming. Farming experience could encourage farmers to do actions that could advance their farming.

Education of farmers affected positive and significant toward technical efficiency level of rice farming at confidence level 95%. Education of farmers could reduce inefficiencies of farmers in rice farming. This was supported by research of (Ogisi *et al*., 2012; Ogundari *et al*., 2010; Donkoh *et al*., 2013; Piya *et al*., 2012; Mailena *et al*., 2014a; 2014b). The level of person education could affect the decision making process, which was related to the maturity of thinking that owned to manage farming activities that more effective and efficient as well as easier in receiving information and new technology. The level of education was one of factors that supported the production process of a farming.

Table 1. The distribution of technical efficiency level of rice farming

	Rice cropping systems	
Interval (%)	SRI	Non SRI
0.3819-0.5746	3	6
0.5747-0.7674	2	17
0.7675-0.9604	42	34
Total	47	57

Table 2. Estimation of parameters

					Collinearity statistics	
Model	Coefficients	Std. Error	t	Sig.	Tolerance	VIF
(constant)	0.821					
age of farmers	0.048	0.013	3.794**	0.000	0.337	2.965
education of farmers	0.022	0.009	2.425*	0.017	0.670	1.493
following extension	0.054	0.012	4.539**	0.000	0.372	2.689
organic fertilizers	0.052	0.010	5.100**	0.000	0.510	1.961
SRI	0.025	0.008	3.204**	0.002	0.844	1.184
Adjusted R Square 0.677						
F = 44.185**						

* Significant at α 5%
** Significant at α 1%

Education is the main modal in analyzing a job, so that farmers can streamline production factors used. The usage efficiency of production factors can reduce the cost of production so that income of farmers can increase.

Frequency of following extension affected positive and significant toward technical efficiency level of rice farming at confidence level 99%. Following extension could reduce inefficiencies of farmers in rice farming. It was strengthened by research of (Lawal *et al*., 2014; Islam *et al*., 2012; Ogisi *et al*., 2012). Extension is one of innovation diffusion ways, so that farmers who were often followed the extension been expected could adopt the innovation which recommended in order of increasing their farming production.

The usage of organic fertilizers affected positive and significant toward technical efficiency level of rice farming at confidence level 99%. The usage of organic fertilizers could reduce inefficiencies of farmers in rice farming. This is due to the organic materials serve as soil and supplement of synthetic chemical fertilizers (Las *et al*., 2006). The Sustainability of high efficiency would depend on the continued support which farmers received in the field of inputs providing (Donkoh *et al*., 2013).

Cropping rice with SRI affected positive and significant toward technical efficiency level of rice farming at confidence level 99%. SRI could reduce inefficiencies of farmers in rice farming. This was due to most of SRI farmers used semi-organic input. Organic SRI can restore the state of soil fertility and rice productivity due to the saturation of fertilizers usage and chemical pesticides (Pirngadi, 2009).

Conclusion

SRI rice farming had a higher technical efficiency level when compared with non-SRI rice farming. This was due to SRI rice farming had more farmers who used organic fertilizers. Partially age of farmers, education of farmers, frequency of following extension, usage of organic fertilizers and SRI affected toward technical efficiency of rice farming. Farmers could increase rice production with organic SRI.

Acknowledgement

The author would like to thank Prof. Dr. Ir. Muhammad Basir, SE., MS and Prof. Dr. Ir. Made Antara, MP who had guided and directed the author. The author also liked to thank the reviewers so this paper could be published.

Funding Information

This article was funded by the University of Tadulako. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Ethics

This article is original and contains unpublished material.

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