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RESEARCH ARTICLE

Effect of Institution on Production Cost Efficiency of Organic Rice Farming in Indonesia

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Abstract: This study is about the effect of an institution on the production cost efficiency of organic rice farming. This research used the stochastic frontier approach with cross-section data and estimated with maximum likelihood estimation (MLE). This study aims to determine the effect of institution variables on production cost inefficiency. A survey was conducted on 216 organic rice farmers during two planting seasons using purposive sampling method in Dlingo Village, Mojosongo, Boyolali, Central Java, Indonesia. The result of the research shows that the average value of production cost efficiency is 0.4268. The role of farmer groups and agricultural counselors is the most dominant variable in determining the production cost inefficiency of organic rice farming.

***Keywords*:** *Indonesia*, *institution, organic rice farming, production cost, stochastic frontier*

JEL Classification: Q1, Q12

The environmental problems have become a global issue and hot topic since the 1970s. Hartati (2012) explained that environmental concern is caused by several factors: (1) the environmental problems always have global effects, (2) the environmental issue is also related to exploitation of global resources, (3) the environmental problems are always transnational, and (4) environment exploitation or degradationhas local or national scale, and they are done in several places throughout the world, thus it can be considered as global problems.

The excessive exploitation of natural resources and environmental degradation have impacts on the environment's health. Ethical concerns about the health of the environment lead to an approach known as the sustainable development approach. The principle of sustainable development in the Stockholm Declaration (Sohn, 1973) contains the human responsibility to

protect the environment and natural resources for present and future benefit.

Agriculture is a natural processing activity related to sustainable development. The use of agricultural means of production input in enhancing productivity has impacts on the environment. Therefore, the concept of sustainable agriculture is an important part of sustainable development. Sustainable agriculture (Salikin, 2003) is a moral call to do good on the natural resources regarding three dimensions of environmental awareness, economic, and social character. One of the sustainable farming practices that consider those three aspects is the organic farming system.

Organic farming is very important because it can indirectly, in the long term, be an alternative solution to the problem of rice production through natural recycling to increase soil productivity. Sutanto (2002a) explained that one of the basic principles of the development of soil fertility is through the management of organic matter. Management of organic material is then applied in organic rice farming.Organic rice farming system is a system of farming that is environmentally friendly. The Food and Agriculture Organization, according to Scherer (2013), described that organic farming is designed to increase soil biological activity; to maintain long-term soil fertility; to promote the use of land, water, and healthy air; as well as to minimize all forms of pollution that may result from agricultural practices.

Another advantage of organic rice farming, in addition to the health of the environment, is the product produced. The rice produced is healthier as it is free from fertilizers and other chemicals. Sutanto (2002b) related that organic farming provides chemicals residue-free agricultural products that improve public health.

An organic farming system is a business in the field of agriculture that combines natural factors of production, labor, and capital. In the farming system, a balance between revenue earned and expenses incurred is needed. The fundamental problem in organic rice farming system is on its efficiency. Organic rice farming system is expected to be efficient. By being efficient, the revenue of organic rice farming system can be increased and the intended final destination such as the welfare of farmers can be achieved. So it can be concluded that organic farming makes an important contribution to human health through the food produced, the health of the economy through the income of farmers, and the health of the earth through environmentally friendly activities.

Research about efficiency in organic rice production using stochastic frontier approach is still limited compared to research about efficiency in conventional rice production, especially about the production cost efficiency. Previous researches use more stochastic frontier production function (Kalirajan, 1981; Jondrow, Lovell, Materov, & Schmidt, 1982; Kalirajan & Flinn, 1983; Kalirajan, 1984; Ekayanake, 1987; Battese & Coelli, 1988, 1992, 1993, 1995; Ajibun, Battese, & Kada, 1996; Xu & Jeffrey, 1998; Sumaryanto, 2001; Ogundele & Okoruwa, 2006; Baten, Kamil, & Haque, 2009; Kusnadi, Tinaprilla, Susilowati, & Purwoto, 2011; Galawat & Mitsuyasu, 2012; Suharyanto, Mulyo, Darwanto, & Widodo, 2013; Kadiri et al., 2014; and Lema, Tessema, & Abebe, 2016). There are several research about production cost efficiency on conventional rice farming with stochastic frontier approach, such as those done by Kolawole (2007), Ghosh and Raychaudhuri (2010, 2015), Hidayah, Hanani, Anindita, and Setiawan (2013), Nandi and Basu (2013), Ajoma, Ezihe, and Odoemenem (2016), and Rathnayake and Amaratunge (2016).

In stochastic frontier, there are error factors caused by factors beyond the farmers' control and those under the farmers' control. This research used error factors caused by factors under the farmers' control. Some factors commonly used are farmers' age, level of formal education, farming period, and the number of family members. Newly used factors are the frequency of participation in extension, the frequency of participation in training or courses, the role of farmer groups and counselors, the role of institutions, and farm management.

The fundamental problem in organic rice farming system is on its efficiency. Even today, the problem of organic rice farming system is the varied production and production cost among farmers leading to the difference in production cost and productivity which then affect the farmers' income. Hence, the aim of this study is to determine the effect of institution variables on production cost inefficiency of organic rice farming using the stochastic frontier production cost function approach. The use of organic production factors is expected to be able to suppress the cost of organic rice production which then increases profit. Production cost inefficiency is one of the factors causing high level of

production cost, low level of production output, and income for the organic rice farmers.

Agricultural institution is a custom that is organized and applied continuously to meet the needs of the society, which areclosely related to the livelihood of agriculture in rural area. In the life of a farmer's community, the position and function of farmer institution is a part of social institutions that facilitate social interaction in a community. In addition, the farmer institution also has a strategic point in moving the agricultural system in the rural area. Institutional role in establishing and developing the agricultural sector in Indonesia is particularly noticeable in the activities of food crops, especially organic rice farming system.

Theoretical Approaches

The approach used in this research is the concept of efficiency proposed by Farrell (1957) and Coelli, Rao, and Battese (1998) who classified efficiency into three classes, namely, technical efficiency, allocative efficiency, and economic efficiency. This research is limited to allocative or production cost efficiency.

Production cost efficiency shows the ability of a farming system to obtain maximum output from a certain number of inputs. This suggests that production cost efficiency is a relative measure of the farmers' ability in using inputs to produce a certain level of output at a certain level of technology. Production cost efficiency can be achieved by a technically efficient farming system.

Aigner, Lovell, and Schmidt (1977), Meeusen and Van den Broeck (1977), Jondrow et al. (1982), and Coelli (1996) suggested that stochastic frontier function is an extension of the original deterministic models to measure the unpredictable effects (stochastic frontier) in the production limits. In production cost function, random error (V_i) is added into a non-negative random variable (U_i). Random error (V_i), is used to calculate the size of the error and other random factors such as weather and others, together with the effect of the combination of input variables that are undefined in the production cost function. Variable V_i is a random variable that is independent and identically distributed normal (independent identically-distributed) with zero mean and constant variant. Variable U_i is assumed as i exponential or half-normal random variable (half-normal variables). To determine the stochastic frontier cost function, change the specification of error of ($V_i - U_i$) to ($V_i + U_i$), so that this substitution will alter the production cost function as the following function:

$$C = \beta_0 + \beta_i P_i + ,\ldots, + \beta_k P_k + (V_i + U_i) ,i = 1,\ldots,N, \quad (1)$$

where:

- C = cost of production on organic rice farming in natural logarithm (ln)
- P_i = input price normalized with output price in natural logarithm (ln)
- β_0 = constant
- β_{i-k} = estimated parameter
- V_i = error factors caused by factors beyond the farmers'control
- U_i = error factors caused by factors under the farmers'control

In the production cost function, U_i determines how far the farmers can operate in their farming system above the limit cost frontier. If allocative efficiency is assumed, U_i is closely related to the production cost inefficiency. If this assumption is not made, the interpretation of U_i in the production cost function is less clear, with both technical and allocative inefficiency used.

Materials and Methods

Determination of Research Place

The total number of certified organic farmers is 521 people spread over five districts, seven villages, and 10 farmers' groups. From the 10 farmers' groups, two groups were chosen, namely *Pangudi Raharjo* and *Pangudi Boga* located in Dlingo Village, Mojosongo Subdistrict, Boyolali Regency, Central Java Province of Indonesia. These groups were chosen because: (i) both groups are located in the same area, (ii) they have the same water source from soil water irrigation, (iii) they are separated from other farmers' groups, and (iv) they can carry out three planting seasons in a year.

Samples of Farmers

There is a total of 521 organic rice farmers with internal control system (ICS) and nationally certified from seven villages (Catur, Jatisari, Dlingo, Metuk, Andong, Wates, and Glonggong) and five subdistricts

(Andong, Simo, Mojosongo, Sambi, and Nagasari) in Boyolali Regency. From this population of farmers, the sample of 216 (organic rice farmer with national certification) was taken through purposive sampling method during two planting seasons. They are the members of *Pangudi Raharjo* and *Pangudi Boga* farmer groups in Dlingo Village, Mojosongo Subdistrict, Boyolali Regency, Central Java, Indonesia.

Data Analysis

To determine the effect of institutionon the cost efficiency of organic rice farming system in Boyolali, stochastic frontier cost function with cross section data and the estimation was used.Stochastic frontier cost function is assumed to have Cobb-Douglas function form that transformed into natural logarithm (ln). Stochastic frontier cost function is formulated as follows:

$$C = \beta_0 + \beta_i P_i + ,\ldots, + \beta_k P_k + (V_i + U_i) \quad (2)$$

where:

- C = cost of production on organic rice farming in natural logarithm (ln)
- P_i = input prices normalized with output prices in natural logarithm (ln)
- β_0 = constant
  $\beta_{i\text{-}k}$ = estimated parameter
- V_i = error factors caused by factors beyond the farmers' control
- U_i = error factors caused by factors under the farmers' control

In cost function of organic rice farming system, factors estimated to affect the cost of production are the cost of land lease, the price of organic riceseed, the price of solid organic fertilizer, the price of liquid organic fertilizer, the price of liquid organic pesticides, the price of solid organic pesticides, the wage of labors, and the tractor's rental fee as well as the cost of cultivars used as dummy variables. By inserting these variables into the frontier equation, then the equation model of frontier production cost function estimator of organic rice farming can be written as follows:

$$\ln C = \beta_0 + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_3 + \beta_4 \ln P_4 + \beta_5 \ln P_5 + \beta_6 \ln P_6 + \beta_7 \ln P_7 + \beta_8 \ln P_8 + \beta_9 D_1 + \beta_{10} D_2 + \beta_{11} D_3 + (V_i + U_i) \quad (3)$$

where:

- C = cost of production onorganic rice farming (IDR/planting season)
- P_1 = the cost of land lease (IDR/ha/planting season)
- P_2 = the price of organic rice seeds (IDR/kg/ planting season)
- P_3 = the price of solid organic fertilizer (IDR/kg/ planting season)
- P_4 = the price of liquid organic fertilizer (IDR/ ltr/planting season)
- P_5 = the price of liquid organic pesticide (IDR/ ltr/planting season)
- P_6 = the price of solid organic pesticide (IDR/kg/ planting season)
- P_7 = the wage of labors (IDR/man days/planting season)
- P_8 = tractor's rental fee (IDR/ha/planting season)
- D_1 = Dummy 1 (D_1 = 1for *mentik wangi* cultivar; D_1 = 0 for other cultivars)
- D_2 = Dummy 2 (D_2 = 1 for IR64 cultivar; D_2 = 0 for other cultivar)
- D_3 = Dummy 3 (D_3 = 1 for *pandan wangi* cultivar; D_3 = 0 for other cultivars)
- β_0 = constant
- $\beta_{1,..,11}$ = coefficient of regression of production cost factors
- v_i = errors caused by factors beyond the farmers' control
- u_i = errors caused by factors under the farmers' control

To see the effect of the factors determining the level of cost inefficiency in organic rice farming system in Boyolali, Central Java, Indonesia, the following formula is used:

$$U_i = \boldsymbol{\delta}_0 + \boldsymbol{\delta}_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 + \delta_{10} Z_{10} \quad (4)$$

where:

- U_i = production cost inefficiency
- Z_1 = the farmer's age (years old)
- Z_2 = formal education level of the farmer (years)
- Z_3 = period of organic rice farming system (years)
- Z_4 = number of family members (person)
- Z_5 = frequency of participation in extension (times)

Z_6 = frequency of participation in training (times)
Z_7 = coaching or courses about organic rice farming (score)
Z_8 = the role of farmer groups and agricultural counselors (score)
Z_9 = the role of institutions/ associations (score)
Z_{10} = farming system management (score)
δ_0 = constant
$\delta_{1,..,10}$ = coefficient of regression on determinant factors of production cost inefficiency

Testing a hypothesis on the variables that influence the production cost inefficiency can be formulated as follows:

$H_0:\delta_i = 0$: If $t_{count} < t_{table}$, then H_0 was accepted (H_1 rejected). It means that the variables did not influence the production cost inefficiency of organic rice farming in Boyolali, Central Java, Indonesia.

$H_1:\delta_i \neq 0$: If $t_{count} > t_{table}$, then H_0 was rejected (H_1 accepted). It means that the variables influenced the production cost inefficiency of organic rice farming in Boyolali, Central Java, Indonesia.

Result and Discussions

Factors that Effect of Production Cost Function

Production cost of organic rice is determined by the use of the cost of the inputs, such as the cost of land lease, the cost organic paddy seeds, the cost of organic fertilizer (solid and liquid), the cost of organic pesticide (solid and liquid), labor cost, tractor's rental fee, and the cost of cultivars used. Analysis of production cost function describes the relation between production cost and inputs cost which is normalized with output price. In this research, production cost function with stochastic frontier Cobb-Douglas model and MLE as estimator was used.

All variables estimated to have an impact on production cost in organic rice farming system produce negative coefficient in accordance with the assumption of the stochastic frontier of production cost function. Among the eight variables estimated to affect production cost, the variables significantly affecting production cost are the cost of land lease, the price of organic riceseeds, the price of solid organic fertilizer, the wage of labors, and tractor's rental fee. The price of liquid organic fertilizer, liquid organic pesticide, and solid organic pesticide are not statistically significant.

The variables that negatively influence the production cost of organic rice farming are the cost of the land lease, the cost of organic rice seeds, cost of solid organic fertilizer, labor cost, and tractor's rental fee. These variables must be suppressed in order to reduce the cost of the inputs. This is an implication of the variables in the inputs, in the production cost function. It shows that if the variables are raised at a certain level, the production cost of organic rice farming will also increase. The variety of *mentik wangi* has the lowest value of cost production compared with other varieties (IR64, *pandan wangi,* and *padi merah*). The result of estimation of the cost production function is shown in Table 1.

The estimation results in Table 1 show that the value of the log likelihood function with MLE method amounted to 472.9363 which is much greater than the value of the log likelihood function with Ordinary Least Squares method in 84.2166. It indicates that the production cost function of the organic rice farming system using MLE method is better and in accordance with the conditions in the field. The value of sigma-square is equal to 0.2639 which shows the distribution of the error term of inefficiency (u_i) and the value is very small so it is normally distributed, or in other words, the value of $\sigma_u^2 > 0$. Therefore, it can be concluded that there is no evidence that all farming system done by the farmers is 100% efficient. It suggests that the variation of production contributed by cost inefficiency amounted to 26.39% (if $\sigma_u^2 = 0$, it means that all farming system done by the farmers is 100% efficient).

Table 1 shows that the gamma value (γ) is equal to 0.9701 and statistically, the estimated value of γ in the model is significant at α = 1%. It indicates that 97.01% of production cost variations are caused by inefficiencies (u_i) and 2.99% of the variations are caused by the uncontrolled variables or measurement error (v_i) or a factor that cannot be controlled by farmers. It suggests that the difference of stochastic frontier production cost function can properly explain the existing data on the occurrence of production cost inefficiency on organic rice farming system. Then, the result of the LR calculation of restricted parameter test is equal to 374.3945 which is greater than the critical

Table 1. *Estimation Result of Production Cost Function*

Variable	Parameter	Coefficient of regression	Standard error	t-ratio
Constant	β_0	0.0572***	0.3992	14.324
The cost of land lease	β_1	-0.0631***	0.0260	-2.425
The cost of organic rice seeds	β_2	-0.1811***	0.0236	-7.690
The cost of solid organic fertilizer	β_3	-0.1785***	0.0207	-8.670
The cost of liquidorganic fertilizer	β_4	-0.0004^{NS}	0.0025	-0.165
The cost of liquid organic pesticide	β_5	-0.0037^{NS}	0.0026	-1.430
The cost of solid organic pesticide	β_6	-0.0046^{NS}	0.0029	-1.532
The wage of labors	β_7	-0.1696***	0.0155	-10.971
Tractor's rental fee	β_8	-0.1807***	0.0288	-6.273
Dummy 1	β_9	-0.0826***	0.0321	-2.572
Dummy 2	β_{10}	-0.0627***	0.0263	-2.387
Dummy 3	β_{11}	-0.0471*	0.0274	-1.720
Sigma-square		0.2639***		
Gamma		0.9701***		
Log likelihood function		472.9363		
LR test of the one-sided error		374.3945		
Mean efficiency		0.4268		
Number of observations		216		

Source: Analysis of Primary Data 2016
Note:
**** = significant at α=1% t-table 1%*
*** = significant at α=5% t-table 5%*
** = significant at α=10% t-table 10%*
NS = non significant at α=10%

value from the table of Kodde and Palm (1986) and significant at α = 1%, that means there are inefficiency effects in the model that are stochastic. This fact identifies that organic rice farmers have not been fully efficient in carrying out their farming system.

The Causing Factors of Production Cost Inefficiency

There are several factors predicted to be the cause of the inefficiency of the production cost of organic rice farming, including: farmers' age; formal education level of farmers; period of organic rice farming; the number of farmers' family members; the frequency of participation in extension; frequency of participation in training, coaching, or courses about organic rice farming; the role of farmer groups and agricultural counselors; the role of institutions or associations; and farming system management on organic rice farming. The estimation result of factors causing production cost inefficiency on organic rice farming is shown in Table 2.

In general, the role of institutions has impacts on the inefficiency of the production cost of organic rice farming. Factors causing the inefficiency of production costs of organic rice farming are the age of farmers (α = 1%), the level of formal education of farmers (α = 1%), the frequency of participation in extension (α = 1%), coaching or courses about organic rice farming (α = 1%), the role of farmer groups and agricultural counselors (α = 1%), the role of institutions or associations (α = 5%), and farm management (α = 1%). While the period of organic rice farming system, the number of family members, and the frequency of participation in training do not statistically show significant influences on the inefficiency of organic rice production costs at α = 10%.

Table 2. *Estimation Result of Factors Causing Production Cost Inefficiency*

Variable	Parameter	Coefficient of regression	Standard error	t-count
Constant	δ_0	-0.1249***	0.0274	-4.383
Farmers' age	δ_1	0.0009***	0.0023	4.125
Formal education level of the farmers	δ_2	-0.0421***	0.0067	-6.268
Period of organic rice farming	δ_3	0.1092^{NS}	0.1584	0.689
Number of farmers' family members	δ_4	-0.1376^{NS}	0.2295	-0.599
Frequency of participation in extension	δ_5	-0.1255***	0.0193	-6.391
Frequency of participation in training	δ_6	0.0273^{NS}	0.0628	0.434
Coaching or courses about organic rice farming	δ_7	-0.2927***	0.0496	-5.898
The role of farmer groups and agricultural counselors	δ_8	-0.5497***	0.0921	-5.597
The role of institutions/ associations	δ_9	-0.0495**	0.0214	-2.317
Farming system management	δ_{10}	-0.4409***	0.1458	-3.024

Source: Analysis of Primary Data 2016
Note:

**** = significant at α=1%* *t-table 1% = 2,358*
*** = significant at α=5%* *t-table 5% = 1,980*
** = significant at α=10%* *t-table 10% = 1,658*
NS = non significant at α=10%

The age of the farmer (0.0009) has a positive correlation with inefficiency in organic rice farming. It shows that the older the farmer's age, inefficiency will increase. It proves that older farmers will result in a more inefficient farming practice. The causes of inefficiencies which have negative correlation are the level of formal education of farmers, the frequency of participation in extension, coaching or courses about organic rice farming, the role of farmer groups and agricultural counselors, the role of institutions or associations, and farm management. It means that the higher the value of these variables, inefficiency in organic rice farming will decrease.

The role of farmer groups and agricultural counselor is the most dominant variable in determining the production cost inefficiency with a coefficient value of -0.5497. It means that as the value of the role of farmer groups and agricultural counselors increase, the production cost inefficiency of organic rice farming will decrease. The second largest variable is the management of farming with a coefficient of -0.4409. It means that better farming management decreases the production cost inefficiency of organic rice farming.

The results of the research show that the farmers are not capable of running organic rice farming system efficiently. The use of cost factors cannot be combined well, causing inefficiency. This is indicated by the average value of efficiency, which is 0.4268 or 42.68%. The cost of production of organic rice farming will be more efficient if the role of farmer groups and agricultural counselors and farm management are improved. To achieve efficient organic rice farming, it is necessary to increase the value of variables: formal education level of the farmers, frequency of participation in extension, coaching or courses about organic rice farming, the role of farmer groups and agricultural counselors, the role of institutions/ associations, and farming system management, as well as to encourage the younger generation to participate in farming system.

In terms of institutions (the role of farmer groups and agricultural counselors), to reduce the inefficiency of farming costs, it is necessary to intensify the group meeting to discuss some matters such as: cultivation technique, marketing, the state of the group, the state of society, and mutual assistance in farm management.

For the farm management, to reduce the production cost inefficiency of organic rice farming, it is necessary to implement good management of farming such as the use of good cultivars, the application of proper tillage as directed, the good arrangement of plants population, the application of proper organic fertilizer, effective and efficient irrigation, and the good handling process of harvesting and post-harvest.

Conclusion

The results of the research about the effect of institutions on the production cost of organic rice farming in Indonesia can be summarized as follows:

1. There aresixtypes of inputsnegatively affecting the production cost of organic rice farming system, that is, the cost of land lease, cost of organic rice seeds, cost of solid organic fertilizer, labor cost, and tractor's rental fee.
2. The average value of production cost efficiency of organic rice farming is 0.4268.
3. There are four institutional variables that negatively affecting the production cost inefficiency of organic rice farming, that is, frequency of participation in extension; coaching or courses about organic rice farming; role of farmer groups and agricultural counselors; and role of institutions/ associations.
4. Variable of the role of farmer groups and agricultural counselors is the most dominant variable in determining the production cost inefficiency of organic rice farming.

Recommendation

This study found that the institutional variable (the role of farmer groups and agricultural counselors) has the most dominant effect on the production cost efficiency of organic rice farming in Boyolali, Central Java, Indonesia. This institutional influence is important for the development of organic rice farming, especially for the development of science for researchers, that is, research on topics of efficiency of organic rice farming associated with agribusiness and rural economic development. For the government, it is necessary to provide facilities and infrastructure for the development of organic agriculture, especially in terms of production costs for farmers. With the policies that favor smallholders or peasants, the government can help them so they can be economically independent and can improve their welfare of life.

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