Profitability and Efficiency of Production Inputs on Rice Farming at Karanganyar, Central Java-Indonesia

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Abstract

Increasing rice productivity and quality is sustainable efforts carried out continually. Socio-economic farmer's characteristics, profits and efficiency study in using production inputs on rice farming was successfully carried out using survey method from 30 farmers with structured questionnaire sampled randomly in Jetis sub-district, Karanganyar district, Central Java. Data analysis was done using descriptive statistics, profit analysis and production function. The results showed that rice farming at Karanganyar district, uniquely, was supported by productive age of farmers with more than 20 years' experiences and 86.7% of family labor. Revenue cost ratio (RCR) of the rice farming was high up to 2.26 mainly influenced by farm size, urea fertilizer and labor. Though the rice farming had high RCR, the farming was still backed up by not efficient yet and inefficient status of production inputs, except labor. Collaboration of farmers, local-national government and utilization of technologies is recommended to improve the rice farming.

Key words: Cost efficiency, production inputs, profit, and rice.

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INTRODUCTION

Rice (*Oryza sativa* L.) is the most important, strategic and politic food commodity in Indonesia due to more than 250 million people of the country depending on the commodity (Romadhon, 2017). Based on Agriculture Department data, it was known that total rice cultivation areas are 4.8 million ha with production of milled dry grain reaching 81.3 million tonnes and production surplus up to 17.4 million tonnes in grain and 2.85 in rice (Kontan.co.id, 2018). The rice price in wholesaler level during 2018 was 12,106 rupiahs per kg and increased 2.26% compared to 2017. Though Indonesian rice self-sufficiency has been established from 2016 till now and high economical values performed, increasing rice production, productivity and quality are generally carried out continually, not only in national level, but also in local scope.

Central Java is one of the main food producers and national food stock buffers in Indonesia, both food and horticulture crops (Statistics of Jawa Tengah Province, 2018). In rice, Central Java is the most important province with 1.8 million ha total rice cultivation areas, 9.51 tonnes per ha and 6.10 tonnes per ha their productivity (Movanita, 2018). In Central Java province, the highest productivity up to 7.53 tonnes per ha noted at Sukoharjo district and the lowest productivity of 4.31 tonnes per ha recorded at Pekalongan district (Statistics of Jawa Tengah Province, 2018). Furthermore, Karanganyar district is one of rice cultivation centers in Central Java with total cultivation areas of 48.131 ha, 311.919 tonnes total of production and 6.48 tonnes per ha their productivity in 2018 (Statistics of Karanganyar, 2018). Though the productivity was still lower than potential productivity of rice that can reach 8.42 to 10.58 tonnes per ha (InvestorDaily, 2019)) and Sukoharjo district, but the value was higher than that of Central Java productivity average value of 6.10 tonnes per ha (Statistics of Jawa Tengah Province, 2018; Statistics of Karanganyar, 2018a). The higher production of the rice both quantity and productivity was mainly reached successfully by optimal rice farming management with production input efficiency.

Production input efficiency is an effort to use resources efficiently in finding the highest production output in the final process. In optimal rice farming that can increase high profitability and production output, the production input efficiency is an important strategy significantly addressed for the purposes. Resource use efficiency on land, labor, fertilizer, herbicides, tools, seeds and equipment that affected to rice output was successfully conducted at Kwande local government area of Benue State-Negeria (Akighir and Shabu, 2011). Efficiency of resource use on labour, seed, fertilizer, plant protection chemical, capital and land for rice production was determined in Manipur-India (Devi and Singh, 2014). Production cost efficiency on labour, herbicides, fertilizer, seed and transportation gave high effect on *Abakaliki* rice production in Ihialia Local Government Area of Anambra State, Nigeria (Egbodion and Ahmadu, 2015). Irrigation, production techniques and amount of agricultural supporting staff were the most important influencing factors of rice production's technical efficiency in Cambodia (Kea et al., 2016). Lack of education, quality seeds, and irrigation machinery exhibited high effect on rice production efficiency at Bihar-India (Ahmad et al., 2017). The production input efficiency studies via paying attention on farm size, seeds, fertilizer, irrigation, labor, control of pests and diseases, government assistance, education, age of farmer, farming experiences, etc were also successfully conducted at Subang and Kerawang district, West Java (Tinaprila et al., 2013);

Tabanan, Buleleng and Gianyar districts, Bali (Suharyanto et al., 2015), North Pamona district, Central Sulawesi (Momondol and Tambe'o, 2016); Jember district-East Java (Wardana et al., 2018).

Though those studies were successfully conducted at several districts and provinces, there is no production input efficiency and profitability study on rice farming at Karanganyar distict, Central Java.

Objective of the study was to analyze production-input efficiency and profitability on rice farming at Karanganyar district, Central Java. The specific objectives were to examine the socio-economic characteristics of Karanganyar rice farmers in study area, to determine production input efficiency and profitability of rice farming at Karanganyar, Central Java.

MATERIAL AND METHODS

Jaten is one of 17 sub-districts of Karanganyar district. The sub-district is located 5 km from Karanganyar City to the west. Total area of the sub-district is 25.55 km^2 with 110 m above sea level (asl), total population is 84,145 persons consisting of 41,425 males and 42,721 females (Statistics of Karanganyar, 2018b). The Jaten has boundaries with Kebakramat sub-district in the north, Sukoharjo district in the south, Surakarta City in the west and Tasikmadu and Karanganyar sub-districts in the east. The several areas of the sub-district are the favoured agricultural area and has tropical climate with the rainy season between September to February and a dry season from March to August. This study was carried out from August to October 2017. The reason in selecting of August to carry out the study was based on reality that in this month, farmers finished their rice harvesting and marketing, so the farmers had enough time for interview both individually and in group.

A random sampling technique was employed to select a total of 30 farmers from the area. Data were collected by means of a structured questionnaire administered to the respondents, complemented with personal interview. The data collected covered (1) the socio-economic characteristics of respondents, 2) quantity and prices of production inputs, and 3) quantity and price of rice.

The rice farmers in Karanganyar district used production inputs in the form of seed, Urea, ZA and Phonska fertilizers, manure and labor. The number of input used was based on the farmer's habits and their capital. To know the profit of rice farming, the data obtained were analyzed financially using formula as described by Girei and Onuk (2016). The profitability of rice farming model is expressed as follows:

$\pi = TR - TC$ and $B/C = \pi/TC$

where :

π = profitability of rice farming (IDR/ha)

TR= total revenue (IDR/ha)

TC = total cost (IDR/ha)

R/C = feasibility of rice farming system

If the R/C > 1 means that the farmers have benefits so that rice farming is feasible to be developed, if R/C < 1 means that the farmers did not get a profit or loss so the rice farming is not feasible to be developed, but if R/C = 1 means farmers do not get profits but also do not gain lose, in this condition farmers are at break-even point.

To explore effect of all factors in the production process, the all factors were analyzed using the production function as described by Kea et al. (2016) as follows:

$$\ln Y = \ln a + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 + \alpha_4 \ln X_4 + \alpha_5 \ln X_5 + \alpha_6 \ln X_6 + \alpha_7 \ln X_7 + \mu$$

where:

Y	= production of rice (kg)
X_1	= area planting (ha)
X_2	= quantity of seed (kg)
X_3	= quantity of Urea (ha)
X_4	= quantity of ZA (kg)
X_5	= quantity of Phonska (kg)
X_6	= quantity of manure (kg)
X_7	= quantity of labor (man/day)
α	= regression coefficient
μ	= galat error

To know the accuracy of the production inputs, further analysis was carried out using value marginal product ($VMPx_i$) dan price of production inputs (Px_i). Production inputs used during rice farming were efficient when $VMPx = Px_i$ or ratio marginal product value and price inputs equal with 1 (Akighir and Shabu, 2016). Mathematically the formula is as follows :

$$VMPx_i = Px_i \text{ atau } VMPx_i/Px_i = 1 = k_i$$

Use of production input is not efficient yet because : 1) its use still low and 2) its use too high (Budiono and Adinurani, 2017) :

1. $k_i > 1$, means that the use of the production inputs, x is not efficient yet, to achieve the efficient production input, x shall be increased
2. $k_i < 1$, means that the use of the production inputs, x is not efficient yet, to achieve efficient production input, x has to be reduced
3. $k_i = 1$, means that the use of production input, x is efficient.

RESULTS AND DISCUSSION

Based on the socio-economic characteristics of respondents, it shows that 50.0 % of farmers were 15 - 60 years old and more than 60 years old (Table 1). The lowest age was 40 years and 77 years was the oldest age of respondent. This result shows that most of farmer was in productive age. The high productive age generally let to high rice farming occurred. The productive age was significantly strengthened by farming experience more than 20 years up to 63.3% and 86.7% of family work on farming activities. The strong points could cover weak characteristic dealing with education level that was only in elementary school.

Table 1. The Socio-economic characteristics of respondents

No	Description	Number	%
1.	Age of the family head		
	a. < 15 years	-	0.0
	b. 15 – 60 years	15	50.0
	c. > 60 years	15	50.0
2.	Education level:		
	a. Not school	3	10.0
	b. Elementary school	17	56.7
	c. Junior high school	5	16.7
	d. Senior high school	4	13.3
	e. Bachelor degree	1	3.3
3.	Farming experience		
	a. < 10 years	1	3.3
	b. 10 – 20 years	10	33.3
	c. > 20 years	19	63.3
4.	Number of family		
	a. ≤ 2 person	7	23.3
	b. 2 – 4 person	20	66.7
	c. > 4	3	10.0
5.	Work of family head		
	a. On farm	26	86.7
	b. Non farm	4	13.3

Performances of production inputs studied in Karanganyar district were expressed on farm size, seed, urea, phonska, and ZA fertilizers, manure and labor (Table 2). From the statistic summaries, it was clearly known that Karanganyar rice farmers were categorized in small scale farmers with farm size from 0.17 to 1.50 ha and 0.58 ha in average. For the small scale farmers, optimal using of all production inputs was generally carried out to gain maximal results. Seeds used by the farmers were Inpari 33 variety in 29.7 till 50.0 kg/ha with 32.5 kg in average. Inorganic fertilizers of urea, phonska and ZA were used on 175.0, 250.0 and 100.0 kg/ha in average respectively. Manures derived from organic materials such as goat, sheep, cow and chicken or plant wastes easily found around farmer environment and cheaper were usually applied 200-350 kg/ha with 262.5 kg/ha in average.

Table 2. The average use of production inputs per hectare on rice farming at Karanganyar district, Central Java

No	Type of Input	Minimum Value	Maximum Value	Average
1.	Farm size (ha)	0.17	1.50	0.58
1.	Seed (kg)	29.70	50.00	32.50
2.	Urea fertilizer (kg)	150.00	200.00	175.00
3.	Phonska fertilizer (kg)	150.00	300.00	250.00
4.	ZA fertilizer (kg)	75.00	150.00	100.00
4.	Manure (kg)	200.00	350.00	262.50
5.	Labor (man/day)	78.00	106.00	93.50

Labor at rice farming in Indonesia, involving at Karanganyar generally comes from within the family and some from outside the family (hired). Labors from family were usually employed for maintaining activities, i.e. fertilizing, weeding, and controlling pest and disease; while hired labors were worked by farmers on land processing, planting and harvesting activities. The labors employed in one planting season were as high as 93.50 man/day with a range of 78 – 106 man/day/ha.

Cost of rice farming is an expenditure of farmers to buy production inputs and pay labor wages. The rice farming activities get a profit when the rice yields derived from the activities can cover all farmer's expenditures and still leave other results to support their daily life. The cost structure of rice farming showed that wage of labor had the largest proportion up to 68.32% from total cost. The wage cost of labor used by farmers to pay nursery, land processing, planting, replacing dead plants, fertilizing, weeding, controlling pest and disease, and harvesting activities. Land processing using tillage machine, planting and harvesting were generally carried out by wholesale model, while weeding, fertilizing and controlling pest and disease were conducted as daily works. Furthermore, second high proportion cost was noted on tractor used during land processing with 11.69% and other production costs were less than 6%.

Rice production yield average obtained by farmers after harvesting time was 5 514.50 kg/ha (Table 3). At price level of IDR 4,200/kg, farmers got the revenue up to IDR 23,160,900/ha. The total production cost for rice farming activities was IDR 10,263,750. By reducing revenue with total production cost, in the end of process farmers gained the profit of IDR 12 897 150/ha. By dividing revenue with total cost of production, it was proved that RCR of rice farming in Karanganyar district was as high as 2.26. The RCR more than 1 gave indication that rice farming in the district was feasible economically to be developed. This is mean that every expenditure cost of IDR 1,000 for the production inputs, farmers got revenue of IDR 2,260.

Table 3. The average of cost and revenue on rice farming at Karanganyar district, Central Java

No	Type of Input	Average	Percentage of total cost (%)
1.	Cost of rice farming :		
	1. Seed (kg)	390,000	3.80
	2. Urea fertilizer (kg)	350,000	3.41
	3. Phonska fertilizer (kg)	600,000	5.85
	4. ZA fertilizer (kg)	180,000	1.75
	5. Pesticides	400,000	3.90
	6. Manure (kg)	131,250	1.28
	7. Labor (man/day)	7,012,500	68.32
	8. Tractor	1,200,000	11.69
	Total	10,263,750	100.00
2.	Production :		
	1. Production quantity (kg/ha)	5,514.50	
	2. Price (Rp/kg)	4.200	
3.	Revenue (Rp)	23,160,900	
4.	Profit	12,897,150	
5.	Revenue Cost Ratio (RCR)	2.26	

The results of the regression analysis of all factors indicated that most of production inputs gave significant effect on rice production at Karanganyar district. The coefficient of determination (R^2) obtained was very high up to 0.9427, meaning that 94.27% of rice production was influenced by variables studied, especially farm size and urea fertilizer, followed by labor (Table 4), while 5.73% was affected by other factors outside of the model such as rainfall, humidity, air temperature, etc. The results were also strengthened by F-test value of 51.72 that was greater than the F-table (3,47). Very significant effect (99%) of rice production was affected by farm size and urea fertilizer with 0.748 and 0.306 regression coefficients, respectively.

Significant effect (95%) of the production was showed positively by labor with 0.290 the regression coefficients and negatively by ZA fertilizer with – 0.021 the coefficients. For the positive effect of variables, increasing of them up to 10% will raise rice production up to 7.48; 3.06 and 2.90% for farm size, urea fertilizer and labor, respectively. However, for negative effect of ZA fertilizer, rising the variable up to 10% will reduce the production of rice down to 0.21%. The variance inflation (VIF) value obtained was less than 10, indicating that the model used was free from multi-collinearity problems.

Table 4. The estimation of factors that influence rice production in Karanganyar district, Central Java

Independent Variabel	Co-efficient.	St. Error	t-test	Probability	VIF
1. Constanta	5.835***	1.048	5.57	<.0001	0
2. Farm size	0.748***	0.201	3.72	0.0012	0.232
3. Seed	0.317	0.226	1.40	0.1749	7.403
4. Urea fertilizer	0.306***	0.148	2.07	0.0506	6.368
5. ZA fertilizer	-0.021 **	0.011	1.86	0.0768	1.955
6. Phonska fertilizer	-0.273	0.209	1.31	0.2046	0.563
7. Manure	0.073	0.083	0.88	0.3868	3.931
8. Labor	0.290 **	0.155	1.86	0.0758	4.089
R^2	0.9427				
F-test	51.72				

Production input efficiency as an effort to use resources efficiently in finding the highest production output can be captured from farmer habit, experience and capital. Results of the study indicated that though the RCR of rice farming at Karanganyar reaching 2.26, production inputs on the Karanganyar rice farming activities were still managed and used in-efficient situation in most of variables, except in labor variable. The RCR was primarily affected by farm size variable. This results, in fact, had closely relation to socio-economic characteristics, where rice farmers at Karanganyar generally had low education level (Table 1) and rice farming was usually carried out based on their parent habits without involving innovation technologies. This situation let to not efficient yet for seed, urea fertilizer and manure and in-efficient status for ZA and phonska fertilizer occurred naturally (Table 5). While labor was the one of the production inputs with efficient status. The efficient status was occurred due to most of Karanganyar farmers dominantly used labor within family to reduce hired labor cost.

Table 5. Estimation of Production Inputs Efficiency of rice farming in Karanganyar district, Central Java

Type of Production Input	Marginal Product	k_i	t_{hitung}	Status
1. Seed	53.788	18.826	1.328	Not efficient yet
2. Urea fertilizer	9.642	20.249	1.965	Not efficient yet
3. ZA fertilizer	-1.158	-2.702***	-2.616	Inefficient
4. Phonska fertilizer	-6.022	-10.538	-1.430	Inefficient
5. Manure	1.534	12.882	0.811	Not efficient yet
6. Labor	17.104	0.958	-0.082	Efficient

Entirely from the study, it was successfully revealed evidents on the rice farming at Karanganyar, Central Java-Indonesia. The Karanganyar rice farming was dominantly supported by farmers who had wide range of age from 15 – 70 years olds, low education level of elementary school and more than 20 years experience on rice farming downgraded from their parents and 90% work on farming activities.

Almost similar results on socio-economic farmer characteristics were also reported on Minahasa-North Sulawesi (Wangke, 2012), Kantong Perantau-West Sumatra (Afrizal et al., 2017). In several areas such as Bagan Terap, Panchang Bedena, Pasir Panjang, Sawah Simpadan, Sekinchan, Sg Leman, Sg Nipah, and Sg Burong of Malaysia, farming of rice was significantly backed with male farmers, married, 18.2% with 40-44 years old, 47.5% primary education, and 88.4% work on farming activities (Alam et al., 2010). In Kano State of Nigeria, rice farming was mainly fullfiled by male farmers, married, 44% with 41-50 years old, small farm size of 0.5-1.0 , 68% inherited, 80% Quranic education (Maji et al., 2012). Almost similar results with difference in 88% primary education were resported at Ogun State of Nigeria (Afolami et al., 2012) and Ekiti State of Nigeria (Osanyinlusi and Adenegan, 2016). Male farmers with 52.6%, married of 93.9%, and 60% illiterate were recorded on rice production in Ethiopia (Tsega et al., 2013), 30-50 years old of farmer age up to 66.1%, 41.9% SSC to intermediate education level, 11-20 year experiences were charateristic performances in Telangana, Coastal Andhra and Rayalaseema regions of Andhra Pradesh-India (Samarphita et al., 2016). From these results, there were almost similar socio-economic characteristics between Karanganyar farmers with Nigeria farmers generally.

The average use of production inputs per hectare on Kranganyar rice farming indicated different performances of 0.58 ha farm size needing 32.5 kg seed, 175 kg urea, 250 kg phonska, 100 kg ZA, 262.5 kg manure and 93.5 man/day. In Sumatra-Indonesia, to produce 2514 kg in 5897 square meters used 27 kg seed, 176 kg fertilizer, and 48 man/day labor (Haryanto et al., 2016). In Haryana state of India, for 2.57 ha land size of rice production and 108 quintals output, it was needed 1217.1 man/day, 441.8 kg NPK, 7854.5 Rs irrigation expenditure, and 2111.1 Rs insecticides (Goyal et al., 2006). In Muara and Temburong district of Brunei, to produce 1.74 tons of rice yield used 182 kg fertilizer, 12.3 ml herbicide, 2.6 ml pesticide and 1.68 man (Galawat and Yabe, 2012), 478.7 kg of rice yield from 0.6 ha farm size in Kwara state, Nigeria demanded 37.8 man/day, 7.34 kg seed, 10.5 kg fertilizer, and 9.9 liters' herbicide (Ogunniyi et al., 2015). These studies figured out that every rice production had different and specific needs to produce optimal rice yield.

Cost and profitability analysis of rice farming in Karanganyar District was high up to 2.26 of RCR, though the rice farming was only supported by male farmers having low education level and more than 20 year experiences. In the previous study in the similar area, the RCR of rice farming was 2.02 (Barokah et al., 2014), 2.88 RCR was reported in Aceh Besar district-Aceh (Fitria and Ali, 2014), 1.97 RCR was noted on organic rice farming at Tasikmalaya district-West Java (Wihastuti et al., 2017), 2.51 RCR of non upsus rice at Batang Asam district-Jambi province (Saidin and Adlaida, 2017), 1.6 benefit cost ratio (BCR) at Tapin district-South Kalimantan (Susmawati, 2018). In other countries, it was reported that BCR of organic rice production in Chitwan-Nepal was 1.15 (Adhikari, 2011), 1.39 – 3.24 BCR were recorded on Mardanai, Sara Saila, Basmati and Fakhre Malakand varieties at Malakand and Lower Dir district, Pakistan (Ahmad et al., 2015). Though each area had different RCR and BCR, it is fact that generally rice farming activities gave positive effects on farmer incomes.

In every area of rice production, successful in rice farming was affected by several factors. At Karanganyar rice-farming, 94.3% of rice production was significantly influenced by farm size, urea fertilizer and labor. Almost similar results on rice production in Sengah Temila sub-district of Landak district was significantly influenced by land size, seeds, pesticides and labors (Pudaka et al., 2018). At Benue State of Nigeria, farm size and fertilizer significantly affect the output of rice (Akighir and Shabu, 2011).

Soil fertility status, access to credit, household size and farmers experience were the factors that influence the efficiency levels of smallholder rice farmers at Southern Malawi (Magreta et al., 2013). Fertilizers, pesticides, labors, experiences, and distance to market were critical variables on rice production at Mekong Delta, Vietnam (Duy, 2015)). Age, education, experience and farm size significantly influence the farmers' efficiency in rice production at Kwara State-Nigeria (Ogunniyi et al., 2015). Abakalake rice production per hectare at Anambra State, Nigeria was obviously influenced by labour, herbicides, fertilizer, seeds and transportation (Egbodion and Ahmadu, 2015). Farm mechanical tools was determinants factor in rice production in Myanmar (Tun and Kang, 2015). Land, fertilizer and pesticide were major factors influencing household's rice production ant Battambang district-Cambodia (Kea et al., 2016). Rice farming efficiency at Bihar-India was affected by seed and household head (Ahmad et al., 2017). Distance to fields, mechanization, agricultural assets, share of remittances, education of household heads, and distance to town were important factors on rice production at Thailand (Ebers et al., 2017). Urea, MP, labor, irrigation and seed were high significant factors on production at Satkhira district in Bangladesh (Islam et al., 2017). Those results indicated that each rice farming area had specific and important factors differently.

Though RCR of rice farming at Karanganyar-Central Java was high, from six variables studied, only labor was in efficient status. While the most of variables was in not efficient yet and inefficient status. Therefore, improvement of those variables were importantly addressed via different approaches such as application of integrated crop management and innovation technologies related to rice cultivation. To support this condition, important role of local and national government is needed to accompany farmers in improving production input management and utilization. In other studies, high efficiency variables on rice production at Lamongan District-East Java-Indonesia were noted on land, urea, fertilizer and herbicide (Budono and Adinurani, 2016), at Mahiyanganaya-Srilangka on farmer experience (Shantha et al., 2013), at Myanmar on labor and mechanical tools (Tun and Kang, 2015), at Jare Bowl Borno State of Nigeria on irrigation water (Wakil et al., 2018). These results gave challenge and chance to keep and maintain efficient production input applied as is as and to optimize and improve inefficient or not efficient yet status to efficient status. The optimization and improvement the status expected can lead to enhancing farmer profits and production input efficiency on rice farming.

CONCLUSIONS

Rice farming at Karanganyar district, uniquely, was supported by productive age with more than 20 years experiences and 86.7% using family labor. The RCR of the rice farming was high up to 2.26 that was mainly influenced by farm size, urea fertilizer and labor. Though the rice farming had high RCR, most of production inputs was still in not efficient yet and inefficient status, except labor. Therefore, to optimize the rice farming at Karanganyar district it was recommended to improve application and utilization of seed, urea, ZA, phonska fertilizer and manure. For those problems, significant role of local and national government and application of innovation technologies on cultivation and agronomical aspects are significantly addressed. Successful improvement of the rice farming at Karanganyar district is depended and affected on mutual and simultaneous collaboration and cooperation between farmers, local-national government and utilization of suitable innovation technologies for the area.

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CONFLICT OF INTEREST

We stated that there is no conflict interest between all authors and research funding institute in accordance with the publication

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