Demand of organic fertilizer at rice cultivation in Klaten Regency

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Abstract. The objectives of this study were to determine the: (1) rice production and productivity, (2) factors that affecting the rice production and productivity, (3) usage of organic fertilizer, and (4) factors that affecting the usage of organic fertilizer. Juwiring district was appointed as the study location due to its contribution of rice production in Klaten Regency as well as Central Java Province. Multiple regression analysis was applied to determine the factors that affecting the rice production, productivity, and demand of organic fertilizer. The average of rice productivity was 6.23ton/ha. Land size, fertilizer, pesticide, and credit accessibility were the factors that affecting the rice production. On the other hand, seed, fertilizer, pesticide, labor, credit accessibility, and land ownership were the factor affecting the rice productivity. Producers used the organic fertilizer approximately 125.46 kg/ha and the factors that affecting it were price of organic and urea fertilizer.

1. Introduction

Agricultural has important and strategic role for developing the nation economic of Indonesia. Fact shows that this sector provide jobs for about 38.29 million peoples (34%), which is also hold the highest portion of Indonesian workforce population. At year of 2016, BPS data also mentioned that agriculture, forestry, and fishery sector, gives support about 1.34% after industrial processing sector (21.02%). Moreover, this sector also becomes the source of raw supply and market for the industry sector. However, in its development, agriculture sector faces obstacles which are sourced from many aspects such as the narrower of the land field mainly in Java island, human resource i.e. old farmers, application of agriculture cultivation technology, post-harvest handling, market information, marketing, and limited capital.

Field size from time to time is narrower. This is caused by the greater conversion of the field for non-agriculture uses. For 10 years from 2002 until 2012, the field size decreased 42,994 hectares or for about 4.3% (Figure 1). [1] research result showed that external conversion factors significantly affect land conversion. The driving factors affecting land conversion are the quality of the land, the need for shelter and the opportunity to buy land elsewhere. Suggestion for reducing the conversion is the government must reinforce regulations in the licensing division. Especially license to develop on wetlands. The government should also tighten the rules of land sale and purchase, especially agricultural land which may be sold but still reserved for agricultural land.
The decreasing of field size and its fertility level cause rice productivity to decrease. To improve soil structure, farmers use organic fertilizer both manure and compost. This is also in line with consumer demands, primarily upper-middle class consumers on organic products. Some studies indicate that not all farmers use organic because of the limited availability of organic fertilizers and the dependence of farmers on inorganic fertilizers, mainly urea.

Organic fertilizer used by farmers is manure. The existence of organic fertilizer from large companies namely petroganik makes organic fertilizers more available. The demand for organic fertilizer input needs to be investigated. Therefore, the purpose of this study is to determine the production and productivity of rice and the factors that influence it, the amount of organic fertilizer demand and the factors that influence it.

Production functions that often used to explain the relation between input and output in agricultural field is neo-classic production function [2].

2. Methods
This research was conducted in Klaten Regency, which is Central Java rice production center. Data were taken at Jaten village, District Juwiring with consideration as rice production center.

Regression model which was used to know the factors that influence rice productivity was multiple linear regression model with Ordinary Least Square method. Mathematically, the equations of factors that affected the productivity are:

\[
\ln Y = a + b_1 \ln X_{1it} + b_2 \ln X_{2it} + b_3 \ln X_{3it} + b_4 \ln X_{4it} + b_5 \ln X_{5it} + b_6 D_{1it} + b_7 D_{2it} + b_8 D_{3it} + u_{it}
\]

Notes:
- \(\ln Y\) = Productivity
- \(A\) = Intercept
- \(Lnb_{1−b_8}\) = Regression coefficient
- \(\ln X_1\) = Seed
- \(\ln X_2\) = Fertilizer
- \(\ln X_3\) = Pesticides
- \(\ln X_4\) = labor time of within-the-family workforce
- \(\ln X_5\) = labor time of outside-family workforce
- \(D_{1}\) = credit access (1, if farmers access credit and 0, do not access credit)
- \(D_{2}\) = land lease(1, if farmers rent land and 0, other)
- \(D_{3}\) = land tenure (1, if land owners are farmers and 0, other)
- \(I\) = number of observations (60 observations)
- \(T\) = time period (planting season I, II, and III)
- \(E\) = Error

3. Results and Discussion
Results showed that 38.33% of farmers were sharecroppers and 36.67% were farmers (Table 1). Because the amount of the labor in rice farming is large enough, so that 27.69 percent of householders do not have a side job.
The average age of the farmers was 58 years, which the youngest was 35 years. This phenomenon is quite interesting, because it could support farmer’s regeneration in rice farming. The average education level of farmers was a secondary school (SMP), which the lowest level of education was not schooling and the highest education was undergraduate.

Table 1. Distribution of Farmers Based on Main Jobs and Side Jobs

| Type of Jobs   | Main Jobs | %     | Side Jobs | %     |
|----------------|-----------|-------|-----------|-------|
| Smallholders   | 22        | 36.67 | 5         | 7.69  |
| Sharecroppers  | 23        | 38.33 | 10        | 15.38 |
| Tenant farmers | 3         | 5.00  | 4         | 6.15  |
| Farm workers   | 0         | 0.00  | 8         | 12.31 |
| Collectors     | 0         | 0.00  | 0         | 0.00  |
| Supplier       | 0         | 0.00  | 0         | 0.00  |
| Traders        | 1         | 1.67  | 7         | 10.77 |
| Others         | 11        | 18.33 | 13        | 20.00 |
| Not working    | 0         | 0.00  | 18        | 27.69 |
| Total          | 60        | 100.00| 65        | 100.00|

Source: Primary Data Analysis, 2016

Information about structure of cost and income per hectare is important to be known as an indicator of funding needs that farmers and creditors need to prepare in rice farming activity per hectare. The average cost which should be prepared for farmer’s rice farming in the planting season I were Rp 14.221,289 which relatively higher than season II and III. Nevertheless, the value of production obtained on planting season I was also higher than season II and III.

Table 2. Average Production’s Cost and Rice Farming’s Income per Hectare

| Categories                  | Planting Season (Rp) | Total (Rp) |
|-----------------------------|----------------------|------------|
|                             | Season I | Season II | Season III |          |
| Production’s value (A)      |          |          |            | 74,050,922 |
| Costs                       |          |          |            |          |
| a. Labors                   | 2,925,912| 2,905,079| 2,896,061  | 8,727,053  |
| b. Inputs                   | 4,197,028| 4,026,775| 3,637,535  | 11,861,338 |
| c. Depreciation costs       | 146,889  | 146,889  | 146,889    | 440,667    |
| d. Others                   | 6,951,459| 6,951,459| 6,951,459  | 20,854,378 |
| Total Costs (B)             | 14,221,289| 14,030,203| 13,631,944| 41,883,437 |
| Income (A-B)                | 12,097,415| 12,522,167| 7,547,903  | 32,167,485 |

Source: Primary Data Analysis, 2016.

Based on Table 2, farmers should provide funds at least four million rupiah to buy input facilities for each planting season such as seeds, fertilizers, and pesticides. Farmers would pay for the other costs that had the highest composition in total cost when the harvest season arrived. Planting season I must be considered because it had the highest cost while planting season II had the highest production. Therefore, rice price tends to be stable because the supply is secure.

The cost of labor per hectare in each season ranges from 20 to 21.5 percent. During the three planting seasons, the average labor cost per hectare was 20.84 percent. Meanwhile, input costs were the second highest after other costs, in terms of the largest contributor to the total cost of rice farming.
per hectare. In planting season I, II, and III, each percentage of production cost was 29.51 percent, 28.70 percent, and 26.68 percent.

**Table 3.** Composition of Total Cost Rice Farming per Hectare (in percent)

| Type of Costs   | Planting Season (%) | Average (%) |
|-----------------|---------------------|-------------|
|                 | Season I | Season II | Season III |
| Labors          | 20.57    | 20.71     | 21.24      | 20.84     |
| Inputs          | 29.51    | 28.70     | 26.68      | 28.32     |
| Depreciations   | 1.03     | 1.05      | 1.08       | 1.05      |
| Others          | 48.88    | 49.55     | 50.99      | 49.79     |

Source: Primary Data Analysis, 2016.

Regression analysis of production function showed the coefficient of determination equal to 0.92. It means 92 percent variation of rice production could be explained by factors such as land size, seeds, fertilizers, pesticides, internal and external labors, machines, access to credit, and land tenure status.

**Table 4.** Multiple Regression Analysis for Factors Influencing Rice Production

| Variable                  | Coefficient | Std. Error | t-Statistic | Prob. |
|---------------------------|-------------|------------|-------------|-------|
| C                         | -0.662309   | 0.270456   | -2.448865   | 0.0154|
| Land Size                 | 0.994354*** | 0.032602   | 30.50016    | 0.0000|
| Seed                      | -0.009009   | 0.006505   | -1.384913   | 0.1679|
| Fertilizer                | 0.031714*** | 0.009009   | 3.520397    | 0.0006|
| Pesticide                 | 0.012968*** | 0.005734   | 2.261718    | 0.0250|
| TKDK                      | 0.003099    | 0.004432   | 0.699158    | 0.4854|
| TKLK                      | 0.005135    | 0.005784   | 0.887901    | 0.3759|
| Machine                   | 0.000009    | 0.003342   | -0.028868   | 0.9770|
| Access to Credit          | 0.088493**  | 0.042422   | 2.086013    | 0.0385|
| Sharecrop Land Area       | -0.001305   | 0.053961   | -0.024185   | 0.9807|
| Sharecrop Land Area       | 0.022382    | 0.038442   | 0.582235    | 0.5612|

Source: Primary Data Analysis, 2016.

Land size had a significant and positive influence on rice production. A percent of additional land size affected a higher rice production for 0.9943 percent. If it is associated with the neoclassical production function, it could be concluded that land size (as one of production factors which was used on rice production) was still in production area II. It means a percent of additional land size affected a higher rice production less than one percent. One way to increase the land size of rice farming is renting someone else’s land.

It is linear with Kea’s research [3] where land area has positive effect on paddy production which estimated with “Stochastic Frontier” model. Areas with large harvested land has capability to use input better so the increased rice production paddy production would be faster than the area with small land area.

Fertilizer had a significant and positive influence on rice production. One percent gain of the fertilizer would advance 0.03 percent of rice production. Fertilizer is used to supply several nutrients that have not been sufficient in the soil, so the plants can grow and increase production. Fertilizer is also used to supply macro or micro nutrients to improve soil structure. Improvements in soil structure encourage improved soil capability to retain water and decrease soil acidity. The use of fertilizer by rice farmers in Klaten Regency is in production area II. Production area II or called a rational area is
an area which the enhancement of production’s factor by one percent will increase production less than one percent.

Pesticides gave the significant and positive impact on rice production. The use of a percent pesticide caused the average of rice production 0.01 percent higher. It is different with Kea’s research [3] that reveals pesticide variable has negative coefficient. It means pesticide lowered rice production.

The access of credit also had significant and positive influence on rice production. Farmers who accessed credits program had 0.08 percent higher rice production than other who did not access credit.

The rice productivity function analysis showed that the coefficient of determination value was 0.44. It means that seeds, fertilizers, pesticides, internal and external labors, access of credit, and land tenure status explained variation of productivity for 44 percent.

Seeds had negative influence to rice productivity. A percent of additional seeds affected a lower productivity for 0.04 percent. Seed varieties commonly used by farmers in Klaten Regency was Inpari 30, Ciherang, and Situbagendit. Farmers used those varieties based on their desires. Nevertheless, there are farmers who used rain intensity to determine the varieties. If high rain intensity was predicted, farmers tend to choose varieties that have strong trunks. The average use of seeds for each planting season was 41.15 kg. Season I used more seeds than other seasons.

**Table 5. Multiple Regression Analysis of Factors Influencing Productivity**

| Coefficient | Std. Error | t-Statistic | Prob. |
|-------------|------------|-------------|-------|
| C           | -1.673534  | -12.9015    | 0.0000|
| Seeds       | -0.040281**| -2.491177   | 0.0137|
| Fertilizers | 0.078407*** | 3.688012    | 0.0003|
| Pesticides  | 0.052768***| 3.874318    | 0.0002|
| TKDK        | 0.028567***| 2.515218    | 0.0128|
| TKLK        | 0.029732***| 2.087733    | 0.0383|
| Access to credit | 0.329294*** | 3.000980    | 0.0031|
| Rent land area | 0.878902*** | 7.771891    | 0.0000|
| Sakap land area | 0.263252*** | 2.696903    | 0.0077|

| R-squared         | 0.466648  |
| Adjusted R-squared | 0.441696 |
| S.E. of regression | 0.556929 |
| F-statistic       | 18.70173  |
| Prob(F-statistic) | 0.000000 |

Source: Primary Data Analysis, 2016.

Notes: ****: significant α = 1 %, ***: significant on α = 5 %

Fertilizer had an effect to increase productivity. A percent of additional fertilizer affected a higher productivity for 0.07 percent. The use of excessive fertilizer had consequences of increasing production costs of rice farming. In terms of plant and soil, excessive fertilizer can: (1) reduce the level of soil fertility and tends to increase soil acidity, so that can disturb the absorption of nutrient, and (2) causes plants become susceptible to pests and diseases due to excessive urea fertilization makes the plant succulent.

Furthermore, if the fertilizer is applied below the plant’s needs, the plant’s growth will not be optimized. As the implication, farmers should use the fertilizer in a balanced way by combining macro and micro fertilizer which were suitable for the plant’s needs. N, P, and K are absorbed from chemical fertilizer while the organic and animal fertilizer is the source of micro elements.

In 2007, the government announced Permentan Number 40/ Permentan/OT.140/04/2007 related to the recommendation of N, P, K in a particular location. Based on this recommendation, farmers in Juwiring, Klaten suggested applying 50 kg/hectare of urea, 75kg/hectare of K, and 50kg/hectare of SP36. From figure 5.16 it is known that on the first, second, and third season, the usage of fertilizers was still below/above the recommendation.
[4] indicated that organic rice farmers in 5th and 8th year more productive than conventional rice farmers. Expected with organic agriculture, the productivity of rice farming in Klaten would be increasing.

**Table 6. The Use of Fertilizer (kg) in a Hectare**

|               | Average Value in A Hectare | Recommendation |
|---------------|----------------------------|----------------|
|               | Season I  | Season II | Season III |                      |
| Urea          | 343.03    | 323.23    | 296.51     | 250                   |
| NPK           | 13.46     | 13.46     | 13.46      | Na                    |
| ZA            | 35.36     | 10.55     | 18.27      | Na                    |
| KCL           | 0.00      | 3.13      | 30.10      | 50                    |
| TSP           | 32.36     | 32.36     | 28.79      | Na                    |
| Organic       | 111.20    | 111.20    | 118.61     | Na                    |
| Phonska       | 602.95    | 559.55    | 364.67     | Na                    |
| SP 36         | 144.22    | 119.85    | 105.44     | 75                    |

Source: Primary Data Analysis, 2016.

Table 6 showed that on the planting season I, II, and III, the use of fertilizers was below/above the recommended dosage. The use of organic fertilizer was low and there were only 33% farmers who used this kind of fertilizer. The availability of organic fertilizer and farmers belief of its effectivity was the main trigger of this condition.

**Table 7. The Use of Urea, KCL, and SP 36 Based on Permentan Recommendation Number 40/Permentan/OT.140/04/2007 (in percent)**

| Categories                | Urea  | KCL  | SP 36 |
|---------------------------|-------|------|-------|
|                           | Se. I | Se. II | Se. III | Se. I | Se. II | Se. III | Se. I | Se. II | Se. III |
| In recommendation         | 35    | 35    | 37    | 0     | 0      | 2       | 0     | 0      | 0       |
| Below recommendation      | 30    | 33    | 35    | 100   | 97     | 83      | 62    | 68     | 70      |
| Upper recommendation      | 35    | 32    | 38    | 0     | 3      | 15      | 38    | 32     | 30      |

Source: Primary Data Analysis, 2016.

Most of the farmers used KCL and SP36 below recommendation. Based on its use, farmers rarely applied the fertilizer as the recommendation. The main factor was the lack of their capital to buy the fertilizer. Urea was the most used among KCL and SP36.

Pesticides gave the significant and positive impact on productivity. The application of a percent pesticide caused the average of productivity 0.05 percent higher.

Family labor (TKDK) and labor(TKLK) also contributed the significant and positive impact on productivity. A percent of additional TKDK affected a higher productivity for 0.02 percent. The same data recorded for a percent additional TKLK.

The access to credit significantly affected the productivity. Farmers who accessed credits program had 0.32 percent higher productivity than other who did not access credit.

The land status related to rent-land had the significant and positive impact on productivity. Farmers who rented the land had 0.87 percent higher in productivity. The use of land which was called as sakap was made a significant and positive impact on productivity. They got 0.26 percent higher in productivity than others.
The demand function analysis showed that the price of urea gave a positive impact. It concluded that organic fertilizer and urea had a substitution relation. Farmers used organic fertilizer when urea’s price was higher.

| Table 8. Regression Analysis for Demand of Organic Fertilizer. |
|----------------|----------------|----------------|
| Variable       | Koefisien      | Prob.          |
| C              | -389.80        | 0.000          |
| Land size      | -0.376         | 0.745          |
| Seed Price     | -0.648         | 0.836          |
| Urea Price     | 29.113         | 0.015**        |
| Organic Price  | 10.781         | 0.000***       |
| Phonska Price  | 5.444          | 0.287          |
| SP-36 Price    | 9.158          | 0.322          |
| Farmer’s Age   | -1.426         | 0.705          |
| Education Level| 0.332          | 0.802          |
| Farmer’s Status| -0.970         | 0.561          |
| R-squared      |                | 0.381          |
| Adjusted R-squared |            | 0.269          |
| F-statistic    |                | 3.418          |
| Prob(F-statistic) |            | 0.002          |

Source: Primary Data Analysis, 2016.

Variable of organic price gave a positive impact to organic fertilizer demand. It was not suitable with demand theory. The phenomenon was caused by the availability of organic fertilizer was not fit with its demand, so the farmers had no choice but bought this fertilizer.

4. Conclusion
Factors affected rice production were land size, fertilizer, pesticide, and credit access. The rice productivity was 6.23 ton/ha and it was affected by the seeds, fertilizer, pesticide, credit access, and the land status. There was 33% of respondents who used organic fertilizer with the average amount was 118 kg/hectare. The factor affected the demand of organic fertilizer are price of urea and the price of organic fertilizer itself.

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