Optimization of Production Factors in Organic Rice Farming in Sleman Regency, Yogyakarta

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Abstract. Rice is a promising commodity to be cultivated organically but still requires attention in the optimal use of production factors to achieve maximum results. The control of production factors is still limited in number by farmers while high production and profits are expected. The purpose of this study was to determine the factors of production, costs, and profits and to analyse the allocation of optimal use of production factors to achieve maximum profit in organic rice farming in Sleman Regency. Farming data were obtained from 70 organic rice farmers and analysed using linear programming methods. The results show that the use of production factors during the two growing seasons showed that the average land use was 1,555 m^2, the use of seeds was not in accordance with the recommendations, more workers used outside the family, dominant farmers used solid organic fertilizers and liquid organic fertilizers as support. The average total cost incurred by farmers is IDR. 2,540,263 and IDR. 2,622,826 with an average profit of IDR. 2,414,237 and IDR. 2,181,8888. Optimization analysis shows that the use of land production factor costs is optimal, while the labour cost, seeds, solid organic fertilizers, and liquid organic fertilizers is still not optimal.

1 Introduction

Many activities in the agricultural sector cause damage to natural resources and the environment. Prevention efforts that can be done are organic farming systems because it can improve land reclamation conditions, and reduce rice production costs [1]. Organic farming is able to maintain the balance of natural conditions, provide sustainability to soil fertility, and control pests and diseases due to an increase in soil organic carbon, total nitrogen, and phosphorus available in the soil [2]. Organic farming offers with biological control and natural fertilization, not only able to increase product quantity but also an alternative production system that aims to improve product quality [3]. Meanwhile, from the demand side, Indonesia has experienced a significant increase in the trend for organic product consumption, ranging from 20% to 25% per year [4]. In organic agriculture, there are several

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promising commodities and have good prospects for continued development, including food crops, animal husbandry, horticultural crops, plantation crops, and spices and medicinal plants [5]. As the results of studies on farming through an organic approach (integrated application of organic amendments with gradual reduction in mineral fertilizers) are more suitable for maintaining the productivity of the rice-wheat system and sustainable in the long term [6].

Yogyakarta Special Region (DIY) is one of the provinces that has the potential to contribute high yields of organic agricultural products, especially for rice and rice, where there are many farmer groups with organic rice farming certification, especially in Sleman Regency, which is as many as 5 farmer groups [7]. However, farmers in Sleman Regency lack understanding in the use of inputs of agricultural production factors in order to minimize the production costs of their farms. This causes farmers to tend to guess in the use of agricultural production factors, if deemed necessary then they will increase the amount so that it will increase the cost of agricultural production.

The results of research in Limbo Makmur Village show that it is not easy for rice farmers to determine the use of their production factors appropriately to obtain maximum profits, especially in the use of capital [8]. The problem faced by many farmers is the lack of ability of farmers to determine, organize, and coordinate the factors of production they master properly causing high production costs and low profits obtained [9]. Furthermore, limited farming capital can hamper the ability of farmers to apply production factors optimally so that their farm productivity cannot increase [10]. Therefore, it is necessary to plan production and control inventory according to constraints while maximizing the total profit surplus in farming [11].

Based on the description of these problems, it is necessary to know the production factors that exist in organic rice farming in Sleman Regency, the amount of costs and profits of organic rice farming in Sleman Regency, the use of optimal production factors to achieve maximum profits. Therefore, this research needs to be carried out as a solution for organic rice farmers in Sleman Regency in determining the amount and cost of production factors or the right amount of production results during running an organic rice farming in order to obtain maximum financial benefits.

2 Research Method

The location of the study was located in Sleman Regency, Special Region of Yogyakarta, which was determined purposively, considering that Sleman Regency has the highest amount of rice production and the number of certified organic rice farmer groups in DI Yogyakarta province, as well as cultivating several varieties of organic rice.

The determination of respondents was done using a census technique where all individuals in the population were interviewed as respondents. The number of samples of organic rice farmers in five certified organic farmer groups in Sleman Regency was 70 farmers.

The data used to support the completeness of the data in this study are primary data and secondary data. Primary data were obtained directly by conducting interviews and observations to the object of research (organic rice farmers) as farmers who were directly involved in farming using questionnaire guidance, while secondary data were used as literature obtained from related agencies such as the Agriculture Office, and UPT Pertanian Sleman Regency.

The descriptive analysis method is used to describe production factors by describing completely about the use of production factors in organic rice farming in Sleman Regency. Meanwhile, the method for calculating the cost, revenue and profit of organic rice farming uses the calculation equation proposed [12], as follows:

$$\pi = TR - TC \tag{1}$$

Information:

Π = Revenue (profit)

TR = Total Revenue

TC = Total Cost

　With:

$$TR = Py . Y \; and \; TC = TEC + TIC \tag{2}$$

Information:

Py   = Product price (IDR)

Y   = Organic rice production (Kg)

TEC = Total Explicit Cost (IDR)

TIC = Total Implicit Cost (IDR)

The method to analyze the use of optimal production factors to get maximum profit in organic rice farming is to use linear programming, starting with formulating a linear program model, which includes the goal function and the constraint function. In this study, the formulation of the linear program model from the research was used [13], which are as follows:

Maximum:

Objective function:

$$Z = P_1.X_1 + P_2.X_2 \tag{3}$$

Constrain:

$a_{1.1}X_{1.1} + a_{1.2}X_{1.2} \leq b_1$

$a_{2.1}X_{2.1} + a_{2.2}X_{2.2} \leq b_2$

$a_{3.1}X_{3.1} + a_{3.2}X_{3.2} \leq b_3$

$a_{4.1}X_{4.1} + a_{4.2}X_{4.2} \leq b_4$

$a_{5.1}X_{5.1} + a_{5.2}X_{5.2} \leq b_5$

Assumption: $X_1, X_2 \geq 0$

Information:

Z   = value of the goal function (maximum profit)

P   = Profit Coefficient of Organic Rice Farming

X_1 = organic rice farm production in Season 1

X_2 = organic rice farm production in Season 2

$a_{1.1}$ = cost coefficient of land used in Season 1

$a_{2.1}$ = labor cost coefficient used in Season 1

$a_{3.1}$ = cost coefficient of seeds used in Season 1

$a_{4.1}$ = cost coefficient of solid organic fertilizers used in Season 1

$a_{5.1}$ = cost coefficient of liquid organic fertilizers used in Season 1

$a_{1.2}$ = cost coefficient of land used in Season 2

$a_{2.2}$ = labor cost coefficient used in Season 2

$a_{3.2}$ = cost coefficient of seeds used in Season 2

$a_{4.2}$ = cost coefficient of solid organic fertilizers used in Season 2

$a_{5.2}$ = cost coefficient of liquid organic fertilizer used in Season 2

b_1 = availability of land cost

b_2 = availability of labor costs

b_3 = availability of seed costs

b_4 = availability of solid organic fertilizer costs

b_5 = availability of liquid organic fertilizer costs

The process of solving linear programming problems for optimization calculations uses the help of LINDO (Linear Interactive Discrete Optimizer) program software. Furthermore, after the initial optimal conditions are known, post-optimal analysis will be carried out to study the values of the decision maker modifiers in a model. If one or more parameters of the model change, the optimal conditions will also change [14]. In the post-optimal analysis, changes are made to the estimators that are considered important in organic rice farming called scenarios. The scenarios made in this study are divided into three scenarios, namely increasing the availability of production factor costs by 10% (scenario I), increasing the selling price of organic rice by 10% (scenario II), and reducing the price of production factors by 10% (scenario III).

3 Results and Discussion

3.1 Production Factors in Organic Rice Farming

Production factors are often also referred to as production sacrifices or in other words factors sacrificed to produce a production. Production factors are certainly very influential on production results, therefore it is necessary to know the quantity and quality of production factors used in organic rice farming. Production factors in organic rice farming in Sleman Regency include:

3.1.1 Land

Land is one of the main factors for organic rice farming, where land is a place to cultivate farming and will affect production results. The land area for organic rice farming activities in Sleman Regency varies greatly, but in general it is less than 0.2 ha. The average area of land cultivated by organic rice farmers in Sesion-1 and Sesion-2 is 1,555 m2. The land cultivated by organic rice farmers in Sleman Regency in this study is not all land owned by themselves. The status of farmers' land ownership consists of the status of their own land and leased land. Farmers as landowners themselves are a group of farmers who own private land as well as people who run or work on their farms, while tenant farmers are groups of farmers who use land owned by others to run their farms with a rental system.

3.1.2 Seed

The use of seeds greatly determines the production results to be obtained, because the use of superior seeds tends to produce good production quality. In general, the use of seeds in large quantities will be able to produce higher production, but this must be accompanied and balanced with the condition of the vast land available [15]. Organic rice farmers in Sleman Regency mostly use rice seeds with the type of milk menthik, and inpari 42 because these varieties are varieties recommended by farmer groups. However, there are also farmers who use other varieties such as menthik wangi, cianjur, red sembada, black sembada, sertani, and inpago. The use of seeds used in organic rice farming in Sleman Regency on a land area of 1,555 m2 is 3.73 kg on Sesion-1, and 4.05 kg on Sesion-2. The recommended use of seeds for organic rice farming is 5.5 kg / 1,555 m2, which means that the amount of organic rice seed use is still below the recommendation.

3.1.3 Labor

The use of labor in farming is a factor that must be met so that agricultural activities can take place. In general, labor can come from within the family or from outside the family, where

the use of labor from outside the family will increase production costs because farmers have to spend more to pay labor wages. Based on the results of research on labor for all stages of organic rice cultivation, starting from seeding, land processing, planting, fertilizing, weeding, spraying, irrigation, harvesting to post-harvest, more use of labor outside the family, namely 10.06 people's workdays on Sesion-1 and 10.35 on Sesion-2, while the use of labor in the family is only 6.02 people's workdays on Sesion-1 and 6.10 HKO on Sesion-2. The use of labor outside the family is greater because organic rice farming requires quite a lot of work, especially in land processing, planting and harvesting activities.

3.1.4 Fertilizer

Fertilizer is a nutrient and vitamin for plant growth and development that farmers use to increase agricultural production. The main content in fertilizers most needed by plants is N, P, and K while the complementary content needed by plants such as Zn, Fe, Ca, and others [16]. The fertilizers used in organic rice farming in Sleman Regency are solid organic fertilizers (manure from goat or cow manure, compost), and liquid organic fertilizers (rabbit and cow urine). The most widely used fertilizer by farmers is solid organic fertilizer amounting to 431.43 kg in Sesion-1 and 467.86 kg in Sesion-2, while the use of liquid organic fertilizer is only 2.43 liters in Sesion-1 and 2.84 liters in Sesion-2. This is because liquid organic fertilizer is used by farmers only as a supporting mixture if the use of solid organic fertilizer is considered less fulfilling or less optimal for the growth of rice plants. It is recommended to use a combination of solid and liquid organic fertilizers, because the combination has an important role to complement the advantages and disadvantages between the two organic fertilizerst [17].

3.2 Farm Analysis

Table 1. Costs, Revenues and Profits of Organic Rice Farming on Land Area 1,555 m2.

No	Production Facilities	Cost (IDR)	
		Season 1	Season 2
1.	Implicit Costs		
	Rent own land	477,429	477,429
	Family labor	421,250	427,125
	Own Capital Interest	32,188	33,692
	Sum	930,867	938,245
2.	Explicit Costs		
	Seed	53,229	57,200
	Solid Organic Fertilizer	431,428	467,857
	Liquid Organic Fertilizer	34,607	39,464
	Labor	577,375	597,375
	Land Rental	100,476	100,476
	Tool Depreciation	63,938	63,938
	others	348,343	358,271
	Sum	1,609,396	1,684,581
3.	Total Cost	2,540,263	2,622,826
4.	Revenue		
	- Production (Kg)	880	853
	- Price (IDR/Kg)	5,630	5,633
	Total Revenue	4,954,500	4,804,714
5.	Profit	2,414,237	2,181,888

The cost of rice farming is the total of all costs incurred by farmers to meet all needs during farming activities, which in this study includes explicit costs and implicit costs. Revenue is the amount of production multiplied by the price per unit of total production and profit is the difference between total revenue and total production costs incurred. The costs, revenues and profits of organic rice farming can be seen in Table 1.

Implicit costs are costs that are not incurred by farmers and explicit costs are costs that are actually incurred and calculated by farmers. The average amount of implicit costs incurred by organic rice farmers in Sleman Regency is IDR. 930,867 on Sesion-1 and IDR. 938,245 on Sesion-2, while the average amount of explicit costs incurred by farmers is IDR. 1,609,396 on Sesion-1 and IDR. 1,684,581 on Sesion-2. Miscellaneous costs in explicit fees include the cost of irrigation dues, agricultural equipment rent, consumption, and land tax. The biggest cost incurred is the cost of labor outside the family because organic rice farming requires quite a lot of labor that cannot be fulfilled by labor in the family starting from land processing activities to post-harvest. The average total cost incurred by farmers per farm is IDR. 2,540,263 on Sesion-1 and IDR. 2,622,826 on Sesion-2.

The average organic rice production per farm is 880 kg on Sesion-1 and 853 kg on Sesion-2, with the average price of dry milled organic rice per kilogram of IDR. 5,630 on Sesion-1 and IDR. 5,633 on Sesion-2. The decrease in the amount of production in Sesion-2 or dry season occurs due to less water availability compared to Sesion-1 or rainy season. In the dry season, sometimes farmers are late in irrigating rice plants because they have to alternate with other farmers. The growth of rice plants is relatively better during the rainy season compared to the dry season because the availability of water is very sufficient so that rice growth is maximized [18]. The average revenue received by farmers after organic rice production is sold is IDR. 4,954,500 on Sesion-1 and IDR. 4,804,714 on Sesion-2. Profit is a reduction between the receipts received and the total costs incurred. The average profit received by organic rice farmers per company is IDR. 2,414,237 on Sesion-1 and IDR. 2,181,888 on Sesion-2. The profit value of organic rice in Sleman Regency is in line with the results of the investment stated by [19] where the profit of organic rice farming in Sleman Regency in 2018 was at IDR. 2,164,953/1,555 m2.

3.2.1 Optimization of Farm Production Factors

Based on the analysis of baiya and actual profits of organic rice farming in Sleman Regency, the profit coefficient and cost coefficient of production factors can be obtained in organic rice farming in Sleman Regency. Objective functions and constraint functions are formulated according to the linear program model as outlined in Table 2 and the formulations in LINDO software are as follows:

Objective Function

Maximize: $Z = 2,743X_1 + 2,558X_2$

Constraint Function

Land Cost	: $656.71X_1 + 677.49X_2$	$\leq 1,155,810$
Labor Cost	: $1,134.80X_1 + 1,201.06X_2$	$\leq 2,023,125$
Seed Cost	: $60.49X_1 + 67.06X_2$	$\leq 110,429$
Solid Organic Fertilizer Cost	: $490.26X_1 + 548.48X_2$	$\leq 899,286$
Liquid Organic Fertilizer Cost	: $39.39X_1 + 46.26X_2$	$\leq 74,072$
Assumption: $X_1, X_2 \geq 0$		

Table 2. Objective Function and Constraint Function

Function	Season1 (X_1) IDR/Kg	Season2 (X_2) IDR/Kg	Budget of Production Factor (IDR)
Objective Function:	2,743	2,558	
Constraint Function:			
Land	656.71	677.49	1,155,810
Labor	1,134.80	1,201.06	2,023,125
Seed	60.49	67.06	110,429
Solid Organic Fertilizer	490.26	548.48	899,286
Liquid Organic Fertilizer	39.39	46.26	74,072

Table 3 results of calculations using a linear program, show that production carried out in actual conditions is still not optimal. The average production produced in actual conditions is still quite different from optimal conditions. To achieve maximum profit, farmers must be able to increase organic rice production by 880 kg at Sesion-1 to reach an optimal production amount of 1,760 kg. Meanwhile, in Sesion-2, the optimization results recommend that organic rice production activities should not be carried out by farmers, because if farmers continue to carry out farming activities on Sesion-2, there will be a maximum profit reduction of IDR. 271.79 which can be seen from the large value of reduce costs, which is 271.79. The value of reduce costs that are more than zero then the activity or product does not provide maximum profit, while the value of reduce costs that are zero means that the activity or product has provided maximum profit, but it will not be profitable if it is done additional activities or products [20].

Table 3. Comparison of Combinations of Actual Production and Optimal Production

Description	Actual Production (kg)	Optimal Production (kg)	Reduce Cost
Season 1	880	1.760	0,00
Season 2	853	0	271,79

Producing or carrying out organic rice farming activities at an optimal production level, the maximum profit that can be obtained by organic rice farmers in Sleman Regency is IDR. 4,827,682 per production activity. Table 4 shows that the profit has a greater value than the actual profit during the two planting periods, where the profit can still be increased by IDR. 231,557 or 5.04%. To achieve maximum profit, farmers must divert the cost of production factors on Sesion-2 to increase the cost of production factors on Sesion-1, so that farmers are able to increase production to reach the optimal amount of production.

Table 4. Comparison of Actual Profit and Maximum Profit Under Optimal Conditions

Description	Actual Profit (IDR)	Maximum Profit (IDR)
Season 1	2,414,237	4,827,682
Season 2	2,181,888	0
Sum	4,596,125	4,827,682

Based on the results of analysis with a linear program, it shows that organic rice farmers in Sleman Regency have not been able to optimally utilize the costs of existing production factors, where labor costs, seed costs and fertilizer costs still have residue while land costs

have been used up. Therefore, it is necessary to optimize land use and income through commodity diversification patterns [21]. This has the potential to maximize net annual returns and production with optimal land allocation [22].

Table 5. Comparison of Actual and Optimal Use of Production Factor Costs

Production Factors	Actual Usage	Slack or Surplus	Optimal Usage	Dual Price
Land	1,155,810	0.00	1,155,810	4.18
Labor	2,023,125	25,876.30	1,997,248.7	0.00
Seed	110,429	3,966.56	106,426.44	0.00
Solid Organic Fertilizer	899,286	36,428.10	826,857.9	0.00
Liquid Organic Fertilizer	74,072	4,745.58	69,326.42	0.00

Table 5 shows the use of unused labor production factor costs so that there is an excess (slack/surplus) of IDR. 25,876.3 from the available labor costs of IDR. 2,023,125. For the use of production factor costs, there is an excess of IDR. 3,966.56 from the cost of available seeds of IDR. 110,429. For the use of solid organic fertilizer production factor costs, there is an excess of IDR. 36,428.1 from the cost of solid organic fertilizer available IDR. 899,286. Similarly, the use of liquid organic fertilizer production factor costs has an excess of IDR. 4,745.58 from the available liquid organic fertilizer costs of IDR. 74,072.

In contrast to these 4 factors of production, the use of the cost of used land production factors (slack / surplus = 0) means that the cost of land production factors has been used optimally. Every additional availability of land costs will increase the maximum profit that can be obtained by organic rice farmers in Sleman Regency by IDR. 4.18 (dual price value = 4.18). When the profit reaches the maximum and the production input has been used up, there will be a maximum profit addition value of the dual price value if the input is added by one unit [23]. Thus, the combination of allocation of optimal use of production factors in organic rice farming in Sleman Regency to produce maximum profit can be determined as follows:

a. The use of land costs of IDR. 1,155,810 or equivalent to an area of 3,110 m2.
b. The use of labor costs amounted to IDR. 1,997,248.7 or equivalent to 32.15 people's workdays
c. The use of seed costs is IDR. 106,426.44 or equivalent to 7.45 kg.

d. The use of solid organic fertilizer costs IDR. 826,857.9 or equivalent to 826.86 kg.
e. The use of liquid organic fertilizer costs IDR. 69,326.42 or equivalent to 4.86 liters.

3.2.2 Post Optimal Analysis

The scenarios made in this study are divided into three scenarios, namely increasing the availability of production factor costs by 10% (scenario I), increasing the selling price of organic rice by 10% (scenario II), and reducing the price of production factors by 10% (scenario III). These scenarios can be used to plan production and control inventories according to constraints while maximizing total profit surpluses [11]. Once the proposed approach is applied to the real scenario, it is expected to bring significant economic improvements [24].

a. Scenario I (Increased Availability of Production Factor Costs)
The availability of production factor costs is one of the factors that can limit farmers from obtaining high profits because the level of production factor costs in organic rice farming in Sleman Regency is quite high while the costs owned by farmers are limited. Sensitivity

analysis can therefore examine how rising costs affect profits [25]. The scenario of increasing the availability of production factors costs by 10% causes the maximum profit level to be different from the maximum profit level of the initial version, namely the maximum profit that can be achieved is IDR. 5,310,450. When compared with the initial optimization results, it shows that the profit received by organic rice farmers can increase by IDR. 482,768.

In terms of input optimization, it is necessary to anticipate risk and uncertainty, because risk-averse or low-risk-loving farmers tend to reduce land allocation for annual crops under uncertainty, while high-risk-loving farmers will do the opposite [26]. Therefore it is proposed maintaining the desired indoor environment to maximize production [27]. Thus ecological and economic terms, as well as the conditions for creating an environment allow for better agricultural development [28].

b. Scenario II (Increase in Selling Price of Organic Rice)

The selling price of organic rice is one of the factors that greatly affects the level of farmers' profits. The high selling price level of organic rice allows farmers to obtain high profits as well. The scenario of increasing the selling price of organic rice by 10% causes the maximum profit level to be different from the maximum profit level of the initial version, where the maximum profit that can be achieved is IDR. 5,818,562. When compared with the initial optimization results, it shows that the profit received by farmers can increase by IDR. 990,880. Thus the increase in the price of cash crops, if it has a large area share, tends to "hold" grain crops grown in the same season [29].

c. Scenario III (Decline in Production Factor Price)

The price of production factors is one of the factors that also affect the level of profit. The low price of production factors allows farmers to save the total cost of production incurred so that farmers will get higher profits. The scenario of reducing the price of production factors by 10% causes the maximum profit level to be different from the maximum profit level of the initial version, the maximum profit that can be achieved is IDR. 5,364,082. When compared with the initial optimization results, it shows that the profit received by farmers can increase by IDR. 536,400.

Table 6 shows the comparison of actual profit and maximum profit after three scenarios of increase and decrease of estimators that are considered important in organic rice farming in Sleman District.

Table 6. Differentiator of Actual Profit and Maximum Profit With 10% Shift

Scenario	Profit (IDR)		Profit Difference (%)
	Actual	Shift 10%	
Cost Availability (+)	4,827,682	5,310,450	9.99
Output Price (+)	4,827,682	5,818,562	20.52
Production Factor Price (-)	4,827,682	5,364,082	11.11

The three scenarios that have been made show the highest maximum profit level that can be obtained is in the scenario of a 10% increase in the output price or selling price of organic rice, which is IDR. 5,818,562 with a profit difference of 20.52% from the actual profit. In the scenario of a 10% decrease in the price of production factors can increase the maximum profit by 11.11% of the actual profit, while in the scenario of increasing the availability of costs by 10% can only increase the maximum profit by 9.99%. In addition to these scenarios, inter-farm cooperation is still needed, the unification of small businesses into unions and associations will help strengthen the position of farmers and gain their market share [30]. In general, a decrease in input prices will increase the cost efficiency of farming. The ability of

farmers to manage costs efficiently is influenced by several factors including experience, land status, credit availability and participation in farmer groups [31].

4 Conclusions and Recommendations

The results showed that the production factors used in organic rice farming in Sleman Regency are land, seeds, labor, solid organic fertilizer and liquid organic fertilizer. The results of the analysis using linear programming obtained information that the combination of the use of production factors applied to organic rice farming in Sleman Regency was not optimal. The effect of change when there is an increase in cost availability, selling prices and a decrease in the price of production factors by 10% shows an increase in maximum profit when compared to actual profits where the highest profit change is found in an increase in selling prices.

Organic rice farmers in Sleman Regency must be careful and meticulous in planning and managing their farms if they want to increase or maximize the results and profits of farming by optimizing the use of production factors that are not optimal, namely the use of seeds, fertilizers, and labor costs, for example by setting ideal planting distances, applying fertilizers with appropriate compositions, and using labor according to their needs. For this reason, it is necessary to have guidance and counseling on how to cultivate and allocate the use of production factors. Farmers should not carry out farming activities on Sesion-2 and divert the cost of factors of production on Sesion-2 to increase the cost of factors of production on Sesion-1. In addition, further processing of production results is needed in order to increase selling prices. Then it needs access to reach and build a wider market share network to the upper middle class consumer segment who are willing to buy at higher prices so that farmers can increase maximum profits.

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