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Production Factors Efficiency Of Potato Farming In Tosari Village

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Abstract

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Potatoes (*Solanum tuberosum* L.), one of seven horticultural products targeted to be developed in 2015 by Directorate General of Horticulture. Pasuruan Regency was able to produce potatoes up to 50% of the total potato production in East Java. Although potatoes cultivation in the Tosari District is relatively large, potatoes productivity is still a problem for the farmers. This study was aimed at analyzing the factors of production that had a dominant influence on potato production and its technical efficiency in the Tosari Village, Tosari District, Pasuruan Regency. Sample was determined by simple random sampling and amounted to 30 potato farmers. Data were analyzed with multiple linear regression models. Analysis revealed that the significant factors affecting potato production in Tosari Village were urea, SP36, ZA and manure. Application of urea, ZA and manure in potato farming in Tosari Village had not been efficient, so it can be added. Meanwhile, SP36 fertilizer was still applied inefficiently, so it must be reduced..

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INTRODUCTION

The sector in Indonesia that is currently being developed is horticulture, because it has an important role in agricultural development. Horticultural commodities are grouped into vegetables, fruits, medicinal plants, and ornamental plants (Kementan, 2015).

Potatoes (*Solanum tuberosum L.*) are the main horticultural commodities targeted for development in the 2015-2019 period by the Ministry of Agriculture (Dirjenhorti, 2015). It is intended to achieve self-sufficiency of potatoes that are planned to be achieved in 2020. Director General of Horticulture also stipulates increase in production and added value of potatoes as one of the strategic targets. Indonesian potato production is still low, due to inadequate soil requirements for potato plants, low available nutrients, emergence of various pests and diseases, provision of fertilizer that is not proportional, use of anorganic fertilizers in very large doses, and incompatibility of potato cultivation.

Potatoes have been cultivated in almost all islands in Indonesia. Although not the largest contributor to potato production nationally, East Java is capable of producing large quantities of potatoes (BPS, 2018). Some research results show the fact that allocation of inputs in potato farming in Indonesia is still inefficient. Thus, production of these commodities can still be increased in order to meet consumer demand.

Development of the processing industry of potato products has increased the demand for potatoes as raw material. Therefore production must also be increased in order to be able to meet these demands. High demand for processed potatoes (potato chips, frozen potatoes, etc.) as a result of the modern lifestyle forced the government to import potatoes. However (Pudjiastuti et al., 2013), (Pudjiastuti, 2014), (Pudjiastuti & Kembauw, 2018), reminded that increasing imports in the long run will disrupt Indonesian economy.

BPS (2018) states that, the potato imports in 2017 for industrial consumers were 51,849 tons and the value was IDR 275 billion. In 2018, this import will decrease significantly to 29,649 tons, or valued at IDR 117 billion. It was indicated that potato imports value by industry dropped significantly (> 50%). So, increasing yield of domestic potatoes is a very important to reduce dependence on imported potatoes. It will be more effective if it is focused on potato center through efficiency of its production factors.

There are several potato centers in East Java, including Tosari District, Pasuruan Regency. The region has been able to produce potatoes up to 50% of the total production in East Java (BPS, 2018). Geographical location (1,700m asl) and temperature (minimum 180-200 °C) suitable for potato cultivation are the main capital for local farmers. Although cultivation of potatoes in Tosari District is quite large, their productivity is still a problem for farmers.

Table 1. Potato Productivity in Pasuruan Regency

Year	Land Area (ha)	Yield (ton)	Productivity (ton/ha)
2013	3.049	64.934	21,30
2014	3.318	88.384	26,64
2015	3.227	90.459	28,03
2016	3.634	97.483	26,83
2017	4.013	110.825	27,62

Source: Kabupaten Pasuruan Dalam Angka, 2019

Potato productivity in Pasuruan Regency tends to increase from 2013-2017, but this figure is still relatively low when compared to national scale productivity. There are many factors that determine potato production, namely land area, chemical fertilizer, and organic fertilizer (Agatha & Wulandari, 2018); land area, seeds and pesticides (Fianda et al., 2016), labor and capital (Mawardati, 2013) and land area (Pratiwi & Hardyastuti, 2018). On the other hand, (Maryanto et al., 2018), (Widayati, 2017), (Rizkiyah et al., 2014) and (Hartati & Setyadji, 2012) stated that potato farming has not been efficient. According to (Sa'diyah & Pudjiastuti, 2017), potato production depends on the allocation of seeds number, land area, artificial fertilizer, manure, labor, and pesticides. Potato farming was also profitable with R/C > 1 (Herliani et al., 2019). This study selects several factors that affect potato farming in Tosari Village based on several previous research results. However, fertilizer variable is based on the type applied by potato farmers in the study location, namely urea, SP36, ZA, KCl, and manure.

This research was intended to analyze: 1) factors that affect potato production and 2) efficiency of production factors in potato farming in Tosari Village, Tosari District, Pasuruan Regency.

RESEARCH METHODS

This research was conducted in Tosari Village, Tosari District, Pasuruan Regency. Pasuruan Regency was determined purposively because it is a center for producing potatoes in East Java. Tosari District was chosen purposively because it is a center of potatoes in Pasuruan Regency and even the largest in East Java Province. Pasuruan Regency contributes to 60% of the province's potato needs.

Population was defined as all Tosari Village farmers who planted granola flower varieties of potatoes, amounting to 62 people. Sample was determined by simple random sampling. According to (Sugiyono, 2019), this method is the process of selecting respondents where each member of population has an equal chance of being elected. Potato farmers generally have a relatively homogeneous land area. Samples number were set at 30 farmers (50% of total population).

Data collected were primary and secondary data. Primary data were collected through interviews using a questionnaire, including: characteristics of farmers such as age, experience, education, number of family members, intensity of attending counseling and production data, potato prices, input prices and use of inputs. Inputs intended: seeds, land, fertilizers by type (urea, SP36, KCl, ZA, manure), pesticides, and labor. Secondary data is data that had been collected, sorted and documented by second parties. These parties are Central Statistics Agency (BPS), Ministry of Agriculture of Indonesia Republic, Department of Agriculture, Village Office. Data collected includes supporting information on primary data such as a general description of the study area, population and so on.

Regression models were used to analyze the effect of seed use, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor on potato production both simultaneously and partially. The regression model used is (Sugiyono, 2011):

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 \dots\dots\dots (1)$$

Where, Y: potato production, a: constant, b: regression coefficient, X1: seed use, X2: land area, X3: use of urea fertilizer, X4: use of fertilizer SP36, X5: use of KCL fertilizer, X6: use of fertilizer ZA, X7: use of manure, X8: use of pesticides and X9: use of labor.

Determination coefficient becomes a basis for measuring goodness of fit the multiple linear regression model. The values range of it is from 0 to 1 (Ghozali, 2012). The closer it is to one, the coefficient will show a better regression model.

F test is a verification procedure whether seed, land area, urea fertilizer, SP36, KCl, ZA, manure, pesticides and labor have a significant effect simultaneously on the yield of potato production. According to (Ghozali, 2012), if the significance probability is <0.05 , then there is a simultaneous real effect of these variables on potato production. Then, it is continued by t-test to find out which variables that influence individually.

The next step was to measure inputs efficiency in potato farming. Allocative efficiency (or price efficiency) will be achieved if the marginal product value (NPM_x) is equal to the intended input price (P_x). This condition is expressed mathematically as:

$$NPM_x = P_x \text{ or } NPM_x/P_x = 1. \text{ } bY.P_x/x = P_x \text{ or } bY.P_x/X.P_x \text{ (2)}$$

Where: b = elasticity, Y = production, P_y = price of goods Y, X = number of production factors X, P_x = price of production factors X. If $NPM_x/P_x > 1$, then input x application is not efficient and must be increased. If $NPM_x/P_x < 1$, then application of input x is inefficient and must be reduced. Price efficiency can be achieved if $NPM_x/P_x = 1$.

RESULTS AND DISCUSSION

Farmer Characteristics

Socio-economic characteristics of farmers in Tosari Village, Tosari District, Pasuruan Regency were observed: age, level of education, farming experience and family members. Farmers distribution according to their characteristics is presented in Table 2.

Most (86.7%) farmers in Tosari Village are in the 30-50 years age category, while the rest (13.3%) farmers are over 51 years old. Age of farmers will determine the pattern of decision making in using production technology, especially those that can increase production. They will be easier to accept innovation for farming development. Most (66.7%) farmers in Tosari Village only had elementary to junior high school education, while the rest (33.3%) had high school education. The fact is that potato farming does not require a high education. So anyone can participate in this farm. Most (60%) farmers in the village of Tosari have been doing potato farming in a period of 6-11 years, so it can be said that farmers in this region have a lot of experience in the cultivation of potato plants. These characteristics are important for decision makers in implementing potato commodity development policies in Tosari Village. The parties concerned with the development of potato crops (both private and government) will be easier to direct farmers who have relatively long experience in potato farming. Most (93.3%) farmers in Tosari Village have dependents of 3-5 people. More and more family members, farmers will try to increase farm income to meet the needs of his family.

Table 2. Farmer Characteristics

Variable	Category	Frequency	Percentage (%)
Age (year)	30-40	14	46,7
	41-50	12	40,0
	> 51	4	13,3
	Total	30	100
Education	Elementary School	8	26,7
	Middle School	12	40,0
	High School	10	33,3
	Total	30	100
Farming experience (year)	1-5	4	13,3
	6-10	14	46,7
	> 11	12	40,0
	Total	30	100
Family members (person)	1-2	2	6,7
	3-4	22	73,3
	> 5	6	20,0
	Total	30	100

Source: Primary Data 2019, processed.

Effect of Production Factor Allocation on Potato Production

Regression models to analyze the effect of seed usage (X_1), land area (X_2), urea fertilizer (X_3), SP36 fertilizer (X_4), KCL fertilizer (X_5), ZA fertilizer (X_6), manure (X_7), pesticide use (X_8) and labor (X_9) on the production of potato farming (Y). Based on the multiple linear regression analysis, the effect of seeds usage, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor on production of potato farming, were presented in Table 3.

Coefficient of determination (R^2) = 0.799 shows that 79.9% of variation in potato production could be explained by variations in the use of seeds, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor, the remaining (20.1%) was explained by other variables.

F test with sig. $F = 0,000$ indicates that the use of seeds, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor simultaneously had a significant effect on the production of potato farming. These results serve as a guideline that t test needs to be done to show which production factors had significant effect on potato production, which is the basis of efficiency analysis. In detail, the partial test results are presented in Table 3.

Table 3. Summary of Regression Test Partially

Variable/parameter	Unstandardized Coefficients		t	Sig.	Justification
	B	Standard Error			
Constant (a)	803,203	210,782	3,811	0,001	-
Seeds (X_1)	0,037	0,130	0,285	0,778	not significant
Land area (X_2)	-41,011	129,512	-0,317	0,755	not significant
Urea fertilizer (X_3)	4,176*	0,548	7,616	0,000	significant
SP36 fertilizer (X_4)	-11,475*	1,275	-8,998	0,000	significant
KCl fertilizer (X_5)	0,869	0,857	1,015	0,322	not significant

ZA fertilizer (X ₆)	18,511*	0,726	25,495	0,000	significant
Manure (X ₇)	0,560*	0,033	16,758	0,000	significant
Pesticide (X ₈)	-57,685	59,261	-0,973	0,342	not significant
Labor (X ₉)	2,664	5,576	0,478	0,638	not significant
R ²	: 0,799				
F Statistic	: 977,132				
Sig. F	: 0,000				
Dependen variable	: Potato production (Y)				

Source: Primary Data 2019, processed.

Based on Table 3, potato production function in Tosari Village can be written mathematically:

$$Y = 803,203 + 0,037X_1 - 41,011X_2 + 4,176X_3 - 11,475X_4 + 0,869X_5 + 18,511X_6 + 0,560X_7 - 57,685X_8 + 2,664X_9$$

where the use of urea fertilizer, SP36 fertilizer, ZA fertilizer and manure have a significant effect on potato production.

The t test showed that urea fertilizer, SP36 fertilizer, ZA fertilizer and manure had a significant effect on potato production. The results of this analysis are in accordance with the findings (Agatha & Wulandari, 2018) although only mentioning chemical fertilizers and organic fertilizers, but different from the findings (Mawardati, 2013), (Pratiwi & Hardyastuti, 2018) and (Fianda et al., 2016) that fertilizers has no influence on potato production and income. The effect of production factors on potato production is explained in detail below.

1. Constant (a)

Constant as a result of regression analysis is 803,203. It shows that without changes in seed, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor, the potato production obtained was 803,203 kg/ha.

2. Seeds (X₁)

Regression coefficient of seed use = 0.037. It shows that an increase one kilogram of seeds in potato farming, production of potatoes will increase by 0.308 kg, if variable land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor were assumed to be constant.

3. Land area (X₂)

Regression coefficient of this variable in potato farming was -41,011. It shows that an increase of one hektare of land planted with potatoes will reduce potato production by 41,001 kg, if variables such as seed use, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor were assumed to be constant.

4. Urea fertilizer (X₃)

Regression coefficient of urea fertilizer was 4.176. It is mean that, an increase one kilogram of urea fertilizer in potato farming, then potato production will increase by 4.176 kg, if variable use of seeds, land area, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor were assumed to be constant.

5. SP36 fertilizer (X_4)

SP36 fertilizer regression coefficient was obtained for -11,475. It is mean that, every increase in the use of SP36 by one kilogram in potato farming will reduce production of potatoes by 11,475 kg, if variable use of seeds, land area, urea fertilizer, KCL fertilizer, ZA fertilizer, manure, pesticides and labor were assumed to be constant.

6. KCL fertilizer (X_5)

Regression coefficient of KCL fertilizer calculation results is 0.869. It is mean that, each increase one kilogram of KCL fertilizer in potato farming, it will increase potato production by 0.869 kg, if variable use of seeds, land area, urea fertilizer, SP36 fertilizer, ZA fertilizer, manure, pesticides and labor were assumed to be constant.

7. Pupuk ZA (X_6)

ZA fertilizer regression coefficient obtained for 18.511. It is mean that, every one kilogram increase in the use of ZA fertilizer in potato farming, it will increase production of potatoes by 18,511 kg, if variable use of seeds, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, manure, pesticides and labor were assumed to be constant.

8. Manure (X_7)

Regression coefficient of manure is 0.560. That is, every one kilogram increase in the use of manure in potato farming, production of potatoes will increase by 0.560 kg, if variable use of seeds, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, pesticides and labor were assumed to be constant.

9. Pesticides (X_8)

Regression coefficient of the use of pesticides in potato farming is -57,685. That is, every one kilogram increase of pesticides in potato farming, it will reduce production of potatoes by 57,685 kg, if variable use of seeds, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure and labor were assumed to be constant.

10. Labor (X_9)

Regression coefficient of labor use in potato farming was obtained at 2.664. That is, each increase of one man working day (HOK = hari orang kerja) in potato farming, it will increase production of potato farming by 2,664 kg, if variable use of seeds, land area, urea fertilizer, SP36 fertilizer, KCL fertilizer, ZA fertilizer, manure and pesticides were assumed to be constant.

Efficiency of Potato Production Factors

Allocative efficiency of potato production factors that have a significant influence on potato production in Tosari Village: urea fertilizer, SP36 fertilizer, ZA fertilizer and manure, can be seen in Table 4.

NPM_{xi}/P_{xi} urea fertilizer usage of 36.36 shows that application of urea fertilizer was not yet efficient. $NPM_{xi}/P_{xi} > 1$, indicates the need for addition of urea fertilizer in potato farming, if farmers want to achieve conditions of efficient use of urea fertilizer.

NPM_{xi}/P_{xi} for SP36 fertilizer was -99.92, indicating that the use of SP36 fertilizer was not efficient. $NPM_{xi}/P_{xi} < 1$ indicates the need to reduce SP36 fertilizer in potato farming, if farmers want to achieve efficiency conditions of SP36 fertilizer.

NPMxi/Pxi for ZA fertilizer was 161.18, proving that the use of ZA fertilizer was still not yet efficient. $NPMxi/Pxi > 1$, indicates the need for addition of ZA fertilizer in potato farming, if farmers want to achieve efficiency conditions of ZA fertilizer usage.

Table 4. Efficiency of Potato Farm Production Factors

Variable	Bi	Py	Xi	Pxi	NPMxi	NPMxi/Pxi	Efficiency
Urea fertilizer	4,176	8.000	183	2.100	76.361,14	36,36	Not yet
SP36 fertilizer	-11,475	8.000	200	2.100	-209.828,57	-99,92	Not
ZA fertilizer	18,511	8.000	212	2.100	338.486,86	161,18	Not yet
Manure	0,560	8.000	2750	500	43.008,00	86,016	Not yet

Source: Primary Data 2019, processed.

NPMxi/Pxi of manure is 86,016, which is an indicator that the use of manure is still not yet efficient. $NPMxi/Pxi > 1$ indicates the need to add manure to potato farming can be done, if farmers want to achieve conditions of efficient use of manure.

CONCLUSIONS

Production factors that had a significant influence on potato production in the Tosari Village were urea fertilizer, SP36 fertilizer, ZA fertilizer and manure with regression coefficients respectively for 4.176, -11.475, 18.511 and 0.560. The use of production factors in potato farming in Tosari Village has not yet reached efficiency. The results of the efficiency analysis revealed that urea fertilizer, ZA fertilizer and manure applied by farmers were classified as inefficient (with NPMxi/Pxi respectively: 36.36; 161.18; and 86.016), while SP36 fertilizer was classified as not efficient (with NPMxi/Pxi: -99,92).

RECOMMENDATION

To increase production yields or achieve inputs efficiency of potato farming in Tosari Village, farmers should increase urea fertilizer, ZA fertilizer, and manure, and the other hand, reduce the use of SP36 fertilizer. Application of organic fertilizer (manure) and balanced anorganic fertilizer can be based on the experience of farmers, because farmers better understand the management conditions of potato farming. Future studies can use different regression models, for example, Cobb Douglas production function which may be more suitable for research in agriculture, considering that other production factors have no significant effect. Another alternative is to add variables based on relevant research results.

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