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## Efficiency Of Production Factors Used In Carrot (*Daucus carota*) Farming

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### Abstract

The farmers' income is uncertain in Boyolali following the unstable weather. This study aims to know the factors that affect the production of carrots and the efficiency level of production factors in carrot farming. The method used in this research was the survey method that was performed in the Argo Ayuningtani Farmer Group, Senden Village, Selo District, Boyolali Regency. The respondent was determined by observation of as many as 30 carrot farmers. The collected data were in the form of primary and secondary data. The primary data were obtained from literature studies and studies of other institutions that related to this research. Data were analyzed using quantitative analysis using the Cobb Douglass model. The results of the study found that several factors that simultaneously affected the productivity of carrot farming were the total area of land (X1), labor (X2), seeds (X3), organic fertilizer (X4), fertilizer Za (X5) used by farmers. The number of seeds is the most influential production factor in the productivity of the Argo Ayuningtani Farmer Group, Senden Village, Selo District, Boyolali Regency.

**Keywords:** factors of production, Cobb Douglass, productivity

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### Introduction

Indonesia is an agrarian country where most of the population is farmers (1). Indonesia's archipelago with mountainous topography is suitable for planting various plants (food, plantation, horticulture, and others). With this consideration, the agricultural sector is vital in creating jobs to generate income for people, especially those who live in rural areas (2). The agricultural industry is one of the critical sectors and must be developed. The development of the agricultural sector can be done by empowering the people's economy through an agribusiness approach that will create advanced, efficient, and resilient agriculture (3). The development of the agricultural sector includes various sub-sectors such as horticultural crops, food crops, fisheries, livestock, plantations, and forestry (4).

Horticulture is a vital commodity in the agricultural sector, contributing to the national

economy, farmers' income, employment, and various aspects of community life. In addition, there are several benefits of horticultural commodities in people's lives, including food, culture, health sector, and economic field. Carrot (*Daucus carota*) comes from East Asia and Central Asia temperate regions. In Indonesia, carrot cultivation was initially concentrated in Lembang and Cipanas, West Java, then spread to vegetable centers in Java and outside Java. As a result, the national carrot harvest area reaches 27,149 ha spread over 22 provinces.

The carrot is a biennial tuber vegetable (a plant that lives in two seasons) in the form of a shrub. This type of vegetable is easy to find in various places and can be grown throughout the year, both rainy and dry. Carrots have short stems that are barely visible. The roots are taproots that change shape and function to become round and elongated. Carrot plants can

grow optimally in areas with cold temperatures or mountains with an altitude of about 1200 meters above sea level. Carrots have wet leaf stems in the form of a bunch of midribs on the petiole that emerges from the upper tuber's base, similar to celery leaves (5). Efficiency is related to the relationship between the output in the form of goods or services produced and the resources used to produce the output (6). Meanwhile, Raharjo (7) suggests that efficiency is a condition or condition where completing a job is carried out correctly and with full capabilities. Mathematically, efficiency is a comparison between output and input or, in other terms, output per unit of input.

Carrot production in Boyolali Regency fluctuates every year. So that makes farmers a little confused with the price of carrots in the market. When the main harvest, carrots can reach the price of Rp. 2,000.00 per kg, but in the dry season, the price of carrots reaches Rp. 9.000,00 per kg. The weather conditions are not stable, along with changes in land area, which increases. There is an increase in demand for other commodities such as chilies, tomatoes, etc. (8). This study aimed to know what production factors affect the production of carrots and the efficiency of the use of production factors in carrots farming. The income and farming efficiency analysis has not been done during unstable weather changes.

## Material And Methods

The location of this research was the Argo Ayuningtani farmer group, Senden Village, Selo District, Boyolali Regency, which was determined purposively. This area was defined as a research area because the average productivity of carrots in the Argo Ayuningtani farmer group has not yet reached the average productivity of carrots in the Boyolali Regency. The average productivity of carrots in Boyolali Regency is 15.98 tons/ha, while the productivity of carrots in the Argo Ayuningtani farmer group is 12.29 tons/ha (9). In addition, the Argo Ayuningtani farmer group produces organic vegetables. Therefore, the quality of carrots in the Argo Ayuningtani farmer group is of superior quality because of the good quality and quantity of carrots. This research was conducted in December 2020.

The analytical method used was the descriptive analysis method. The Cobb-Douglas production function was used to explain the relationship between production and the factors of production that influence it. The production factors that were suggested to have affect to the amount of carrot production (Y) were the amount of land area (X1), the number of workers (X2), the number of seeds (X3), The amount of organic fertilizer (X4), and the amount of fertilizer Za (X5). The Cobb-Douglas function equation as follows:

$$Y = b_0 \cdot X_1^{b_1} \cdot X_2^{b_2} \cdot X_3^{b_3} \cdot X_4^{b_4} \cdot X_5^{b_5} \cdot E$$

note :

Y	= Carrot Production (Kg)
b <sub>0</sub>	= intercept
X <sub>1</sub>	= Land area (M <sup>2</sup> )
X <sub>2</sub>	= Labor (HKO)
X <sub>3</sub>	= Seed (Kg)
X <sub>4</sub>	= Organic fertilizer (Kg)
X <sub>5</sub>	= Fertilizer Za (Kg)
b <sub>1</sub> -b <sub>5</sub>	= Regression coefficient
e	= Error

To calculate the production factor efficiency, the formulae based on Cobb-Dougllass production function technique was used (10). The formula is as follows:

$$b_i \cdot Y \cdot P_y / X_i = P_x$$

or

$$NPM_{xi} = P_{xi}$$

or

$$NPM_{xi} / P_{xi} = 1$$

Information :

B <sub>i</sub>	= i-th production factor (input) regression coefficient
Y	= production (output)
P <sub>y</sub>	= unit price of output
X <sub>i</sub>	= use of the i-th average factor of production (input)
P <sub>xi</sub>	= unit price of the i-th input

The calculation criteria is as follows: if  $NPM_{xi} / P_x < 1$ , then production factors (inputs) are not efficient. Thus, the use of production factors (inputs) needs to be reduced. If  $NPM_{xi} / P_x = 1$ : the use of production factors (inputs) is efficient, and the use of production factors (inputs) has reached the optimal combination (11).

## Results And Discussion

### *Analysis of the production function of carrot farming*

Production function analysis explains the relationship between production and production factors used in carrot farming (12). The production factors are land area, labor, seeds, manure, and Za fertilizer. The model for estimating the carrot production function is a Cobb-Douglas function. This function is multiple non-linear regression so that to perform multiple linear regression analysis, it must be converted into a linear equation. For this reason, the existing equations must be logarithmic into a multiple linear regression model, namely as follows:

$$\ln Y = 7.6746 + 6.5497 \ln X_1 + 3.9296 \ln X_2 - 1.4630 \ln X_3 + 3.1760 \ln X_4 + 5.3826 \ln X_5$$

The value of the coefficient of determination is a measure that shows the contribution of the independent variable to the dependent variable. In other words, the coefficient of determination shows the variation of the Y derivative, which is explained by the linear influence of X. If the value of the coefficient of determination given the symbol R<sup>2</sup> is close to 1, the independent variable gets bigger. The approach to the relationship with the independent variable can be said that the use of the model can be justified (13). The coefficient of determination (R<sup>2</sup>) can be seen in the Model Summary table in the Adjusted R square column (Table 1). Adjusted R square 0.484 means that the change in carrot production can be explained by 48.4% by factors of production of land area, labor, seeds, organic fertilizers, Z-fertilizers. In contrast, other factors outside this research model explain the remaining 51.6%.

Table 1. The accuracy of the Multiple Linear Regression Model in Carrot Farming in the Argoayuningtani Farmer Group, Senden Village, Selo District, Boyolali Regency in 2020.

Model Summary	Nilai
R	0,696
R square	0,484
Adjusted R square	0,361
Std. Error of the Estimate	0,57651
F test	0,011

The simultaneous F test shows (Table 1) whether all independent variables or independent variables included in the model have a combined effect on the dependent variable. The F test is done by comparing the calculated F results with the F table, so we accept the alternative hypothesis, which states that all independent variables simultaneously and significantly affect the independent variables. The calculated F value of 0.011 is smaller than 5% so that all factors of Za fertilizer (X1), organic fertilizer (X2), seeds (X3), land area (X4), and labor (X5) simultaneously have a very significant effect on production.

A partial test or t-test aims to determine the effect of production factors (X) separately (partial) on carrot production (Y). If the significance level of p-value < 1%, the production factors used in the analysis have a very significant effect on carrot production (Y)(14,15). If the p-value is > 1% and < 5%, then the production factors used in the analysis

significantly affect carrot production (Y). However, if the p-value > 5%, the production factors used in the analysis have no significant effect on carrot production (Y). The value of the t-count can be seen in column t, to know the level of significance in column Sig, and to know the value of the regression coefficient can be seen in table 2. The results of the t-test analysis showed that the land area factor had a t-count value (-0.918) with a significant value based on  $0.369 > 0.05$ , meaning that land area had no significant effect on production. The regression coefficient value is negative 0.550, meaning that for every 5% increase in land area used, production decreases by 0.550%, assuming other variables are considered constant (*ceteris paribus*). The results of the t-test analysis show that the labor factor has a t-count value (2.207) with a significance based on  $0.039 < 0.05$ , meaning that labor has a very significant effect on production. The regression coefficient value is positive at 1.481, meaning that for every 5%

increase in labor used, production increases by 1.481%, assuming other variables are considered constant (*ceteris paribus*). The results of the t-test analysis showed that the seed factor had a significant t-count (0.440) based on  $0.664 > 0.05$ , meaning that the seed had no significant effect on production. The regression coefficient value is positive at 0.119, meaning that for every 5% increase in seeds, the production increases by 0.119%. The results of the t-test analysis showed that the organic fertilizer factor had a significant t-value (1.280) based on  $0.214 > 0.05$ , meaning that organic fertilizer had no significant

effect on production. The regression coefficient value is positive at 0.316, meaning that for every 5% increase in organic fertilizer used, the production increases by 0.316%. The results of the t-test analysis showed that the Za fertilizer factor had a t-count value (-1.180) with a significance of  $0.284 > 0.05$ , meaning that the Za fertilizer had no significant effect on production. The regression coefficient value is negative 0.372, meaning that for every 5% increase in Za fertilizer used, the production decreases by 0.372%, assuming other variables are considered constant (*ceteris paribus*).

Table 2. Testing of Variables Affecting Production Factors of Shallot Farming in the Argoayuningtani Farmer Group, Senden Village, Selo District, Boyolali Regency in 2020.

Variable	Coefficient	T	Sig.
Land area (X1)	-0,550	-0,918	0,369
Labor (X2)	1.481	2,207	0,039
Seed (X3)	0,119	0,440	0,664
Organic Fertilizer (X4)	0,316	1,280	0,214
Fertilizer Za (X5)	-0,372	-1,100	0,284

#### *Analysis of the efficiency of using the production factors of carrot farming*

Table 3 shows that the efficiency of land use (X1) has a value of -0.014 which means the value is less than one. It means that land area production factors are inefficient and must be reduced (16–18). The efficiency of using labor (X2) has a value of 4.68, meaning the value is more than one and labor production factors are not efficient and need to be added. The efficiency of using seeds (X3) has a value of

12.39. As the value is more than one, it clarifies that the use of seed production factors is not efficient and needs to be added (19). The efficiency of using organic fertilizer (X4) is 3.61, meaning that organic fertilizer production factors are inefficient and need to be added. Finally, the efficiency of using Za fertilizer (X5) has a value of -20.32 which is less than one. Thus, production factors for Za fertilizer are inefficient and need to be reduced (20).

Table 3. Efficiency Analysis of the Use of Carrot Farming Production Factors in the Argoayuningtani Farmer Group, Senden Village, Selo District, Boyolali Regency in 2020

Variable	NPMXi	Pxi	$\frac{NPMxi}{Pxi}$	
Land area (X1)	-16.841,30	1.185.000	-0,014	Not efficient
Labor (X2)	351.089,59	75.000	4,68	inefficient
Seed (X3)	3.489.850,04	281.666,67	12,39	inefficient
Organic Fertilizer (X4)	2.867,16	793,33	3,61	inefficient
Fertilizer Za (X5)	-45.994,54	2.263,33	-20,32	Not efficient

#### **Conclusion**

Based on the results, the labor (X2) has a very significant effect on carrot production. The production factors in the form of land area (X1), seed (X3) regression, organic fertilizer (X4), and fertilizer Za (X5) have no significant effect. The

use of production factors in carrot farming has not yet reached the maximum efficiency level. Factors that are not efficient are land area (X1), labor (X2), seeds (X3), organic fertilizer (X4), and Za fertilizer (X5). Carrot production factors

need to be optimized by referring to the existing dosage standards.

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