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Estimating Return to Scale Production of Seaweed Farming in Tarakan City

Estimasi Skala Penerimaan Produksi pada Budidaya Rumput Laut di Kota Tarakan

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Abstract

The development of seaweed cultivation by farmers cannot be separated from production factors such as capital, seeds, labor, and land area, which greatly support the success of seaweed cultivation. This study aims to analyze the factors affecting seaweed production and how to return to scale. The research was conducted in Pantai Amal Village. The number of samples in the study was 59 seaweed farmers using the incidental sampling method. The data analysis technique used multiple linear regression analysis in the form of the Cobb-Douglas function logarithm using the SPSS 26 software. The results showed that simultaneously the capital factors (X1), seeds (X2), labor (X3), and land area (X4) jointly affect the production (sig=0.00). Only the farmer's capital partially showed a significant effect (0.00) smaller than the significance level of = 0.05. The business scale has shown increasing returns to scale with a coefficient value of 1.15, which means that all inputs used in production are increased by 1. The resulting production will be increased by 1, and the resulting production will increase by a more significant proportion, namely 1.15. Thus, seaweed farmers' use of production factors is efficient.

Keywords: Cobb-Douglas, Production Factors, Return to Scale, Seaweed

Abstrak

Pengembangan budidaya rumput laut oleh petani tidak terlepas dari faktor-faktor produksi seperti modal, bibit, tenaga kerja dan luas lahan yang sangat menunjang keberhasilan suatu budidaya rumput laut. Penelitian ini bertujuan untuk menganalisis faktor-faktor yang mempengaruhi produksi rumput laut dan bagaimana skala produksi usahatani rumput laut di Kelurahan Pantai Amal. Penelitian dilakukan di Kelurahan Pantai Amal, dengan jumlah sampel sebanyak 59 petani rumput laut yang diambil dengan metode insdental sampling. Teknik analisis data menggunakan analisis regresi linear berganda dalam bentuk logaritme fungsi Coob-Douglas dengan menggunakan bantuan *software* SPSS 26. Hasil penelitian menunjukkan bahwa secara simultan faktor modal, bibit, tenaga kerja, dan luas lahan secara bersama-sama berpengaruh terhadap produksi (sig=0.00). Secara parsial hanya modal petani yang menunjukkan pengaruh nyata (0.00) lebih kecil dari taraf signifikansi α= 0,05. Skala usaha sudah menunjukkan peningkatan *returns to scale* dengan nilai koefisien=1.15 yang berarti proporsi penambahan produksi lebih besar daripada proporsi penambahan input modal, bibit, dan tenaga kerja dengan demikian penggunaan factor-faktor produksi oleh petani rumput laut sudah efisien.

Kata kunci: Cobb-Douglas, Faktor Produksi, *Return to Scale*, Rumput Laut

1. Introduction

Tarakan City is one of the areas in North Kalimantan Province that has the potential to develop seaweed. Farmers cultivate seaweed almost along the coast of Pantai Amal Village, including in the middle of the sea, which is far from residential areas. With the available potential, seaweed cultivation is an option for empowering coastal communities in Pantai Amal Village. Judging from the amount of production, seaweed production in Tarakan City in 2017 reached 129,375 tons (BPS, 2019). In 2018, production increased to 159,469 tons (BPS, 2020), and production fell to 152,577 tons (BPS, 2021). This indicates that seaweed production in Tarakan City is still fluctuating. The inputs or production factors usually influence the occurrence of fluctuations.

Generally, in seaweed cultivation, land area affects the production obtained. The number of seeds, capital, and labor can affect production results (Dinas Pangan, Pertanian, dan Perikanan, 2019; Nurul, 2021; Ernawati, 2020; Umaldin, 2014). The development of seaweed cultivation by farmers cannot be separated from production factors such as capital, labor, and location, which greatly support the success of seaweed cultivation (Anggadiredja, 2011; Suparman, 2013; Sakti & Amalia, 2020). However, these factors are complicated for farmers to obtain. Limited land is good for seaweed cultivation, and clearing new land requires a long time and capital for seaweed farmers. Besides, the area has not regulated coastal waters' use or spatial planning, so there is an overlap between various activities. In the same, circumstances like this make investments that will be unsafe in the long term.

Meanwhile, the lack of educated and trained human resources through structured education and training activities according to the cultivation segment and the low salary or wages obtained in conducting the seaweed cultivation process causes the quality of seaweed to decline. Based on the background description, the paper aims to analyze the factors of seaweed production and how to return to scale production of seaweed farming in Pantai Amal Village, Tarakan City.

2. Material and Method

2.1. Time and Place

The research was conducted in Pantai Amal Village, Tarakan Timur District, Tarakan City. The location selection was carried out because the area was a center for seaweed production in Tarakan City. This research was conducted in December-February 2022.

2.2. Methods

Respondents in this study were seaweed farmers in Pantai Amal Village. The total population is 587 seaweed farmers. If the subject is less than 100, it is better to take all, but if the subject is more than 100, it can be taken between 10-15% or more (Sugiyono, 2012). In this study, researchers took 10% of the population of Pantai Amal Village, so the number of samples in this study was 59 people. The sampling method in this study was carried out using a non-probability sampling model with an incidental sampling technique.

2.3. Data Analysis

Data To analyze the factors that influence the production of seaweed farming in Pantai Amal Village. Then, we use the logarithmic Coob-Douglas function (Machmuddin et al., 2017; Machmuddin et al., 2019). Mathematically, it can be written as follows:

$$Y = \beta_0 + \beta_1 \, LnX_1 + \beta_2 \, LnX_2 + \beta_3 \, LnX_3 + \beta_4 \, LnX_4 + e \ldots\ldots\ldots\ldots\ldots (1)$$

Description:

Y	= Production	X3	= Labor (HOK)
β_0	= Constant	X4	= Land size (Ha)
X1	= Capital (IDR)	e	= error term
X2	= Seeds (Spread)		

One of the main reasons why researchers use the Cobb-Douglas function is because the results of estimating the line through the Cobb-Douglas function will produce a regression coefficient as well as show the amount of elasticity, where the elasticity of production will measure the reaction ability of the input to the output. The sum of the production elasticity of each factor of production at the same time shows the level of business scale (return to scale). Machmuddin et al. (2017); Ramadhan (2011); Rafiie (2013). The business scale (Return to scale) determines whether the business is experiencing a decreasing, increasing, or constant scale. To assess the scale of these results can be made as follows (Soekartawi, 2003): 1) $\beta 1 + \beta 2 + \beta 3 + \beta 4 < 1$ (decreasing return to scale) is the proportion of additional production is smaller than the proportion of additional capital, seeds, labor, and land area, which causes the yield scale to decrease. 2) β1 + β2 + β3 + β4 = 1 (constant return to scale) is the proportion of additional production is equal to the proportion of additional capital, seeds, labor, and land area, which causes a fixed yield scale. β1 + β2 + β3 + β4 > 1 (increasing return to scale is the proportion of additional production is greater than the proportion of additional capital, seeds, labor, and land area, which causes the scale of yield to increase.

3. Result and Discussion

3.1. Characteristics of Respondents

In this case, the characteristics of respondents consist of gender, age, formal education of respondents, number of family members, and farming experience. Based on Table 1, the respondents' gender was 33.3% male and 66.7% female. Table 1 also shows that the average age of the respondents is in the range of 15 to 64 years, which indicates that the age of the respondents is productive. Productive age indicates respondents have physical potential in business development and are actively trying to find information. Productive age will produce relatively better productivity for older adults (Ishak & Afrizon, 2011).

Table 1. Characteristics of respondents

Characteristics of respondents	Remarks/Category	Frequency	%
Gender	Male	13	33. 3
	Famale	27	66.7
Age	0-14 years old	0	0
	15-64 years old	56	95
	>64 tears old	3	5
Respondent formal education	Elementary school	22	37
	Junior High School	21	36
	Senior High School	16	27
	S1	0	0
Number of Family Members	1-5 person	42	71
	6-10 person	17	29
Experience	1 – 5 years	20	34
	6 – 10 years	34	58
	11 – 15 years	5	8

The respondents' formal education was at junior high school, senior high school, and tertiary education (9 to 16 years). The level of education can influence the mindset of farmers in implementing the ideas they get. Educated farmers are generally more receptive to innovation than uneducated farmers, although this is not necessarily the case for every farmer. The average education of respondents is elementary school (37 %) and junior high school (36%).

The number of dependents in the family is one factor that influences the respondent's activities in managing his farm and influencing a person's decision to work. Family members assist in farming activities in Pantai Amal Village, so the more dependents the family is, the lower the wages for labor will be; the highest number of family dependents is 1-5, with a total of 42 people, with 71%. Farming experience is one of the important factors in supporting the success of farming. The experience of farming seaweed farmers in Pantai Amal Village is at most 6 to 10 years with a total of 34 people (58%), meaning that farming experience can influence the mindset so that farmers are more careful in managing their farms.

3.2. Analysis of Seaweed Farming

Seaweed farmers cultivate seaweed (*Eucheuma cottoni*) using the basic Long Line method, commonly called the long rope method, which uses a long rope stretched as land or a place to tie the rope (Suparman, 2013). This method is in great demand by farmers in Pantai Amal Village because it has advantages, including flexibility in site selection, ease of application in seaweed cultivation, cheaper cost, and ability to be applied in deeper waters. The following presents data on the average production and use of inputs by seaweed farmers in the Pantai Amal sub-district using the Long Line method during one production period.

Table 2. Average production and use of respondent's inputs per 1 planting season

No	Input	Unit	Average
1	Production	kg	895
2	Capital	IDR	84.745.763
3	Seed	Span	27
4	Labour	HOK	23
5	Land Size	Ha	0.5

Table 2 shows that the average number of respondents' production in 0.5 ha of the expanse is 895 kg, and the capital amount is an average of IDR 84,745,763. On average, the number of workers outside the family is 23 HOK. Land preparation is the most important thing in seaweed cultivation. Usually, farmers prepare land for 2-3 days, and four or more people carry out land preparation. A bottle is attached to each end of the main rope to prevent the seaweed from sinking. A weight is tied to each end of the main rope, and a bottle keeps the seaweed from drifting away. The seeds used by farmers (respondents) are local seeds that are not too old, have many branches, are healthy, and have bright colors. Installation of seeds on stretch ropes will generally be tied to small ropes contained in stretch ropes. The average use of seeds by respondents is 27 spans, and the length of the stretch ropes ranges from (25 to 50 m). Mother and children usually do seed tying. Seed drying is done from 8 am to 4 pm. After binding the seeds, the seaweed is then installed in the field. Usually, the installation of seeds is done in 5-8 hours. To float the seaweed at the farmer's location, use a 1500 ml beverage bottle and tie each stretch of rope to the five bottles. The stretch rope filled with seeds will be tied to the main rope at the location with a distance between ties of ± 60 cm.

Maintenance carried out is only carried out on land improvements. The repairs are like replacing a damaged float, a loose main rope, or a broken rope, then fixing the weights (pegs) pulled out. Farmers do not always need to maintain seaweed. After the seaweed is approximately 45 days old, harvesting is ready to be carried out by untying the stretch rope from the main rope and then lifting it onto the boat. Farmers harvest grass by boat. After being brought to the ground, the seaweed is released from the stretch rope. Harvesting generally requires four or more people, and the time farmers need to harvest is 3 to 4 days, which means they spend 4 to 5 hours daily (only once a day is harvested).

Farmers carry out post-harvest handling by direct drying after harvesting. Farmers dry the seaweed on wooden clotheslines and dry them in direct sunlight. Drying is done for approximately four days and is dried in the sun for about 2 hours, depending on the hot conditions of the sun. After drying, the seaweed is then put into sacks to be sold. Dried seaweed is sold to collectors at 15,000/kg during the study.

3.3. Factors Affecting Seaweed Production

Based on this research, four production factors are thought to affect seaweed production in Pantai Amal Village: capital, seeds, labor, and seaweed area. The influence of production factors on seaweed production can be analyzed through multiple linear regression using the Cobb-Douglas equation. From the processing results using the SPSS application, the R^2 test was carried out to measure how far the model's ability to explain variations in the dependent variable was carried out. The Adjusted R^2 value obtained is 0.886, meaning that the variance of production factors of capital, seeds, labor, and land area contributes 88.6% to seaweed production. The remaining 11.4% is influenced by factors not examined in this study.

To see the effect simultaneously (simultaneously), the F test is carried out. Table 3 shows that the Fcount value is 49,099, with a significance level of 0.000, less than the significance level used in this study, which is 0.05. Thus, it can be concluded that capital, seeds, labor, and land areas simultaneously affect the production of seaweed farming in Pantai Amal Village.

Table 3. F-test calculation results (simultaneously).

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	2.430	4	0.607	49.099	0.000
	Residual	0.668	54	0.012		
	Total	3.098	58			

Table 4. Results of regression analysis

Production Factor	Unstandardized Coefficient		Standardized Coefficients Beta	t	Sig
	B	Std.Error			
Constant	-13.546	1.503		-9.015	0.000
Capital (X_1)	1.136	0.082	0.889	13.883	0.000
Seeds (X_2)	0.005	0.071	0.005	0.076	0.940
Labor (X_3)	0.007	0.004	0.100	1.556	0.125
Land Size (X_4)	0.001	0.023	0.003	0.051	0.960
R^2 : 0.886					
F count: 49.099	sig = 0.000				
Significance α = 5 %					

Table 4 shows that the constant value (α) is negative, which is -13,546, meaning that if the capital, seeds, labor, and land area are equal to zero (0), production will decrease by -9.015. To find out which factors of production have the most significant influence on the level of production, a partial test (t-test) was conducted. Based on the partial test (t-test), it was found that the most influential and significant factor in seaweed production (Y) was the capital factor or variable (X1). The capital variable has a positive sign and significantly affects seaweed production at a significance of = 5% (0.00 < 0.05). The variables of seed (X2), labor (X3), and land area are positive but have no significant effect on production (Y). In this case, it is assumed that the capital factor (X1) is the most influential because capital is used to increase the supply of inputs, such as the number of ropes, the number of seeds, and land area as a medium for growing seaweed to increase seaweed production in Pantai Amal Village.

The seed variable (X2) has no effect because, on average, the respondent farmers use local seeds with the characteristics of many branches and healthy and bright colors. As for the labor use variable (X3), it is suspected that it does not have a significant effect because, in seaweed cultivation, maintenance activities are carried out only on repairing the location of seaweed cultivation, such as replacing a damaged buoy as well as a loose main rope or a broken rope, then repairing it. Ballast (peg) that is pulled out. Maintenance of seaweed is not all or not all carried out by the respondent farmers. The land area (X4) is thought to have no effect because the respondent's land area is not all optimized for planting seaweed attached to a rope. The same analysis by Ernawati (2020) shows that land area is not thought to affect production.

3.4. Return to Scale Seaweed Production

Return to scale determines whether the business has decreased, increased, or fixed its scale. Based on the Cobb-Douglas function. The return to scale in the seaweed production business is shown in Table 5.

Table 5. Results of return to scale analysis of seaweed production

Production Factors's	coefficient Factors
Capital	β1 = 1.136
Seeds	β2 = 0.005
Labor	β3 = 0.007
Land Size	β4 = 0.001
∑ βi =	1,149

Based on the seaweed business in Pantai Amal Village, the result is 1.15. These results indicate that the number of returns to scale is more than 1, which means it is in a condition of increasing returns to scale (Ramadhan, 2011). The value of increasing returns to scale is 1.15, meaning that if all inputs are increased by 1%, production output will increase by 1.15%. This shows that if all the inputs used in production are increased in number, the resulting production will increase by a larger proportion.

4. Conclusions

Based on the results of research carried out in Pantai Amal Village regarding the factors that affect the production of seaweed farming using the Cobb-Douglas function. Labor and land area have a simultaneous effect on seaweed production. The results of the R test show a value of 0.886, the capital production factor. Seed, labor, and land area contributed 88.6% to seaweed production. The results of the t-test of the most influential factor on production, namely capital, showed a significant effect (α 0.05) on seaweed production in Pantai Amal Village with a significant value (0.000 <0.05). This is presumably because capital is the determining factor in increasing the procurement of inputs, such as the number of ropes seeds and the land area as a medium for growing seaweed, thereby increasing seaweed production. The business scale of seaweed production in Pantai Amal Village is in a condition showing increasing returns to scale with a coefficient value of = 1.15, which means that an additional 1% of inputs in the form of capital, seeds, and labor will result in further production of 1.15%.

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