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ANALYSIS OF SEAWEED CULTIVATION BUSINESS EFFICIENCY IN EAST LOMBOK REGENCY

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Abstract: **The objectives of this research are 1). To analyze the production level and profitability of seaweed cultivation business in East Lombok Regency 2). To determine the influence of the use of production inputs for seaweed cultivation business in East Lombok Regency 3). To analyze the technical efficiency of the seaweed cultivation business in East Lombok Regency 4). To find out the obstacles faced in the seaweed cultivation business in East Lombok. This study uses a descriptive method. Data collection by quantitative and qualitative data type interview methods. The respondents in this study are seaweed farmers in Seriwe Village because it is a cultivation center in East Lombok Regency. The determination of respondents was determined using the Degree of Variability because the number of samples was already known. The results of the study show that the production produced by farmers in carrying out seaweed cultivation business is 1,040 kg per cultivated land area or 43.33 kg per are, with a selling price of 20,000/kg. The average profit per production process is IDR 10,458,265 or IDR 435,761 per are. Production inputs that do not affect the seaweed cultivation business are experience, while the variables of land area, labor, number of seeds and rope length greatly influence. Seaweed cultivation in East Lombok Regency is technically efficient. The average technical efficiency value is 0.98. The obstacles faced by seaweed cultivators in the country are unconducive weather, minimal availability of seeds, pests and diseases (ice-ice), and still lack of capital.**

Keywords: **Production, Profit, Stochastic Frontier, Technical Efficiency.**

I. INTRODUCTION

Indonesia is an archipelagic country with abundant marine resources, making it one of the largest producers of seaweed in the world. With a total of 17,504 islands and a coastline length of 81,000 km, it has great potential for the development of seaweed commodities, where development activities have been carried out throughout Indonesian waters starting from Nangroe Aceh Darusalam to Papua [21].

According to national production data, Indonesia's seaweed production in 2022-2026 is projected to reach 11.65 million tons, based on the report [25]. This production supports the blue economy development target with a focus on the sustainability and competitiveness of fishery products [27].

Until now, the largest production of seaweed in Indonesia is almost entirely supported by cultivation activities. Based on data from the Ministry of Maritime Affairs and Fisheries, around 99.73% of Indonesia's seaweed production comes from cultivated products. This can happen because the natural potential of the sea is very supportive so that it can be carried out almost in all regions of Indonesia [27]. Most of the seaweed cultivation business actors are people on the coast of the region, for this reason it is very rare for private companies to participate in the seaweed cultivation process. Thus, the government is obliged to assist in the provision of seaweed processing plants, the provision of equipment and can maintain a balance of supply and demand so that there is no supply and demand fluctuation [28].

One of the main seaweed producing areas in Indonesia is West Nusa Tenggara Province, especially East Lombok Regency. The region has very supportive geographical conditions, such as clear sea waters, stable temperatures, and ideal salinity levels for the growth of seaweeds, particularly Eucheuma cottonii *and* Gracilaria [38]. East Lombok's strategic position in national seaweed development is further emphasized through the plan to build an International Tropical Seaweed Research Center in Ekas Bay, as well as the implementation of large-scale seaweed cultivation piloting with international partners in the same region [24].

However, the large volume of production achieved is not fully proportional to the level of welfare of cultivators equally. A number of problems are still faced by cultivators in the field, including the scarcity and low quality of seeds, the limited supply of tissue culture seeds that must be shared with other regions such as Bali, NTT, and Sulawesi, simple drying facilities for harvests, and processing facilities that cannot be operated optimally due to limited supporting infrastructure [14]. On the environmental side, climate change triggers the spread of ice-ice disease which is estimated to reduce national seaweed production by 10 to 20 percent, while the conversion of coastal land also increases erosion and turbidity of waters which has an impact on aquaculture productivity [4].

The purpose of this research is to determine the level of production and profits of seaweed cultivation business in East Lombok Regency. To find out the influence of the use of seaweed cultivation business inputs in East Lombok. To analyze the technical efficiency of the seaweed cultivation business in East Lombok Regency. To find out the obstacles faced in the seaweed cultivation business in East Lombok.

II. METHODS

This research uses a descriptive method, which is to analyze by describing or describing the data that has been collected as it is without intending to make conclusions that apply to the public so that it can be easier to understand and conclude. In this study, the unit of analysis is seaweed cultivation business farmers located in East Lombok Regency (Seriwe Village, Jerowaru District) [2][4][45].

This research was conducted in East Lombok Regency, West Nusa Tenggara Province. The sample area was selected by purposive sampling (deliberate) on the basis of planting area and seaweed production. The selected sub-district and village are Seriwe Village, Jerowaru District, East Lombok Regency [45].

The method of sampling uses Degree of Variability, which is the degree of variability of a population where a population with high variability means very heterogeneous. In determining the number of samples when the number is already known (finite) Yamane and Isaac and Michel [45] can be used.

The number of seaweed farmers in Seriwe Village is 247 people, referring to the formula above, the number of samples to be used is 70 samples, where the sample error is 10%. Meanwhile, farmer sampling was done using the Simple Random Sampling method [45].

The data used in this study used two sources, namely primary data and secondary data. Primary data is obtained directly from direct sources or related parties regarding the problem to be researched. The primary data to be taken is the amount of production per planting season, as well as the production factors used. Secondary data are obtained from secondary sources that are not directly involved in the problem but support the research as supporting data [45].

III. RESULTS AND DISCUSSION

Revenue is the amount received from the sale of its products to traders. Revenue is obtained from the result of multiplying the amount of production obtained (output) with the selling price per unit of production [12][46]. In this study, business revenue is broken down into revenue per seaweed cultivation business and revenue per hectare. Revenue per farming business is the revenue obtained on an average land tenure area of 24 acres per planting area.

It is known that the average production of dried seaweed per land area is 1,040 kg. The average selling price of dried seaweed at the time of the study was 20,000 per kg. Thus, the average revenue received by cultivators in one planting season is 20,794,286 per cultivated land area (24 acres) [46].

Table 3.1 Average Revenue, Income and Profit of Seaweed Cultivation Business in Seriwe Village 2026

No	Description	per Production Process	
		per Area Tanam (24 are)	per are
1.	Production (kg)	1.040	43,33
2.	Price (Rp/Kg)	20.000	20.000
3.	Production Value (Rp)	20.794.286	866.428
4.	Total Cost (Rp)	10.336.020	430.666
5.	Profit (Rp)	10.458.265	435.761

Source: Processed Perimeter Data (2026)

Cultivation business income is the difference between revenue and total costs during one planting season. The analysis of seaweed cultivation business income aims to find out the income made by farmers. The average income per business received by farmers is 10,458,265 per cultivated land area or around 435,761 per are [43][46].

Furthermore, classical assumption tests were carried out including normality tests, multicollinearity tests, and heteroscedasticity tests [19][20]. The classical assumption test aims to ensure that the regression model used is valid. The results of the normality test using the normal P-P Plot of Regression Standardized Residual with dependent variables (production), it can be seen that the data points (observed cumulative probability) are generally spread along a diagonal line (normal line), although there are slight deviations at the bottom and top end of the graph. The results of the multicollinearity test showed that the labor variable had a tolerance value of 0.843 and VIF of 1.186, the experience variable had a tolerance value of 0.983 and VIF of 1.018, and the seed variable had a tolerance value of 0.133 and VIF of 7.520. The three variables met the required criteria (Tolerance > 0.10 and VIF < 10), so it can be concluded that the three variables did not experience symptoms of multicollinearity [17]. Based on the results of the heteroscedasticity test shown on the Scatterplot graph between the Regression Standardized Predicted Value (X-axis) and the Studentized Residual Regression (Y-axis) with the production-dependent variable, it can be seen that the data points are randomly spread around the zero on the Y axis, both above and below the zero, without forming a specific clear pattern such as a narrowing pattern. widened, wavy, or formed a certain systematic curve [17].

In this study, the Cobb-Douglas production function was used with the Ordinary Least Square (OLS) method which aimed to analyze the factors that affect the production of seaweed cultivation business carried out using SPSS 27. The model of the Cobb-Douglas function regression equation in this study is formulated as follows [34]:

$$\text{Ln } Y = \text{Ln } \beta 0 + \beta 1 \text{ Ln } X1 + \beta 2 \text{ Ln } X2 + \beta 3 \text{ Ln } X3 + \beta 4 \text{ Ln } X4 + \beta 5 \text{ Ln } X5 + \varepsilon i$$

The variables used in the estimator function model are dependent variables, namely seaweed production (Y) and independent variables which are suspected to affect seaweed production (Y) consisting of Land Area (X1), Labor (X_2), Number of Seeds (X3) and Cultivation Experience (X4) rope length (X5). The magnitude of the influence of available production inputs on seaweed production can be seen in the following table:

Table 3.2 Results of Analysis of the Use of Inputs that Affect Seaweed Production in Seriwe Village with the 2026 OLS Method

No	Variabel	Coeficin Back	Std Error	t-count	Coefficients Beta	Sig
1	Konstanta	-1.853	.345	-5.376		.000
2	Land Area (X1)	.385	.168	2.287	.345	.025
3	Workforce (X2)	.119	.047	2.502	.090	.015
4	Number of Seedlings (X3)	.298	.100	2.975	.270	.004
5	Experience (X4)	.024	.018	1.317	.044	.193
6	Length of Rope: Ris (X5)	.401	.182	2.205	.327	.031
R Square		.930				
F-count		169.341				
F-table		2,36				
a		0,05				

Source: Primary Data Processed (2026)

Based on the results of the regression analysis, a determination coefficient (R2) of 0.930 was obtained, which shows that there is a very strong relationship between independent variables such as land area, seeds, labor, business experience and dependent variables. Furthermore, the R Square value (coefficient of determination) of 0.930 indicates that the independent variables in this model are able to explain 93.0% of the variation that occurs in the dependent variables, while the remaining 7.0% is explained by other variables outside the model that were not included in this study such as climatic factors, planting distance and rainfall [19][20].

Table 3.3 Coefficient Results of Determination (R2) with OLS Method

Model Summaryb				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.964a	0,930	0,924	0,08358

a. Predictors: (Constant), LnX5, LnX4, LnX2, LnX3, LnX1

b. Dependent Variable: LnY

Based on the results of the F (simultaneous) test shown in the table, the F value was obtained with a significance level (Sig.) of <0.001. To determine the test results, the significance value is compared to the significance level used, which is 0.05 (α = 5%). The significance value obtained (<0.001) was much smaller than the significance level of 0.05, so it can be concluded that H0 is rejected and H1 is accepted**,** which means that independent variables namely land area, seeds, labor, business experience and rope length simultaneously (together) have a significant effect on the dependent variable [19][20].

Table 3.4 Results of Simultaneous Tests with OLS Method

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Say.
1	Regression	5,914	5	1,183	169,341	.000b
	Residual	0,447	64	0,007		
	Total	6,361	69			

a. Dependent Variable: LnY

b. Predictors: (Constant), LnX5, LnX4, LnX2, LnX3, LnX1

The t-test was carried out to find out how much influence each independent variable (land area, labor, number of seeds, cultivation experience and rope length) individually in explaining the dependent variable (seaweed production). For the partial interpretation of regression coefficients can be explained as follows [19][20]:

The constant value was -1.853 with a calculated t-value of -5.376 and a significance value of <0.001. This constant value indicates the amount of production if all independent variables (land area, labor, number of seeds, cultivation experience and rope length) are equal to zero or constant.

The variable coefficient of land area has a regression value (B) of 0.385, with a standardized beta coefficient value of 0.345, a calculated t-value of 2.287, and a significance value of 0.025. This shows that partially, the land area variable has a positive and significant effect on the production variable. A positive coefficient value of 0.385 indicates that the relationship between land area and production is unidirectional, meaning that every time there is an increase in the land area variable of 1%, it will cause an increase in the Y variable by 3.85%, assuming that other independent variables (labor, number of seeds, cultivation experience and rope length) are in a fixed or constant condition. The value of this coefficient also shows the magnitude of production elasticity from the input of land area to production output, which means that the increase in land area makes a considerable and real contribution to increasing production yield.

The labor variable has a regression coefficient value (B) of 0.119, with a standardized beta coefficient value of 0.090, a calculated t-value of 2.502, and a significance value of 0.015. Although the value of the coefficient is relatively small compared to the other variables of 0.119, it is statistically significant, meaning that every 1% increase in labor will increase production by 1.19%, assuming the other variables are constant. This relatively small elasticity value indicates that although labor has a real effect, its contribution to increased output is not as large as that of other variables with higher coefficients.

The variable number of seedlings has a regression coefficient value (B) of 0.298, with a standardized beta coefficient value of 0.270, a calculated t-value of 2.975, and a significance value of 0.004. Even among other independent variables, the number of seedlings had the highest t-count value (2.975), which suggests that this variable has the strongest level of statistical confidence in influencing production. This means that every 1% increase in X3 will increase production by 2.98%, and this influence is one of the most statistically reliable in this model.

The cultivation experience variable had a regression coefficient value (B) of 0.024, with a standardized beta coefficient value of 0.044, a calculated t-value of 1.317, and a significance value of 0.193. In other words, the variations that occur in the variables of cultivation experience have not been statistically proven to contribute significantly to changes in the production variables in this model. This condition can be caused by several factors, such as the influence of cultivation experience which is naturally small on the production process, the influence of overlap with other independent variables, or the possibility that the cultivation experience variable requires interaction with other variables to be able to show a significant influence.

The string length variable had a regression coefficient value (B) of 0.401, with a standardized beta coefficient value of 0.327, a calculated t-value of 2.205, and a significance value of 0.031. Interestingly, the rope length variable had the highest regression coefficient value among all the independent variables studied, which was 0.401, which means that any 1% increase in rope length would increase production by 4.01%, assuming the other variables remained constant. This shows that the length of the rope is the variable that contributes the most to the increase in production output compared to the other variables in this model.

This study uses the Cobb-Douglas stochastic frontier production function with the Maximum Likelihood Estimation (MLE) estimation method. The analysis was carried out with the frontier 4.1c program. The value of technical efficiency is estimated by comparing the actual production results with the frontier production of each observation. Technical efficiency is obtained from the results of the analysis of production functions with frontier 4.1 with the results of production functions as follows:

$$LnY = Ln\ \beta0 + \beta1\ Ln\ X1 + \beta2\ Ln\ X2 + \beta3\ Ln\ X3 + \beta4\ Ln\ X4 + \beta5\ Ln\ X5 + (vi\text{-}ui)$$

Table 3.5. Results of Estimation of the Production Function of the Seaweed Frontier Stochastic Frontier in Seriwe Village with the 2026 MLE Method

Variabel	Coeficin	standar error	t-ratio
konstanta	-1.845	0.337	-5.468 ***
Land Area	0.384	0.165	2.328 **
Workforce	0.12	0.044	2.671 ***
Number of Seeds	0.299	0.096	3.093 ***
Experience	0.023	0.018	1.289 ns
Rope Length	0.399	0.177	2.246 **
Sigma Squared (p2)	0.006	0.001	5.548 ***
gamma (y)	0.10	0	7.380 ***
Log-likelihood function OLS	77.596		
Log-likelihood function MLE	82.593		
LR test of the one-side error	10.004		

Remarks: *** = significant at 99% confidence level (t-table = 2.656)
** = significant at 95% confidence level (t-table = 1.998)
* = significant at 90% confidence level (t-table = 1.669)
ns = insignificant

The estimation results using the MLE method showed three parameters, namely the sigma squared (σ2), gamma (y) value and the MLE likelihood function log. The value of the sigma squared parameter (σ2) is 0.006 and is significant at the 99% confidence level, in other words, technical inefficiencies or random variables contribute 0.6% to the production of seaweed farming businesses. From the table, the gamma value (y) is 0.10 indicating that 10% of the error term in the production function is due to the effect of technical inefficiency. The rest, however, is influenced by unpredictable factors such as climate, weather and the spread of disease. The low gamma value illustrates that the production potential of seaweed is almost entirely utilized by farmers. Therefore, technical efficiency in the seaweed business does not really need to be improved and has reached the maximum limit.

Furthermore, the log likelihood function value obtained of MLE was 82,593 greater than the log likelihood function value of OLS of 77,596 which means that the MLE estimation method is better than the OLS method and can represent field conditions. These results show that the model in the study is said to be good or good enough to describe the actual condition of seaweed farming in Seriwe Village. The generalized likelihood (LR) ratio value is 10,004 and is smaller than the Kodde and Palm table values at 95% confidence level (10,004 < 13,401). This figure indicates that this stochastic frontier production function has not been able to explain the existence of technical efficiency and inefficiencies in the production process [12].

The results obtained using the frontier 4.1c program obtained a very high technical efficiency value with an average of around 0.98. The following are details of the results of the estimated technical efficiency value of seaweed farming in Seriwe Village.

Table 3.6 Distribution of the Technical Efficiency Value of the Seaweed Business in Seriwe Village 2026

Technical Efficiency Level Distribution	Number of Farmers	Percentage (%)
0,81 - 0,90	0	0%
0,91 - 1,00	70	100%
Average	0.98	
Minimum	0.98	
Maximum	1.00	

Source: Primary Data Processed (2026)

Technical efficiency is intended to measure what level of production can be achieved out of the potential production that a farmer may be able to achieve. From Table 4.6, the average technical efficiency value of seaweed cultivation business in the research area is 0.98, meaning that overall seaweed cultivation farmers have achieved technical efficiency (ET > 0.70). With this very high average efficiency value, farmers can still improve to get maximum results or achieve efficiency values = 1.00 [9][10].

Based on the results of interviews with seaweed farmers, it was found that several obstacles were faced, including lack of seeds, pests and diseases, an uncertain climate, and lack of capital. The biggest obstacle faced by seaweed cultivators in Seriwe Village is the climate (72.4%) where climate change which has often been uncertain in recent years has occurred in several areas in East Lombok Regency. Furthermore, a significant obstacle is the lack of availability of seeds owned by farmers with a total of 41 people (58.6%). This is due to the lack of care in the sterilization process of the stall (thallus) or seedlings that will be used in the production process. The third biggest obstacle is the existence of pests and diseases as many as 32 people (45.7%). The pests and diseases that often attack seaweed, namely ice-ice disease, can damage plants up to 90% to 100%. The last obstacle is the lack of capital owned, which is 22 people (31.4%). The cause of this lack of capital is the low economic level of farmers causing limited capital.

IV. CONCLUSION AND RECOMMENDATION

Conclusion

1. Theproduction produced by farmers in carrying out seaweed cultivation business is 1,040 kg per cultivated land area or 43.33 kg per are, with a selling price of 20,000/kg. The average profit per production process is 10,458,265 or IDR 435,761 per are.
2. Production inputs that do not affect the seaweed cultivation business are experience, while the variables of land area, labor, number of seeds and rope length greatly influence.
3. The seaweed cultivation business in East Lombok Regency is technically efficient with an efficiency value of 0.98.
4. The obstacles faced by seaweed cultivators in the country are unconducive weather, minimal availability of seeds, pests and diseases (ice-ice), and still lack of capital.

Recommendation

1. For seaweed cultivators, it is recommended to optimize the use of production that has been proven to affect production.
2. For local governments and related agencies, it is necessary to increase support for seaweed cultivation businesses through the provision of superior seeds in a sustainable manner, the provision of production facilities and infrastructure, ease of access to capital, and the implementation of training and counseling on good cultivation techniques, especially in pest and disease control.
3. Given that the results of the study show that the seaweed cultivation business has reached a high level of technical efficiency, cultivators are expected to maintain this level of efficiency by continuing to implement cultivation practices in accordance with operational standards and evaluating the use of inputs periodically so that efficiency is maintained.
4. To anticipate climate change obstacles and pest and disease attacks, the government and fisheries extension workers need to strengthen the assistance system for farmers through the provision of weather information, the application of aquaculture technology that is adaptive to climate change, and the development of effective and environmentally friendly pest and disease control methods.

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