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The Effect of Production Factors on the Productivity of Seaweed *Gracilaria sp.* in the policulture cultivation system with Milkfish (*Chanos chanos)* in Luwu District

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Abstract— *This research was conducted to see to what extent the production factors used by the polyculture system of Gracilaria sp and milkfish farmers in Luwu Regency affect the production of Gracilaria sp. This research was conducted by interviewing Gracilaria sp cultivators in Luwu Regency by taking samples from three districts. The results show that the R2 value is 0.689 which means that 68.9% of the production / harvest can be explained by the production input, while the remaining 31.1% is influenced by other factors. In addition, it is also seen that the Fcount value obtained is 38.294 while Ftable (0.05) is 2.50 at the 95% confidence level, which means that the production input has a significant effect on the production of Gracilaria sp. Meanwhile, partially each production input has an effect on production, except for fertilizer production input.*

Keywords— ***Cobb-Douglas, Gracilaria sp., Polyculture, Production factors.***

I. INTRODUCTION

Seaweed is a fishery commodity that has economic value and is widely practiced by people in Indonesia. The territory of Indonesia which is dominated by marine waters which is the land for seaweed cultivation and relatively easy cultivation techniques from seaweed have made seaweed become one of the stars. Besides, the determination of seaweed as a priority commodity in fisheries revitalization has a very large development prospect, namely the availability of 1.1 million ha of land spread across almost all provinces in Indonesia (Bhakti FK, 2016).

The world's need for seaweed increases every year, causing the development of seaweed cultivation to be something that needs to be done. In 2015, the Ministry of Marine and Fisheries is committed to strengthening Indonesia's position as a major player in the world's seaweed industry and has set a target of increasing seaweed production by 45% in 5 years, namely 19.5 million tonnes by 2019 (Dirjen Perikanan Budidaya, 2015). FAO data 2015 shows that the total world seaweed production in 2013 reached 26.98 million wet tons, and Indonesia contributed 34.47 percent of this production, which is around 9.30 million wet tons (KKP, 2018).

One of the fisheries production centers in Indonesia is South Sulawesi. As one of the largest seaweed producing areas in Indonesia, South Sulawesi contributed 30% of the total seaweed produced by Indonesia in 2016 amounting to 3,409,048.20 tons (BSN, 2017). The types of seaweed that are widely cultivated by people in South Sulawesi are *Euchema Cottonii* and *Gracilaria sp.*

Gracillaria sp is one type of seaweed that is widely cultivated by cultivators in Luwu District. Seaweed cultivation is increasingly attractive to people living in coastal areas for several reasons. First, it does not require relatively high capital. Second, the cultivation technology applied is simple so that it is easily adopted by the small community. Third, in terms of time, it is relatively efficient. Fourth, a short cultivation cycle. Cultivator farmers can harvest the results within 45 days. Fifth, it can be done by anyone, including housewives (Yayasan WWF Indonesia, 2014).

Production factors consist of natural resources, human resources, capital, entrepreneurship, and information. A study conducted by (Inrise, 2015 in Pratomo N, 2018) shows that farmers' knowledge of seaweed production is also still limited. Besides, the lack of capital is also a problem in the production and increasing income of seaweed cultivators (Sari R.R and Dewi M.H.U, 2017).

Knowledge and capital lowness cause farmers in Luwu District to speculate in the process of cultivating Gracilaria seaweed. This speculation is an attempt by farmers to reduce production costs due to a lack of capital. However, due to the lack of knowledge of farmers about seaweed production, it is feared that the speculation will cause low income of Gracilaria seaweed farmers. A study conducted by (Patawari A.M.Y., 2018) shows the income of Gracilaria seaweed farmers in Seppong Village, North Belopa Sub-district, Luwu District is classified as lacking.

Based on the above, it can be seen that the use of production factors is not appropriate, so it is necessary to do research on the effect of production factors on the productivity of Gracilaria sp in polyculture cultivation with milkfish in Luwu Regency.

II. METHODS

2.1. Time and Location of Research

This research has done in November 2020 in 3 sub-districts, namely Suli Sub-district, South Ponrang Sub-district, and East Walenrang Sub-district in Luwu District, South Sulawesi Province.

2.2. Collecting Data Method

The collected data consists of 2 (two), namely primary data and secondary data. Secondary data is obtained through related offices or agencies. Primary data is obtained through surveys and interviews with *Gracilaria* seaweed farmers in the Luwu District. Seaweed cultivators who are used as respondents are those who live and carry out *Gracilaria* seaweed cultivation in Luwu District. Based on data from the Dinas Perikanan Kabupaten Luwu, it is known that there are 80 groups of *Gracilaria sp* cultivators, spread across 9 (nine) sub-districts. Of the 9 (nine) Sub-districts in Luwu Regency, it was divided into three sampling areas based on the similarity of characteristics and proximity of the sub-districts. The sub-districts of Larompong, Suli, Belopa, and North Belopa become region I, Kamanre, South Ponrang, and Bua sub-districts become region II, and East Lamasi and East Walenrang sub-districts become region III. Each area was taken 1 sub-district as a sample and all groups in the sub-district were taken representatives, they were the chairman and secretary to be interviewed as respondents. Interviews were conducted with *Gracilaria* seaweed farmers using a pre-arranged list of questions (questionnaire). These aim to determine the production factors of *Gracilaria* cultivation carried out by respondents.

2.3. Data Analysis Method

To see how much influence each production factor has on the production of *Gracilaria sp.* and whether production factors have the most effect on the production of the data obtained were analyzed using Cobb-Douglas analysis with the help of SPSS 20 and Microsoft Excel applications. The Cobb-Douglas production function can be written with the following formula (Soekartawi, 2003).

$$Y = b_0 X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} e^{u}$$

Y: Dry Seaweed Gracilaria sp. production (kg)
X1: Land Area (m^2)
X2: Seed weight of Gracilaria sp. (kg)
X3: The amount of fertilizer used (kg)
X4: Number of milkfish seeds spread (unit)

Furthermore, to determine the closeness of the relationship between production factors (Xi) and production (Y), the correlation coefficient (R) is used and to find out the extent to which the factors of production (Xi) can explain production (Y), the coefficient of determination (R^2) is used.

III. RESULTS AND DISCUSSION

3.1. Profile of Respondents

1. Land Ownership

Based on the pattern of land ownership for business, it is divided into 3, namely: self-owned land, leasehold land, and production sharing land (Hayami and Oksuka, 1993). Based on research by Koirala, Mishra, and Muhanty, 2016, shows that this land ownership pattern has a significant effect on farmers' income.

Table 1. Pattern of Land Ownership

Worker Status	Number of Respondents	Percentage
Owner	51 persons	69%
Worker	14 persons	19%
Tenant	9 persons	12%

Source: Primary Data

From the table above, it can be seen that the land management status of seaweed cultivators as respondents is 69% are own owners, 19% are workers with profit-sharing systems and the remaining 12% are land tenants.

2. Age

Age is an important factor influencing people to think and act. At a young age, someone will be more open to accepting environmental changes, and also the level of acceptance of innovation will be faster and easier. Agricultural activities, in this case, seaweed cultivation, also require stronger energy. This is because in addition to having experience, knowledge, and seriousness, the cultivation of seaweed *Gracilaria sp*. also requires a resilient workforce.

Table 2. Age Range of Respondents for Gracillaria sp.

Age Range	Number of Respondents	Percentage
≤ 30 years old	4	5,4%
31-59 years old	61	82,4%
≥ 60 years old	9	12,2%

Source: Primary Data

Based on the table above, it is showed that the majority sample is still classified as productive, namely, 82.4% in the age range of 30-59 years old, while those in the ≤ 30 years age range are only 5% and those in the age range ≥ 60 are 12.2%. According to Samun et al.(2011), farmers at the age of 30-59 years old still have a strong physique that can support their farming activities and are easy to accept changes in technological innovation. Meanwhile, those aged >59 years old are often considered not agile and not fast enough to accept new technology (Sunar, 2012).

3. Work Experience

Success in managing *Gracilaria sp*. Also influenced by experience in cultivating seaweed *Gracilaria sp*.. According to Hilgard and Bowder, (1975), repeated experiences in certain situations lead to changes in a person's behavior in certain situations as a learning process.

Table 3. Experiences of Cultivators of Gracilaria sp.

Experience	Number of Respondents	Percentage
1-5 years	5	6,8%
6-10 years	13	17,6%
11-15 years	21	28,4%
16-20 years	20	27,0%
21-25 years	5	6,8%
26-30 years	10	13,5%

Source: Primary Data

From the table above, it is found that the largest number of respondents who have 10-15 years of experience with a percentage of 28.4%, but slightly different from those who have 16-20 years of experience with a percentage of 27.0%. Besides, some respondents had 1-5 years of experience as much as 6.8%, 6-10 years as much as 17.6%, 21-25 years as much as 6.8%, and 26-30 years as much as 13.5%.

4. Level of Education

According to Soekartawi (2001), the level of education will greatly affect the way of thinking and one's absorption of new technology. The level of education affects the way business owners think and act in doing their business. Based on the data obtained in the field, it was found that the research sample education was very diverse from elementary school (SD) to senior high school (SLTA). For more details, it can be seen in Table 6 below:

Table 4. Educational Level of Gracilaria sp. Cultivators.

Educational Level	Number of Respondesnts	percentage
Not SD	1	1%
Elementary School (SD)	21	29%

Junior High School (SMP)	25	34%
Senior High School (SMA)	26	35%
Undergraduate	1	1%

Source: Primary Data

From the table above, it is found that the educational level of Gracilaria sp. At the SMA and SMP levels are the most with a percentage level of 35% and 34%, then some do not complete elementary school with a percentage of 1%, then graduate from elementary school with a percentage of 29% but there are also undergraduate at 1%

5. Other Occupation

A person's steps or actions to increase their household income are to get other jobs besides their regular jobs. For farmers, their regular job is farming. However, there are still other jobs they do to increase family income to fulfill household consumption.

Table 5. List of other occupations of respondents

Other Occupation	Number of Respondents	Percentage
None	36	49%
Farmer	31	42%
Trader	5	7%
Breeder	1	1%
Seaweed E.Cottonii Cultivator	1	1%

Source: Primary Data

From the table above it is known that the number of respondents who do not have other occupations is 49% and those who have other occupations are 51% with each percentage of the occupation, namely farmers by 42%, traders by 7%, breeders by 1% and seaweed E. Cottonii cultivator at 1%. This shows that the majority of Gracilaria cultivators have other occupations to get additional income for their household.

3.2. Production Factor

Based on the results of production input data processing, it can be seen the effect of production input on seaweed production Gracilaria sp. in the Luwu District. The amount of influence can be seen in the following table

Table 6. Summary of Data Processing Results using SPSS

Model Summary[b]

Model	Change Statistics					Durbin-Watson
	R Square Change	F Change	df1	df2	Sig. F Change	
1	.689[a]	38.294	4	69	.000	1.813

a. Predictors: (Constant), Milkfish, Fertilizer, Land_Area, Number_of_seed

b. Dependent Variable: Harvest

Source: Primary Data Processing

From the table above, it can be seen that the R^2 value is 0.689 which means that 68.9% of the production/harvest can be explained by the production input, while the remaining 31.1% is influenced by other factors. Besides, it is also seen that there is an effect of production input on the production of *Gracilaria* sp. This can be seen from the F_{count} value obtained is 38.294 while F_{table} (0.05) is 2.50 at the 95% confidence level, which means that the production input has a significant effect on the production of seaweed *Gracilaria* sp.

From the analysis, the coefficient value of each independent variable (land, seed weight, fertilizer, and milkfish) was also obtained. The coefficient value aims to determine which independent variable has a significant effect on the

dependent variable, namely seaweed production *Gracillaria* sp. If t significance is used as a measure, the t significance value must be compared with the alpha level (α = 0.05). If the significance of t count<table, it is declared significant. However, if the significance of t count>table, it is declared insignificant.

Table 7. Coefficient Table of Each Production Factor

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.069	.616		-.112	.911
	Land_area	.456	.071	.537	6.450	.000
	seed_weight	.239	.078	.257	3.074	.003
	Fertilizer	-.055	.024	-.164	-2.241	.028
	Milkfish	.194	.059	.248	3.266	.002

a. Dependent Variable: Harvest

Source: Primary Data Processing

The results of the multiple linear regression data processing above can simply be written through the following equation:

$$Y=-0{,}069X1^{0{,}456}X2^{0{,}239}X3^{-0{,}055}X4^{0{,}194} + e \text{ …….. } (1)$$

With:

Y= Dry Seaweed Gracilaria sp. production (kg)

X1= Land Area (m^2)

X2= Seeds weight (kg)

X3= Fertilizer (kg)

X4= Milkfish (unit)

From the table above information is obtained about the effect of each production input on the production of *Gracilaria sp.* as follows:

a. Land Area

In this variable, T_{count} is 6,450, which is greater than T_{table}, which is 1.995, so that the land area has a significant effect on the production of *Gracilaria sp*. The regression coefficient for the land area is 0.456, which means that each additional 1 m^2 of land will increase seaweed *Gracilaria sp*. production up to 0.456 kg. This is consistent with the results of research by Wibawa M A (2017) and Risna, Munarka, & Surullah (2018) that state that land area affects the production and income of cultivators.

b. Seeds Weight

In this variable, the T_{count} is 3.074, which is greater than the T_{table}, which is 1.995, so that the seed weight has a significant effect on the production of *Gracilaria sp*. Seaweed. The regression coefficient value for Seed Weight is 0.239 which means that every 1 kg of *Gracilaria sp*. will increase the production of *Gracilaria sp*. up to 0.239 kg. This is following the research of Sabarno A., et al. (2018) which states that seed weight greatly affects production.

c. Fertilizer

In this variable, the T_{count} is -2,241, which is smaller than T_{table}, which is 1.995, so that fertilizer has no significant effect on *Gracilaria sp*. Seaweed production. The regression coefficient for fertilizer is -0.055, which means that the addition of 1 kg of fertilizer will reduce seaweed *Gracilaria sp*. production down to 0.055 kg.

It shows that, statistically, fertilizer does not affect the production of *Gracilaria sp*. However, the conditions in the field are still many people using fertilizers, especially SP 36 fertilizers. This is due to the soil conditions in the Bone Bay area, Luwu District which is acidic (Mustafa A & E Ratnawati, 2005), and the phosphate levels in the waters of Luwu District is very low (Patahiruddin, 2015). Phosphate is one of the essential elements for plants and algae and strongly affects the level of aquatic productivity (Yunus et

al., 2010). The use of fertilizer in question is based on (Halid I & Patahiruddin, 2019) which states that one of the diseases that attack seaweed, namely "ice-ice" can be prevented and stopped by using fertilizers containing phosphate. However, public knowledge of the way and the right dose of fertilizer use is not enough to cause people to speculate on this. Apart from the relatively low level of formal education, the education program about *Gracilaria sp* cultivation to the community is also lacking. This is evidenced by the results of interviews with cultivators whom 81% said there was no education program on *Gracilaria sp* cultivation, 14% said sometimes, and 5% said there was.

Table 8. Education Program about Gracilaria sp *cultivation*

Education Program	Number of Respondent	Percentage
There is	4	5%
Sometimes	10	14%
Nothing	60	81%

Source: Primary Data Processing

The use of fertilizers in the cultivation of *Gracilaria sp.* in Luwu District has similarities with several other areas. However, it should be noted that excessive use of inorganic fertilizers or in inappropriate doses can endanger the environment and *Gracilaria sp.* cultivated (Halid I & Patahiruddin, 2019).

d. Milkfish

In this variable, the T_{count} is 3.266, which is greater than the T_{table}, which is 1.995, so that milkfish has a significant effect on *Gracilaria sp.* seaweed production. The value of the milkfish regression coefficient is 0.194, which means that every addition of 1 milkfish will increase *Gracilaria sp.* seaweed production up to 0.194 kg. This is following the results of research by D Fidyansari & W Rafli (2015) that states that the production of seaweed with milkfish reaches 800 kg, while those without milkfish are only 586 kg.

According to Priono B., Septyan A., & Irsyaphiani I. (2012), that the cultivation of *Gracilaria sp.* and milkfish simultaneously can be done even *Gracilaria sp.* can grow to more than 375% for more than two months of maintenance. This is because of the presence of milkfish in *Gracilaria sp.* seaweed ponds will help supply nutrients from the secretions of milkfish and also help prevent algae growth through its movement on the bottom of the water while looking for food (W. Isroni et al., 2020)

IV. CONCLUSIONS AND SUGGESTIONS

4.1. Conclusions

In the Polyculture Gracilaria sp and milkfish culture system, it is known that holistically, the production of Gracilaria sp. can be explained by the production input of 68.9% while 31.1% is influenced by other factors. However, partially, the input of fertilizer production does not have an effect on productivity, while the input production of land area, weight of seedlings and number of milkfish seeds have an effect on the productivity of seaweed Gracilaria sp in the polyculture system with milkfish. So that to save capital, cultivators can reduce or even need to use fertilizers.

4.2. Suggestions

Nutrition for the growth of Gracilaria sp seaweed can be fulfilled by changing the water at a certain time. In addition, it is also necessary to conduct research on the nutritional requirements for the growth of Gracilaria sp. Seaweed and its availability in Bone Bay, Luwu Regency.

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