Analysis of the benefits of seaweed farming and its effects on the environment and community activities (study in the city of Tual, Southeast Maluku)

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Abstract. Analysis of the Benefits of Seaweed Farming and Its Effects on the Environment and Community Activities (Study in the City of Tual, Southeast Maluku). This study aims to analyze how much profit and efficiency levels of seaweed farming in the City of Tual Southeast Maluku and their impact on community activities and the surrounding environment. The method used in this research was business analysis. The business analysis method consisted of business income analysis, revenue cost ratio (R / C) analysis, Break Even Point Analysis, Return on investment (ROI), and descriptive qualitative. The results showed that seaweed farming in Tual City was very profitable, with an average profit for small farmers of IDR 15,134,275 and large farmers of IDR 29,927,120. The result of revenue cost ratio analysis in Tual City was very efficient where the average R / C value for small scale seaweed farming was 3.3, and for large scale, the average R / C value was 3.4. In terms of break-even point where a break-even point for small-scale businesses would occur when the price per Kg of seaweed was in the range of IDR 3,987 with an average production of dried seaweed 1163 Kg. For seaweed farming on a large scale where the break-even point would occur when the price per Kg of seaweed was in the range of IDR 3,847 with an average production of 2275 Kg. From the results of the analysis of return on investment obtained an average of 326% for small farmers, and for large farmers amounted to 342%. Besides, the selection of efficient seaweed cultivation so that it does not have too much impact on community activities and the surrounding environment.

1. Introduction

The fisheries and marine sector in Indonesia continues to make good contributions. This certainly can improve the economy of the community, especially for coastal communities. Not only fish and other marine products are the main export commodities, the commodity in the field of fisheries and marine also has a high economic value is seaweed. Seaweed cultivation or Algae, has long been known in the world community. The species most widely cultivated by farmers are brown handle seaweed because it has a high economic value, besides brown seaweed is the species most commonly studied and exploited commercially [1].
Total seaweed production in Indonesia has increased significantly. According to the Ministry of Maritime Affairs and Fisheries's preliminary data, the national seaweed production in 2014 reached 10.2 million tons or an increase of more than three times. Where previously, seaweed production in 2010 was only around 3.9 million tons. This proves that seaweed is very reliable as a source of livelihood for coastal communities. Apart from the way that cultivation is quite easy and inexpensive, also because this product is still in great demand. In line with the policy of the President of the Republic of Indonesia, the Ministry of Maritime Affairs and Fisheries will continue to provide continuous guidance to the community in terms of cultivating seaweed.

![Figure 1. Target trend and achievement of National seaweed production, 2010 – 2014.](image)

Figure 1 shows that seaweed production contributes significantly to aquaculture production. Nationally, seaweed production gives a share of 70.47% of aquaculture production. The development of seaweed production from 2010 - 2014 showed a very positive trend, with an average increase per year, reaching 27.72%. Therefore seaweed can be regarded as one of the potential world trade commodities that support the economy of coastal communities.

Seaweed has also been developed in almost all parts of the world. In Indonesia, the development of seaweed has been very rapid with several regions becoming the largest producers of seaweed, such as West Nusa Tenggara, East Nusa Tenggara, Sulawesi, Sumatra, Maluku, Java, and other regions. In addition, Indonesia has the potential to develop seaweed covering an area of 1,110,900 hectares, but currently, only 222,180 hectares, or around 20 percent, are utilized [2].

There is a high potential for seaweed cultivation in Eastern Indonesia, especially in Maluku Province, with a sea area of 92.4%. Based on data from the Regional Investment Coordinating Board, potential land for seaweed cultivation in Maluku is 23,613 hectares and only 8,258 hectares of the land that has been used. This shows that the opportunity for the development of seaweed farming is still promising.

The area of seaweed cultivation in Tual City is still classified as very large, namely, 40,213.6 Km², while the potential land for seaweed cultivation is 5,103 Ha, and only 2,374 Ha (42.39%) has been utilized. There are 2,729.38 Ha or 57.61% that have not been utilized, so the opportunity to develop seaweed farming business by the community is still very open. Seaweed production growth in Southeast
Maluku Regency continues to increase as seen from seaweed production in 2015 in five districts in Tual City, namely for PP Kur (1,756.87 tons), South Kur (752.94 tons), Tayando Tam (10,039.26 tons), North Dullah Island (7,529.45 tons) and South Dullah Island (5,019.63 tons).

Consider the magnitude of the potential for seaweed cultivation in the Southeast Maluku Regency because there is still a lot of land that has not been used maximally, of course this is a great opportunity for seaweed farmers to be able to increase production. In addition, the price of seaweed is now starting to get better, where the price of seaweed in the last 3 years has increased significantly. Based on survey results obtained from seaweed farming farmers and collectors, in 2018 the price of dried seaweed is in the range of IDR 17,500 IDR 18,000 per Kg. Previously the price of seaweed in 2017 was in the range of IDR 14,000 to 15,500 per Kg, while in 2016 around IDR 8,500 to 10,000 per kg.

Besides that, one of the most important factors in seaweed cultivation is a strategic location so as not to disturb the activities of the surrounding community. The determination of location must be suitable to protect the surrounding environment so that environmental deterioration on the surrounding community can be prevented. Until now, the people of Tual City who work as seaweed farmers generally usually use coastal waters that are not far from the settlement or village, to be used as a place to cultivate seaweed.

However, to date there has been no clear regulation regarding the use of the coastal area or who has the authority to give permission to the community to carry out seaweed farming activities. This becomes the basis for the need for regulations regarding land use so that community activities both fishermen who make the sea as a livelihood and other sea users who use the sea as a transportation route between villages do not interfere with each other.

In the context of business licensing, in fact, it has been established that everyone who has a business in the field of fisheries such as fishing, cultivation, transportation, processing and marketing of fish in the fisheries management area of the Republic of Indonesia is required to have a Fishery Business Permit. Fishery Business Permit is a written permit that must be owned by a fishery entrepreneur to conduct a fishery business using the production facilities listed in the permit. However, the obligation to have a permit does not apply to small fishermen or micro-cultivation businesses.

In Southeast Maluku Regency itself, almost all seaweed farming farmers are small farmers who live on the coast. The cultivation method used by almost all seaweed farmers in Southeast Maluku is the Long Line method, which is a method of cultivation using a long stretched rope. This method of cultivation is in great demand by the community because the tools and materials used are more durable and easy to obtain.

The technique for seaweed cultivation with the Long Line method is to use 25-50 meters long ropes with anchors and buoys or styrofoam at both ends. To hold the rope to stay afloat on the surface of the sea when planting seaweed, every distance of 4-5 meters is given afloat in the form of a piece of rubber sandals or a used bottle of 500 ml. With a method like this, it will use large tracts of land and can disturb other sea users who make the sea lane as a transportation center or as a livelihood such as fishermen and sea transportation.

The management system of seaweed cultivation, especially the coastal areas for seaweed cultivation in Southeast Maluku Regency is a complex problem because it is related to land ownership issues. Usually, people who want to use the coast for cultivation should ask permission from the landowner or clan head who has authority over the area.

The development of seaweed farming in Tual City has big potential if considered from the ecological aspects as well as a large area that can be utilized by the community for the development of seaweed farming. Especially people who live in coastal areas that make seaweed farming as an alternative for livelihoods. However, on the other hand, there are factors that can affect productivity, efficiency, and profitability of seaweed farming, these factors include; a container of cultivation, seeds, labor, and other supporting factors that can help farmers to increase production and achieve the expected benefits.
In addition to the supporting factors above, seaweed farming is a business that makes sea as the main alternative for seaweed cultivation so that external problems cannot be avoided, one of which is the issue of authority or granting permission to the community in conducting seaweed cultivation business. In addition, less strategic cultivation locations can disrupt the activities of other communities who live on the coast, both communities that make the sea as a transportation route for villages or communities that make the sea as a source of livelihood.

2. Methods

2.1 Place and time
This research conducted in Tual city, Southeast Maluku Regency. The reason researchers chose the city of Tual as a research location because there are many seaweed farmers in the city of Tual and until now many people in the city of Tual who work as seaweed farmers, especially people who live on the coast.

2.2 Population and sample
In this study, the population is all seaweed farmers in Tual City in five districts, namely: districts of PP Kur, Kur Selatan, Tayando Tam, P. Dullah Selatan, P. Dullah Utara with a total sample of 206.

| Sub-district       | Amount |
|--------------------|--------|
| P.Dullah Utara     | 51     |
| P. Dullah selatan  | 42     |
| Tayando Tam        | 73     |
| PP Kur             | 27     |
| Kur selatan        | 13     |
| Total              | 206    |

In this study, the authors narrowed the population of seaweed farmers by calculating the sample size using the Slovin technique with a confidence level of 93% and an error rate of 7%

**Slovin Formula:**

\[ n = \frac{N}{1+N\times e^2} \]

where:

- \( n \) = Amount of sample
- \( N \) = Population
- \( e \) = Fault tolerance limit

**Therefore:**

\[ n = \frac{206}{1 + (206\times 0.07^2)} \]
\[ n = \frac{206}{1 + (206\times 0.07^2)} \]
\[ n = \frac{206}{1 + 1,0094} \]
\[ n = \frac{206}{2,0094} \]
\[ n = 102.5181 \]

From the sample calculation using the Slovin formula with a confidence level of 93%, the sample obtained is 103.

2.3 Data analysis method
The method used in this research is business analysis. The business analysis method consists of business income analysis, revenue cost ratio (R / C) analysis, Break Event Point Analysis, Return on investment (ROI) and descriptive qualitative methods.
2.4. Business revenue analysis
To find out the level of income obtained from production activities, it must first be known the level of total revenue and total expenditure in a certain period. To find out the amount of farming income, mathematically can be formulated as follows [3]. TR (Total Revenue) = (P x Q)
Formula:
\[ \pi = TR - TC \]
Note:
\[ \pi = \text{Profit} \]
\[ TR = \text{Total Revenue} \]
\[ TC = \text{Total Cost} \]
Revenue-cost Ratio Analysis (R/C)
\[ R/C = \frac{TR}{TC} \]
Note:
\[ TR: \text{Total revenue} \]
\[ TC: \text{Total Cost} \]
Criteria in making decisions if RCR > 1, the business is feasible to run. RCR = 1, then the business does not get a profit because the capital spent is equal to revenue. RCR < 1, the business undertaken is not feasible to continue [4].
Break-Even Point Analysis (BEP)
\[ BEP (Kg) = \frac{\text{Total Cost}}{\text{Price per Unit}} \]
\[ BEP (Rp) = \frac{\text{Total Cost}}{\text{Total Production}} \]
Return on investment (ROI)
\[ ROI = \frac{\text{Profit}}{\text{Production Capital}} \]
In addition to the analysis of farming, this research also uses qualitative methods to describe data obtained from the study site, both primary and secondary data and then given interpretation and conclusions.

3. Result and Discussion

3.1. Overview of seaweed cultivation
Some general description of seaweed cultivation in Tual City are explained as follows:

a. Seaweed cultivation in Tual City was carried out by some people who live on the coast and work as seaweed farmers, which were spread in 5 Subdistricts, namely North subdistrict P. Dullah, South P. Dullah, Tayando Tam, PP Kur, and South Kur.

b. Types of seaweed that were cultivated by farmers are *Eucheuma spinosum* (red seaweed)

c. The farmers/community used the long line method in seaweed cultivation. Where there were 9 points of the main rope or more, which were tied using a ballast/anchor made of stone or concrete. The rope for the anchor used a 12mm rope, then was given the main float at each end of the rope which would be tied to a 6mm rope for binding the seeds. Every 1.5 meters’ distance on the main rope was given float in the form of an aqua bottle.

d. The need for seaweed seedlings depends on how big the cultivation container is. The average plot used by the community for seaweed cultivation was 10x50 m and 10x25 m in each unit, there were 10-12 ropes, the distance between ropes was 1 m. The number of seeds used for a 10x50m plot with 10-12 ropes was 500kg and, for 10x25 with 10-12 ropes 250 kg. seed weight at each point 200gram the distance between points was 20-30cm.
e. The seaweed harvest period was 40-45 days or 1.5 months. With the amount of wet seaweed production, an average of 2500-3000 kg or 2.5-3 tons and dry 500-600 kg for large farmers. While for small farmers with an average production of 1250-1500 kg for necessary and dried seaweed 250-300 kg per 1 harvest.

f. The results of seaweed production by farmers were sold in dry form, with the milling process for 3-4 days depending on the weather because the drying process requires adequate sunlight. From 5 kg of wet seaweed = 1 kg of dried seaweed. The price of seaweed was currently around IDR. 17,000, which was bought directly by collectors.

3.2. Profit analysis of seaweed farmer business

Revenue is the result of the difference between revenue and cost used in the production process, economic income that is all revenues minus all production costs. Income is a representation of the income received by the community for work performed during specific periods, either annual, monthly, weekly or daily [5]. The following are the overall income for small and large farmers can be seen in Table 2.

Table 2. average income from seaweed farming in Tual City

|                  | Production (Q) | Total Revenue (QxP) | Total Cost TVC+TC | Income TR-TC |
|------------------|----------------|---------------------|-------------------|--------------|
| Small farmers    | 1163           | IDR. 19,430,883     | IDR. 4,637,500    | IDR. 15,134,275 |
| Big farmers      | 2275           | IDR. 38,681,120     | IDR. 8,754,000    | IDR. 29,927,120 |

Source: primary data processed 2018

From table 4.1 it can be seen the average income of seaweed farmers in Tual City in 1 year (4 harvest seasons), for small farmers with a 10x25 m container was IDR. 15,134,275 with the amount of dried seaweed production was 1163 kg, with a selling price per kg was IDR. 17,000. Whereas for large farmers with a 10x50 m cultivation container with a total production of 2275 kg dry, with the same selling price of IDR. 17,000 per kg. Therefore, the average income for large farmers, amounting to IDR. 29,927,120.

3.3. Analysis of revenue cost R / C ratio of seaweed farming

Analysis of the R / C revenue cost ratio is used to see the benefits and efficiency of a business in a certain period [4], saying that a business can be said to be feasible if TR / TC > 1 and vice versa the business is said to be unfit to run if TR / TC <1. Following is the average revenue cost ratio for small farmers and large seaweed farmers in Tual City can be seen in table 3.

Table 3. average R / C revenue cost ratio for farming large and small scale

|                  | Revenue cost ratio of large scale farmers | Revenue cost ratio of small scale farmers |
|------------------|-----------------------------------------|----------------------------------------|
| TR               | IDR. 29,738,603                          | TR IDR. 15,134,275                     |
| TC               | IDR. 8,754,000                           | TC IDR. 4,637,500                      |
| R/C (TR/TC)      | 3.4                                      | R/C (TR/TC) 3.3                         |
Based on the calculation results of the R / C revenue cost ratio obtained that the average R / C value for small scale seaweed farming was 3.3, and the average value for large scale seaweed farming was obtained an R / C value of 3.4, based on the above criteria if TR / TC > 1 then the business is profitable and efficient, so it can be concluded that the seaweed business in the city of Tual for small and large scale is very efficient and profitable as well as feasible to run.

3.4. Analysis of break-even point (BEP) of Seaweed farming

Break-even point analysis (BEP) is a technique used to determine the sales volume of a business that does not experience a loss and also does not make a profit [6,7]. Circumstances where the business is at the break-even point, a situation where the receipt of seaweed farming (TR) equals the costs incurred (TC) or TR = TC. Analysis of the break-even point for seaweed farming can be seen in table 4.

Table 4. Break-even point for seaweed farming for small and large scale

| Analysis of Break-Even Point (BEP) Seaweed farming for small scale |
|---------------------------------------------------------------|
| BEP (Kg) TC/P | BEP (Rp) TC/Q |
| 273           | IDR. 3,987    |

| Analysis of Break-Even Point (BEP) Seaweed farming for large scale |
|---------------------------------------------------------------|
| BEP (Kg) TC/P | BEP (IDR) TC/Q |
| 515           | IDR. 3,847    |

Source: primary data processed 2018

From table 4.3, it can be seen that the results of break-even point analysis for small scale seaweed farming BEP (kg) will occur when the average production of seaweed farmers was 273 Kg with a selling price of IDR. 17,000, the break-even point TR = TC or revenue equal to the capital spent. Whereas for BEP (IDR), seaweed farming will be at the break-even point when the price per Kg of seaweed was in the range of IDR. 3,987 with an average dry seaweed production of 1163 kg per four times harvest (1 year). For large scale seaweed farming, BEP (Kg) will occur when the average production of seaweed farmers was 515 kg with a price of IDR. 17,000. There will be a break-even point where TR = TC or revenue equal to the capital spent. Further, for BEP (IDR) where seaweed farming will be at the break-even point when the price per Kg of seaweed was in the range of IDR. 3,847 with an average production of 2275 kg.

3.5. Analysis of return on investment (ROI) of seaweed farming

Return on Investment (ROI) analysis is a measure or amount used to evaluate the efficiency of an investment compared to the cost and initial capital spent. From the results of the analysis of return on investment (ROI) of grass farming obtained based on the comparison of profits and capital where the value obtained was 326% for small farmers, this means that farmers got a profit of 326%. Which means that every investment or capital spent by the farmer was IDR.100 for seaweed cultivation, the farmer would reap a profit of IDR.326. Whereas for seaweed farming on a large scale were the results of the comparison of revenue with capital spent amounting to 342% this showed that every IDR.100 of capital spent by farmers in the business would provide a profit of IDR. 342.

3.6. Seaweed cultivation and environment

Legally regarding licensing conditions, the majority of small and medium-sized businesses in Southeast Maluku Regency do not yet have a permit, although they have not yet received a permit, the business
continues to run. The Ohoi (village) government as well as from the Ministry of Maritime Affairs and Fisheries in Southeast Maluku Regency generally actively support efforts to empower coastal communities in establishing and developing seaweed cultivation businesses.

Based on the results of interviews with farmers about the location and licensing for seaweed cultivation. Some farming communities said that licensing for seaweed cultivation locations directly through the Government of Ohoi (village head), besides that, in general, the people who conduct seaweed cultivation were people who originally came from the village and were domiciled in the village. Moreover, there was no land lease process, because all the people especially those from the village have the same rights if they want to cultivate seaweed as long as they want to, said several people interviewed and did not violate the regulations made by the Ohoi government, and to date there were no regulations what was clear from the Tual city government regarding the location of seaweed cultivation because until now there has been no prohibition from the government or village apparatus. Even the city and village governments are very supportive because the existence of seaweed cultivation can increase community income, especially people who live on the coast.

Besides that, most of the people who work as seaweed farmers were people who did not have permanent jobs, but some had side jobs such as ship laborers, gardeners, and also fishers. Because seaweed cultivation was not done every day, only during the binding of the seedlings, the harvesting period, the process which took a little time only at the beginning namely the preparation of the cultivation container, for the drying process was also usually done in front of a house or open field.

In general, the selection of locations for seaweed cultivation in Tual City already had a joint agreement between the community and village officials, where the choice of location must be conducive and productive, therefore they did not disturb the activities of other communities, or sea transportation routes. Besides, seaweed cultivation locations are usually far from tourism potential locations because several villages did have tourism potential that was developed so that the selection of aquaculture locations must be appropriate.

4. Conclusion

Based on the results of the study can be concluded as follows:

1) In terms of the benefits of seaweed farming in the city of Tual, it is very profitable where the average profit gained from the sale of seaweed during four harvest seasons (1 year), for small farmers IDR. 15,134,275 and for large farmers is IDR. 29,927,120. This is certainly very helpful for the community, especially to meet the economic needs of the people, especially the coastal community.

2) Based on the analysis of R / C revenue cost ratio where the seaweed business in Tual City is very efficient where based on the results of the average analysis of R / C values for seaweed farming with a small scale of 3.3 and for large scale the average value of R / C 3.4 this shows that the seaweed business in the city of Tual is very feasible to be developed and has a fairly high level of efficiency.

3) In terms of break-even point where a break-even point for small-scale businesses will occur when the average production of BEP (Kg) produced by seaweed farmers is 273 Kg, with a price of IDR. 17,000. Whereas the BEP (Rp) for seaweed farming will be at the break-even point when the price per Kg of seaweed is in the range of IDR. 3,987 with an average dry seaweed production of 1163 kg per four times harvest (1 year). For large scale seaweed farming, BEP (kg) will occur when the average production of seaweed farmers is 515 kg with a price of IDR. 17,000. Whereas for BEP (IDR) where seaweed farming will be at the break-even point when the price per Kg of seaweed is in the range of IDR. 3,847 with an average production of 2275 kg.
4) From the return on investment (ROI) analysis, an average of 326% is obtained for small farmers. This means that farmers get a profit of 326%. From the capital of IDR.100 farmers will reap a profit of IDR. 326. For large farmers where the results of the comparison of revenue with capital spent amounting to 342%, this shows that each IDR. 100 of capital issued will provide a profit of IDR. 342.

5) The issue of granting authority for seaweed cultivation in Tual City has been through a mutual agreement between the village community and the head of Ohoi (village), so there is no land leasing process, and the Tual City government is also very supportive of the community in the seaweed cultivation business, besides that the location used by the community does not interfere with the activities of other communities or sea transportation routes.

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