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Research Article

Farming Production Analysis of Seaweed and Farmer's Perception towards Climate Change Effect in Southeast Sulawesi, Indonesia

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Abstract

Background and Objective: The seaweed farming has a high economic value for the community's economic development as well as one of the cores of the national economic support. Therefore, it is relatively easy for farmers to adopt its technical cultivation. Moreover, 80% of fishery products in Southeast Sulawesi are seaweed commodities. This study was to know the income of seaweed in Southeast Sulawesi and the coping strategy of climate change effect. **Materials and Methods:** This research was carried out from September-December, 2019 in Regency of Central Buton and Bombana, Southeast Sulawesi, Indonesia. There were 311 farmers selected by simple random sampling. Primary data was collected through direct face to face interviews guided by questionnaires, while secondary data was obtained from documentary observation from related institutions. This was then analyzed descriptively. **Results:** The result revealed that the average income of seaweed farmers is approximately IDR 8,566,000 for each production season. Moreover, in conforming climate change, farmers had been prepared with superior and qualified seed and strong construction stretch which was relatively safe for deeper waters. At the same time, they also had livelihood alternatives. **Conclusion:** The results of the analysis and discussion showed that average income of seaweed farmers was IDR 8,566,000 for each production season, R-C ratio value is 2.30 and it means that seaweed farming is financially profitable to continue to work on.

Key words: Seaweed, coping strategy, climate change, quality seeds, farming production

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The seaweed farming has a high economic value for the community's economic development as well as one of the cores of the national economic support. Seaweed does not require sophisticated technology and high production costs. Therefore, it is relatively easy for farmers to adopt its technical cultivation. Moreover, 80% of fishery products in Southeast Sulawesi are seaweed commodities. According to Director General of Aquacultur¹ that seaweed itself is utilized to produce various and high-added-value products such as; food ingredients, cosmetic and medicine.

The seaweed farming is categorized in a field of fishery. It has a good prospect to be developed in almost all coastal areas in Indonesia². Seaweed is a top export commodity and has been prioritized by the Ministry of Maritime Affairs and Fisheries of Republic of Indonesia. Based on data from the 15 major regions of seaweed producers in Indonesia, Southeast Sulawesi is the top 4¹. In 2016, seaweed production amounted to 480,728 t per year. It was increasing in the next one year which amounted to 872,615 t per year. While, it decreased by about 50% in 2018 to 492.505 t per year. The regency of Central Buton and Bombana are two of the seaweed production centers in Southeast Sulawesi. The regency of Central Buton seaweed productions in the last three years, from 2016-2018 were 97.924, 356.417 and 183.552 t, respectively³. Based on this data, the seaweed production is yet still optimal. According of the Ministry of Maritime Affairs and Fisheries of republic of Indonesia⁴ has enforced seaweed factories in three regency i.e., Wakatobi, Central Buton and Bombana. However, to develop a seaweed industry sustainably, it involves many challenges and problems, spinning from upstream to down stream problems.

The aforementioned upstream problems are the phenomenon of global climate change and the diversion of land in which the area of seaweed construction is converted to tourism attractions transportation land or land diversion. Moreover, global climate change, in fact, affects the productivity of seaweed and farming activity in general⁵. In the downstream problems, bargaining position and low added value become remarkable for farmers. All those problems and challenges inevitably could affect farmers income. The adaptation strategies employed by seaweed farmers differed combined with several adaptation options according to the resources. Nevertheless, there have been failures, due to time-consuming factors, inefficient allocation of resources and the impact of non-optimal aquaculture results. There has been no specific government policy that has focused on tackling the problem of climate change. Seaweed farmers are still

constrained by limited working capital, difficulties in obtaining quality seeds and the absence of accelerating farming technology to cope with climate change. Therefore, this study wants to know the strategies in dealing with the challenges and problems, particularly the climate change effect. This study also wants to know the amount of recent seaweed farmers income.

MATERIALS AND METHODS

Time and location: This research was carried out from September-December, 2019. The research location was in seven districts of Central Buton Regency (Rahia, Gu, Wakambangura, Mawasangka) and Bombana Regency (Laea, Batu Putih, East Poleang). The location of the research was determined purposively with the consideration that the location is the center of seaweed production.

Sample of variable and data resource: Populations in this study were 622 seaweed farmers in the study location. From all populations, 311 samples were selected by a simple random sampling method. The type of data used is primary and secondary data. Primary data is obtained directly from seaweed farmers consisting of the amount of production, costs and revenues which was done by direct interview. Meanwhile, secondary data is obtained through searching related documents. To find out the income of seaweed farmers, the amount of revenue and the amount of cost must be known first.

Data analysis: The income analysis using the formula was proposed by Soekartawi⁶:

$$TR = P \times Q$$

Where:

- TR = Total revenue
- P = Selling price of seaweed in one season (IDR/t)
- Q = Number of production in one season (t)

The formula to find out the production cost and it was proposed by Soekartawi⁶:

$$TC = FC + VC$$

Where:

- TC = Total cost in one production
- FC = Fixed costs incurred in one production (IDR)
- VC = Variable costs in one production (IDR)

The analysis of revenue was proposed by Aluman *et al.*⁷:

$$\Pi = TR - TC$$

Where:

- Π = Profit/income
- TR = Total revenue (IDR)
- TC = Total cost (IDR)

R/C analysis is to figure out whether this farm is profitable/loss and feasible/unfeasible. Adaptation strategies for dealing with climate change are analyzed descriptively. The formula used was proposed by Soekartawij⁶:

$$R/C = TR/TC$$

Where:

- If: $R/C > 1$ farming is feasible
- $R/C = 1$ breakeven farm
- $R/C < 1$ farming is not feasible

RESULTS

Identity of respondents: Respondents identities consist of age of the respondent, level of education, number of family members and seaweed farming experience. It is presented in Table 1.

Based on the data in Table 1, it can be seen that from 311 respondents, the average age of the respondent is 48 years. This showed that the age of the respondents included in the productive age category is still relatively strong and healthy in running seaweed farming. Averagely, farmers stopped their education level when they were 6 years in Elementary School (ES).

Analysis of fixed costs: To analyze the fixed costs of seaweed farming production, it was presented in Table 2.

Fixed costs are not influenced by the size of the production. The fixed cost for seaweed farming comes from boat, wood, net, tarpaulin and rope procurement. It can be seen that in one harvest period, the fixed cost of seaweed farming is IDR 814,000.

Analysis of variable costs: The variable cost for seaweed farming in detail can be seen in Table 3.

Variable cost is strongly influenced by the size of the production. Types of production activities consist of seaweed seedlings, planting, maintenance, harvesting and seed costs. The variable cost in a single production season is IDR 5,800,000.

Table 1: Identity of respondents of seaweed farming in Southeast Sulawesi province

Variables	Value
Age (years)	48
Education (years)	6
The amount of family members (person)	5
Experience in farming business (years)	16

Source: Primary data, 2019

Table 2: Fixed costs for seaweed farming production in Southeast Sulawesi province in one harvest season

Cost type	Duration in usage	Investment cost (IDR)	Depreciation cost (IDR/Season)
Boat machine	5 years	1,500,000	50,000
Boat	5 years	12,000,000	400,000
Wood	3 months	300,000	150,000
Net	3 years	450,000	25,000
Tarpaulins	1 years	480,000	80,000
Rope			
Rope No. 2.5 in size	2 years	520,000	43,000
Rope No. 4 in size	3 years	1,200,000	66,000
Total		16,450,000	814,000

Source: Primary data, 2019

Table 3: Average cost of seaweed farming in Southeast Sulawesi province

Cost type	Volume	Unit	Prices (IDR)	Total value
Tying seaweed seeds	100	Stretching lines	10,000	1,000,000
Planting	6	Work day	100,000	600,000
Maintenance	60	Liter	10,000	600,000
Harvest	6	Work day	100,000	600,000
Seeds	600	kilogram	5,000	3,000,000
Total				5,800,000

Source: Primary data, 2019

Table 4: Average income of seaweed farming per production season

Total production (IDR)	Selling price of seaweed (IDR)	Income (IDR)
1,012	15,000	15,180,000

Source: Primary data, 2019

Income analysis: Data related to the average income of seaweed farming is presented in Table 4.

The result of the analysis, the average revenue received in one production season is IDR 15,180,000. It comes from its total production which is about IDR 1,012,000 times selling price of seaweed.

Revenue analysis: Data on average income obtained by seaweed farmers in one production season is presented in Table 5.

The income is the difference between revenue and costs incurred. The average income in one production season is IDR 8,566,000. Based on the result of the analysis of R/C seaweed farming is 2.30, which means that seaweed cultivation has benefited and is worthy to develop.

Adaptation strategies of climate change: Based on the results of the study, there is a relationship between climate change and the productivity of seaweed. Unpredicted climate

Table 5: Costs and revenues analysis in one production season

Descriptions	Unit	Per farm
Costs (C)		
Fixed Cost (FC)	IDR	814,000
Variable Cost (VC)	IDR	5,800,000
Total Cost (TC)	IDR	6,614,000
Revenue (R)		
Production	Kg	1,012
Price	IDR	15,000
Total Revenue (TR)	IDR	15,180,000
Income (I) = TR-TC	IDR	8,566,000
R/C	Ratio	2.30

Source: Primary data, 2019

Table 6: Respondents perceptions related to the impact of climate change on seaweed yields

Perception	Number of respondents	Percentage
Very good	0	0.00
Good	0	0.00
Moderate	73	23.47
Bad	203	65.27
Very bad	35	11.25
Total	311	100.00

Source: Primary data, 2019

Table 7: Respondents perceptions toward the impact of climate change on the quality of seaweed

Perception	Number of respondents	Percentage
Very good	0	0.00
Good	0	0.00
Moderate	79	25.40
Bad	207	66.56
Very bad	25	8.04
Total	311	100.00

Source: Primary data, 2019

changes the cropping pattern and decreases the durability of seaweed. As a result, it is susceptible to disease and triggers suboptimal growth. The respondents perceptions toward climate change are seen in Table 6.

Based on the data in Table 6, it can be seen that the impact of climate change was very influential on seaweed yields. There were 38 respondents or 73.47% of respondents revealed that climate change had a moderate effect. Meanwhile, 203 respondents or 65.27% of respondents said that it affected negatively and 35 respondents or 11.25% of respondents said that the effect was very bad. Respondents perceptions related to the impact of climate change on the quality of seaweed are presented in Table 7.

Based on the interview, 79 respondents or 25.40% was revealed that climate change has a moderate effect. Moreover, 207 respondents or 66.56% of farmers stated that climate change causes a bad effect. The other 25 respondents or 8.04% stated that it has a very bad effect. The analysis of respondents perceptions related to seaweed selling prices is presented in Table 8.

Table 8: Respondents perceptions related to the impact of climate change on the selling price of seaweed

Perception	Number of respondents	Percentage
Very good	0	0.00
Good	2	0.64
Moderate	81	26.05
Bad	201	64.63
Very bad	27	8.68
Total	311	100.00

Source: Primary data, 2019

The climate changes erratically also impacts the selling price of seaweed. The correlation can be seen from the low quality of yields which in turn will reduce the selling price of seaweed. The analysis showed that there were only 2 respondents or 0.64%, who stated that uncertain climate change had a good impact on the selling price. This might be due to the quality of the seeds and good care so that the durability of the seaweed was strong enough to deal with the conditions of climate change. While the respondents perceptions stating moderate impact were 81 respondents or 26.05%. Moreover, 201 respondents or 64.63% claimed a bad effect of climate change. The rest 27 respondents or 8.68% said that the effect was very bad.

DISCUSSION

The result of research showed that an education level indicated the low education category of the farmers (Table 1). However, the farmers are able to read, write and count. The farmers admit that to cultivate seaweed does not require a high level of education, because used to carry it out based on hereditary experience and simple implementation. However, to further increase production and productivity, it is very necessary to have a capability in mastering technology and the importance of establishing institutional farmers to improve their bargaining position and to carry out effective and efficient farming. The average number of family dependents is mostly five people in one family. Furthermore, the farmers have been cultivating seaweed for approximately 16 years. This showed that the farmers are very experienced.

Fixed costs are not influenced by the size of the production (Table 2). The fixed cost for seaweed farming comes from boat, wood, net, tarpaulin and rope procurement. The variable cost is strongly influenced by the size of the production. Types of production activities consist of seaweed seedlings, planting, maintenance, harvesting and seed costs (Table 3). Based on the result of the analysis of R/C seaweed farming are 2.30, which means that seaweed cultivation has benefited and is worthy to develop (Table 5) and it is financially profitable and worth it for developed as an activity

fishing business⁸. How it was affecting is by longer rainy season and water content which then reduced the quality seaweed. It supported the research of Indrawasih⁹ which stated that seaweed cultivation was also influenced by climate change. Kartono *et al.*¹⁰ stated that climatic and environmental aspects such as; light intensity, temperature, salinity and sea wave can affect the growth of seaweed biomass. Lately, the Indonesian weather has changed. This is related to the El Nino and La Nina phenomena characterized by natural phenomena such as the rising sea surface temperatures¹¹. To describe the adaptation strategies undertaken by seaweed farmers in dealing with climate change, this research is based on the respondents perceptions regarding their knowledge and experience (Table 6). According to respondents, there are several changes caused by climate change, namely air temperature, rainfall intensity and wind speed, erratic tides and rising strong wave. It was claimed that the seaweed farming was influenced by high waves. This was also corresponded with the results of research conducted with Tejasinarta¹², that's the selling price of seaweed greatly affects the revenue obtained by seaweed farmers. The selling price of seaweed is determined by the quality of seaweed and the phenomenon of climate change can have an impact on the quality of seaweed.

Due to the phenomenon of climate change, the majority of respondents admitted that it had disrupted people's understanding and knowledge related to the calculation of seasons that have been understood so far (Table 7). However, most respondents have been able to overcome them with various adaptation strategies, even though the adaptation strategies so far are only short-term strategies in order to meet basic living needs. There are several strategies undertaken by farmers, namely: (1) Using stronger buoys, but this certainly consequently cost higher, (2) Using a high quality seeds that are resistant to disease, although it will certainly be more expensive and (3) Expanding the cultivation area in a relatively safer surrounding area or in deeper waters and (4) Stop for a while doing seaweed cultivation to do other alternative businesses (Table 8). This result is in line with stated by Amri and Arifin¹³, that's conducting adaptation activities in the form of expanding the area of cultivation and in fact it has been carried out without scientific or technological support.

The knowledge of seaweed cultivation technology is needed by the community, especially in coastal areas that have uncertain climate change. Therefore, the results of this study can give an idea to seaweed farmers about the production costs incurred and the income obtained at each planting season.

CONCLUSION

The result reveals that the average income of seaweed farmers was IDR 8,566,000 per production season. R-C ratio value is 2.30 and it means that seaweed farming is financially profitable to continue to work on. In dealing with climate change, seaweed farmers use strong ropes, seek quality seeds, expand the area of cultivation that is relatively safer or deeper and stop for a moment by doing other types of supporting business.

SIGNIFICANCE STATEMENT

This study discover that's there are several strategies undertaken by farmers namely: using stronger buoys, using a high quality seeds that are resistant to disease, expanding the cultivation area in a relatively safer surrounding area or in deeper waters and stop for a while doing seaweed cultivation to do other alternative businesses. This study will help the researcher to understanding the income of seaweed and the coping strategy toward the climate change effect. Thus, a new theory that's the positive and significant effect on the production of seaweed farming in Southeast Sulawesi is global climate change.

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