Strategy for the Development of Seaweed Cultivation in Karawang Regency, West Java Province

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Authors’ contributions

This work was carried out in collaboration among all authors. Author MFAP designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors AN and AR managed the analyses of the study. Author AAHS managed the literature searches. All authors read and approved the final manuscript.

ABSTRACT

Seaweed is one of the leading commodities in the marine sector which has a high selling value. However, this potential is currently not optimally utilized in Karawang Regency. Karawang Regency has a large enough potential for aquaculture ponds, has a pond area of 18,273.30 hectares, and only 1% is cultivated for seaweed. This research aims to formulate a seaweed cultivation business development strategy that has not developed optimally. The respondents in this research were all 60 seaweed cultivators in Karawang Regency. The data used were primary and secondary data. Primary data were obtained through an interview with seaweed cultivators and using the questionnaire. Secondary data were obtained from institutions/agencies related to research, such as the Karawang Regency Fisheries Service. The data analysis method used in this research is qualitative analysis. Qualitative analysis was used to determine a seaweed cultivation development strategy using a SWOT analysis. The results showed that the relative position of seaweed cultivation development based on the SWOT analysis is in the first quadrant which means the strategy used is a progressive or aggressive. The progressive strategy of developing seaweed cultivation can be carried out with strategies such as increasing production to meet the demand for seaweed.
expanding the area for seaweed cultivation, empowering local communities about seaweed cultivation and diversifying processed seaweed products.

**Keywords:** Seaweed; development strategy; SWOT; cultivation.

1. INTRODUCTION

Seaweed is one of the main commodities of aquaculture with high economic value and wide market opportunities, both national and export-oriented [1]. It is not only economically valuable, but seaweed is also good for human health and nutrition. In Indonesia itself the use of seaweed for industry starts for the agar industry (*Gelidium* and *Gracilaria*) (*Rhodophyta*) then for the handicraft industry (*Eucheuma*) (*Rhodophyta*), and the alginate industry (*Sargassum*) (*Ochrophyta*, *Phaeophyceae*) [2]. Agar from the genus *Gelidium* can be used for pharmaceutical applications, while agar from the genus *Gracilaria* is used as a food industry ingredient [25]. One of the areas in West Java that has the potential to develop seaweed cultivation is the Karawang Regency for the cultivation of *Gracilaria* sp. [3].

Karawang Regency has a very large potential for fisheries and marine resources [4]. In the catchment fishery sector, Karawang Regency has a wide variety of fish potentials and has a fairly high economic value. This condition is supported by the length of the coast that it has that stretches to the north along 84.23 km [5]. The aquaculture sector of Karawang Regency has the potential for ponds around 18,275.00 ha, calm water ponds with an area of 1,088.80 ha, and Minna Padi around 9,241.23 ha, and fish cage 148 units [5]. The people of the north coast of Karawang are currently trying to develop seaweed. The Karawang Regency Government is optimizing the cultivation of seaweed in people's ponds on the north coast of Karawang. From the potential of 18,000 hectares of seaweed land, around 2,500 hectares can be used for seaweed ponds [5].

Karawang Regency has the potential for the development of *Gracilaria* sp cultivation, which is recorded at 18,870 ha and only 1,224 ha has been utilized [5]. This shows that seaweed cultivation has not developed well considering the area of Karawang Regency waters has large fishery resources. Constraints in the development of seaweed cultivation in the waters of Karawang Regency include the low level of knowledge and skills of the community regarding agricultural resource processing, especially seaweed farming [3].

Seaweed is one of the leading commodities in the marine and aquatic sector which has a high selling value [6]. However, this potential is currently not optimally utilized in Karawang Regency. Besides, large market opportunities are not matched by optimal seaweed production, so seaweed demand is often not fulfilled [7]. A development strategy is needed for seaweed cultivation so that seaweed production in the coming year will be better so that the income of seaweed cultivators can increase [8].

Business development strategy is a process of determining action that requires management decisions in developing a business in a better direction. Therefore, the nature of the business development strategy is future-oriented [9]. The development of a business is the responsibility of every entrepreneur or entrepreneur who needs foresight, motivation, and creativity [9]. If this can be done by every entrepreneur, there is the great hope of being able to make a business that was originally small to medium scale and even into a large business [9]. The business development strategy has the function of formulating and considering internal and external factors faced by an entrepreneur [10]. Strategy formulation is the development of a long-term plan for effective management of environmental opportunities and threats, considering the company's strengths and weaknesses. The formulated strategy is more specific depending on the functional activities of management [10]. Based on this description, it is necessary to conduct research aimed at developing a strategy for developing seaweed cultivation in Karawang Regency.

2. METHODOLOGY

This research was conducted from July to November 2020 in Karawang Regency in 2 sub-districts, namely Tirtajaya District and Cibuaaya District. These two sub-districts are the center of seaweed cultivation activities, with details in Tirtajaya Subdistrict as many as 46 business units and in Cibuaaya District 14 business units out of a total of 60 cultivation business units in Karawang Regency. Determination of the research location is done purposively with the consideration that the area is one of the seaweed cultivation centers in Karawang Regency.
The population in this study amounted to 60 seaweed cultivators. According to [11], if the research subject is less than 100 units (people), it is better if all of them are taken as research respondents. Referring to the opinion [11], the respondents in this study were all seaweed cultivators in Karawang Regency.

The types of data used are primary data and secondary data. Primary data obtained through interviews with seaweed cultivators and using a questionnaire. Secondary data were obtained from institutions/agencies related to research, such as the Karawang Regency Fisheries Service.

The data analysis method used in this research is qualitative analysis. Qualitative analysis was used to determine a seaweed cultivation development strategy using a SWOT analysis. SWOT analysis is used to obtain a basic view of the strategies needed to achieve a certain goal, in this case, an assessment of what efforts can be used as alternative solutions in strategy management and development [12].

3. RESULTS AND DISCUSSION

3.1 The Condition of Seaweed Cultivation in Karawang Regency

Karawang has a large enough potential for aquaculture ponds, has a pond area of 18,273.30 hectares, which is used for milkfish cultivation land and only 1% is cultivated seaweed. A long coast reaching 84.23 km, then the potential for this fishery activity is very large to be developed sustainably [5]. The pond cultivation area in Tirtajaya and Cibuaya Districts is a pond that has brackish water content, the source of which comes from a mixture of fresh water and saltwater from the sea. Most of the pond area is used for the cultivation of milkfish ponds by monoculture and only a small portion of the pond area has been used for the cultivation of polyculture ponds for milkfish and seaweed Gracilaria [5].

The pond area in Karawang Regency consists of the ponds owned by Forestry and the ponds. The majority of these owned pond areas are used as an area for the cultivation of milkfish ponds in a monoculture manner, while only a small portion has been used as a polyculture pond business area [7]. With a pond area of 190 hectares, polyculture cultivation has the potential to be developed more optimally in Karawang Regency. The results of the interview indicated that the low utilization of the pond area for polyculture cultivation was due to the influence of local culture and the mindset of farmers. Farmers think that the most suitable pond business for them to do is milkfish. The new aquaculture system being implemented is considered quite difficult to develop even though it has a higher potential in terms of income.

The poly-culture pond that has developed in the research location is the polyculture of milkfish and seaweed. Polyculture pond cultivation is a system of cultivating two or more types of commodities/species in the same pond area [13]. This is done because the two commodities have high economic value, so that polyculture cultivation can increase the production output per unit of pond area and the income of these farmers. The harvest period for milkfish commodity is once every 6 months and Gracilaria seaweed commodity can be harvested every 2 months. Polyculture cultivated seaweed is a type of Gracilaria. This type of seaweed has characteristics that are most suitable for cultivation in pond areas compared to other types of seaweed and can help create natural food for milkfish [14].

Based on observations, the implementation of polyculture pond cultivation consists of the process of sowing seeds, controlling and routine management, harvesting until reaching the post-harvest process. Routine control and management that is carried out include the activity of leveling seaweed which collects in a place in the pond due to being carried by the wind and eliminating disturbing organisms, water replacement activities, and fertilizing activities. During the harvest period, the activities carried out include harvesting milkfish using nets and harvesting seaweed Gracilaria which is suitable for harvesting using rubber carpet harvesting tools. Post-harvest process, milkfish that has been harvested from the ponds are sorted before being sold to the market, while seaweed Gracilaria that has been harvested needs to go through the drying process first. This was done to achieve the level of dryness of the seaweed Gracilaria as required by the Mina Agar Makmur Cooperative. After that, the dried seaweed can be packed in a sack and sold through the cooperative.

The method of cultivating seaweed in Karawang Regency uses the sowing method. According to Decree of The Minister Of Marine And Fishery of The Republic of Indonesia Number 1 of 2019, the
method of sowing is a way to cultivate seaweed in ponds or in ponds with the following conditions

a) location of ponds close to the coast and freshwater sources to reduce water salinity;
b) a minimum tidal difference of 30 (thirty) cm so as to facilitate water circulation in the ponds;
c) bottom muddy sand waters;
d) annual fluctuations in water quality, as stated in Table 1.

3.2 Characteristics of Seaweed Cultivators in Karawang Regency

This research was conducted in Karawang Regency, precisely on the coast or north coast area. There were 60 respondents or seaweed cultivators in Karawang Regency. As many as 46 respondents carried out seaweed cultivation activities in Tirtajaya District and 14 respondents in Cibuaya District. This happens because the area of land for seaweed cultivation is indeed wider in Tirtajaya Subdistrict than in Cibuaya District, and farmers prefer to carry out seaweed cultivation activities adjacent to the Mina Agar Makmur Cooperative to make it easier in terms of sales.

Male respondents were 56 people with a percentage of 93.3% and female respondents were 4 people with a presentation of 6.67%. This is because we interviewed head of household and only 4 households were headed by women, as they had to replace their husbands who were sick or died.

The characteristics of seaweed cultivators in Karawang Regency have an age ranging from 25-70 years. As many as 60 respondents with an average age of 44.3 years, 66.7% were aged 15-50 years. This means that most respondents are of productive age [15].

There are 3 people or 5% of the respondents who did not complete elementary school (ES). Generally, the level of formal education of the respondents in the study area was completed (SHS) / equivalent, namely 50%. The primary (ES) and junior secondary (JHS) levels respectively were 11.7% and 25% and respondents who were able and graduated in college were 8.33%. People who have higher education are more able to take advantage of the technology used by society and education is part of human capital which plays a role in increasing one's productivity [16].

3.3 Strategy for the Development of Seaweed Cultivation in Karawang Regency

The strategy for developing seaweed farming in Karawang Regency is obtained from internal and external factors. The first step taken is capturing information and identifying external (opportunities and threats) and internal (strengths and weaknesses) factors related to this seaweed cultivation by conducting discussions and interviews using questionnaires to the perpetrators or an expert. From this analysis, several alternative strategies were obtained including the SO strategy, the WO strategy, the ST strategy, and the WT strategy. Several alternative strategies that can be used by seaweed cultivators in Karawang Regency can be seen in Table 1.

In facing competition, a business unit must recognize its environment, both internal and external. The internal environment is the state of the business unit itself, such as the advantages and disadvantages of the business [17]. Meanwhile, the external environment is the condition around the business unit such as competitors, conditions, economy, government, and others that can affect the business unit [18]. Therefore, a SWOT analysis is required which consists of Strength, Weakness, Opportunity, and Threat. Based on the results of data collection and analysis on seaweed cultivation in Karawang Regency, a SWOT analysis can be compiled as follows.

IFE matrix analyzes internal factors strategy that consists of strength (strength) and weakness (weakness) [17]. The IFE matrix is used to determine the weight, rating, and score of each variable of internal strengths and weaknesses of seaweed cultivation in Karawang Regency using

| Parameter   | Unit | Range     |
|-------------|------|-----------|
| Temperature | °C   | 25-28     |
| Salinity    | g/L  | 15-30     |
| pH          | -    | 6.5-9.0   |
| Clarity     | cm   | 50-70     |
data obtained from questionnaires that have been filled in by seaweed cultivators in Karawang Regency. The IFE matrix for seaweed cultivation in Karawang Regency consists of eight internal factors. IFE matrix analysis for seaweed cultivation in Karawang Regency can be seen in Table 2.

Based on Table 2, it is known that among the factors of internal strategy, the greatest strength factor is the product quality factor with a score of 0.68. This shows that good quality seaweed products in Karawang Regency are indeed true, and also shows that the quality of seaweed products is the main factor that can have a positive influence on the development of seaweed cultivation in Karawang Regency. Therefore, the quality of seaweed in Karawang Regency needs to be maintained to remain an advantage for seaweed cultivators in Karawang Regency. The biggest weakness factor is seaweed production which has not been maximized with a score of 0.36. This shows that seaweed production that has not been maximized is a very influencing factor, this is due to limited capital, seeds, and a lack of instructors related to technology for seaweed cultivation, and poor financial management. This weakness needs to be overcome with the assistance of providing capital and counseling by experts from the government. EFE matrix analysis for seaweed cultivation in Karawang Regency can be seen in the Table 3.

Based on the EFE matrix table, it is known that external strategic factors, the greatest opportunity factor is the existence of a supporting cooperative with a score of 0.68, which means that seaweed cultivation in Karawang Regency has an institution that can empower local communities and build resource-based rural industries local (seaweed). The existence of this cooperative is also very helpful for farmers to sell their harvest seaweed to a wider market. The biggest threat factors for seaweed cultivation in Karawang Regency are climate change and weather with a score of 0.24. This shows that climate change and weather greatly affect the production of seaweed in Karawang Regency which is at risk of experiencing failure in harvesting. Climate and weather affect decreasing salinity in seaweed aquaculture ponds [19].

The strategy matrix aims to determine the position of business activity through the values obtained from the IFE and EFE analysis. Through this position, it will be known where the business position and the strategies that must be taken to overcome the obstacles experienced [20].

The strategy matrix analysis was carried out by calculating the scores on the EFE (External Factor Evaluation) matrix tables and IFE (Internal Factor Evaluation) for seaweed cultivation in Karawang Regency. From the results of the IFE and EFE matrix analysis, the first step in determining the position of the cultivation business is carried out by calculating the total strength score and the total weakness score on internal factors, as well as calculating the opportunity and threat scores on external factors.

Based on the total score of internal and external factors of seaweed cultivation in Karawang Regency, a diagram can be made, namely by finding the intersection point of the X-axis and Y-axis by calculating the difference between the values of internal and external factors. The intersection point of the X-axis (W-S axis) is obtained from the difference between the total strength and weakness factors, namely 1.42, and the intersection point of the Y-axis (O-T axis) is obtained from the difference between the total opportunity and threat factors, namely 1.39. The internal and external matrix diagrams can be seen in Fig. 1.

Based on the results of the strategy matrix graph on seaweed cultivation in Karawang Regency, it is known that the position of seaweed cultivation is in quadrant I which supports aggressive strategies. This position indicates an advantageous position, that the business is facing a large market opportunity and the business has several advantages or strengths. The focus of this strategy is to use strength to get or seize bigger market opportunities [18].

The strategy that can be applied to the cultivation of seaweed in Karawang Regency is the SO strategy. SO strategies that can be carried out are increasing production to meet the demand for seaweed, expanding the area for seaweed cultivation, empowering local communities about seaweed cultivation, and diversifying processed seaweed products in Karawang Regency.
| Internal Factors | Strength(S) | Weakness(W) |
|-----------------|-------------|-------------|
|                 | 1. Extensive cultivation land | 1. Availability of seeds |
|                 | 2. The workers available | 2. Limited capital |
|                 | 3. Good quality yields | 3. The development of science and technology is difficult to follow |
|                 | 4. Cheap and simple cultivation technology | 4. The production has not been maximized |

| External Factors | Opportunities(O) | Threats(T) |
|-----------------|-----------------|------------|
| SO Strategy     | WO Strategy      |
|                 |                 |            |
| 1. High demand for seaweed | 1. Increase production to meet the demand for seaweed | 1. Increase source of business capital |
| 2. The existence of a cooperative that supports | 2. Expanding seaweed cultivation area | 2. Build a seed garden. |
| 3. Export market potential | 3. Empowerment of local communities regarding seaweed cultivation | 3. Increasing cooperation with stakeholders to increase the continuity of seeds and production |
| 4. Regional government superior commodities | 4. Diversification of processed seaweed products | 4. Optimizing the role of the extension agent |

| ST Strategy | WT Strategy |
|-------------|-------------|
| 1. Tides of seawater | 1. Improve the facilities and infrastructure to support seaweed cultivation activities. |
| 2. Pests and weeds attack | 2. Increased access to capital |
| 3. Climate change and weather | 3. Optimizing the role of extension agents |
| 4. Competitors from other regions | |
Table 3. Matrix analysis of IFE (Internal Factor Evaluation)

| Strength                                           | Rating | Weight | Score |
|----------------------------------------------------|--------|--------|-------|
| Potential of cultivated land which is still wide  | 4      | 0.16   | 0.64  |
| The workers available                             | 3      | 0.15   | 0.45  |
| Good quality yields                               | 4      | 0.17   | 0.68  |
| Cheap and simple cultivation technology            | 3      | 0.15   | 0.45  |
|                                                    |        |        | 2.22  |

| Weakness                                           |        |        |       |
|----------------------------------------------------|--------|--------|-------|
| Availability of seeds                              | 1      | 0.06   | 0.06  |
| Capital limitations                                | 2      | 0.11   | 0.22  |
| The development of science and technology that is  | 2      | 0.08   | 0.16  |
| difficult to follow                                |        |        |       |
| The production has not been maximized.             | 3      | 0.12   | 0.36  |
|                                                    |        |        | 0.80  |
| Total                                              | 1.00   | 3.02   |       |
Seaweed is Indonesia’s leading commodity. The marketing of seaweed is quite widespread, not only for domestic markets but also for foreign markets (exports). In 2019, the export value of Indonesian seaweed reached the US $ 324.84 million or grew by 11.31% compared to 2018 which amounted to US $ 291.83 million. In the period 2014-2019, the average national seaweed export was also recorded to have grown by 6.5% per year [21]. The increasing world demand is a great opportunity for Indonesia, especially for Karawang Regency, to maximize the potential for seaweed production, both as raw material and as a processed product. This large demand should be able to motivate cultivators to be even more productive.

Seaweed cultivation in Karawang Regency is a profitable business for the Karawang community, especially in Tirtajaya and Cibuaya Districts. Karawang has a pond area of 18,273.30 hectares, which is used for milkfish cultivation and only 1% is cultivated seaweed [5]. The expansion of the cultivation area is needed so that the distribution of cultivation activities occurs in every coastal area of Karawang and can increase seaweed production and increase employment.

In addition to a large cultivation area, there are quite a lot of workers in the Karawang Regency. This, if used properly, can increase seaweed production. Besides, community empowerment or training on the cultivation of seaweed also needs to be carried out by cooperatives and the local Fisheries Service so that many workers can cultivate and process seaweed properly.

Seaweed is beneficial for humans, namely as an antioxidant, antibacterial, anti-cholesterol, anti-inflammatory, and anti-diabetic [22]. The content of seaweed makes seaweed one of the food commodities that has the potential to become a variety of healthy food diversification. The lack of diversification of seaweed products in Indonesia is still a challenge for the seaweed sector to increase the economic value of seaweed. Seaweed product diversification is needed as an effort to increase seaweed demand [23]. Apart from providing added value to seaweed, the diversification of seaweed products can also create jobs and increase income [24].

Besides, there are still strengths and opportunities that confirm that the internal and external environment is indeed very supportive of cultivating seaweed. The problem is how serious and consistent the farmers are in the building and utilizing this potential by continuing to dedicate thoughts, knowledge, and others to try to increase the income and welfare of the cultivators, as well as making efforts to ensure food security through local resource-based development.
Fig. 4. Respondent’s level of education

Level of Education

- Not Finished ES
- ES
- JHS
- SHS
- University

Fig. 5. Matrix of seaweed cultivation business strategy in Karawang regency
Table 4. Matrix analysis of EFE (External Factor Evaluation)

| Opportunity                          | Rating | Weight | Score |
|--------------------------------------|--------|--------|-------|
| High demand                          | 3      | 0.15   | 0.45  |
| The existence of cooperatives that support | 4      | 0.17   | 0.68  |
| Export market potential              | 3      | 0.16   | 0.48  |
| Prime government commodities         | 3      | 0.15   | 0.45  |

| Threat                              |       |        |       |
|-------------------------------------|-------|--------|-------|
| Tides of seawater                   | 2     | 0.09   | 0.18  |
| Pest and weed attack                | 2     | 0.09   | 0.18  |
| Climate and weather changes         | 2     | 0.12   | 0.24  |
| Competitors from other areas        | 1     | 0.07   | 0.07  |
| Total                               | 1.00  | 2.73   |       |

Based on observations, several additional strategies can be able to answer problems of seaweed cultivation in Karawang Regency. First, conducting mutually beneficial cooperation with various parties, both private and university, in improving cultivation, processing, and marketing technology in improving the welfare of members (cultivators) and group partners. Second, providing education and health bailout services for cooperative members and cultivators. Third, increasing partnerships that have been well established, through family gatherings can forge closer cooperation between members and cultivators in general.

4. CONCLUSION

Based on the results of research and discussion, it can be concluded that the relative position of the development of seaweed cultivation based on the SWOT analysis is in the first quadrant, which means the strategy used is the progressive or aggressive strategy. The strategy for the progressive development of seaweed cultivation can be carried out by increasing production to meet the demand for seaweed, expanding the area for seaweed cultivation, empowering local communities about seaweed cultivation, and diversifying processed seaweed products.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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