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Which is better: Rawai or gosepa technique for seaweed farming? (Case study: Ceram Island, Mollucas, Indonesia)

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Abstract

Seaweed as one of the fishery resources is a cultivation with high economic value. Given its wide benefits, the seaweed commodity has a good market opportunity with considerable potential. This study aims to determine the appropriate cultivation techniques for seaweed cultivation businesses on Seram Island. The research method obtained from the results of questionnaires, interviews and observations in the field related to the use of swamp and gosepa cultivation techniques. Findings in the field show that the used of technology that is still very simple is carried out by trial and error to find out the better technique to get optimal results. The results of trials by cultivators show that the *longline* technique still gives the best results compared to the *gosepa* technique which is an innovation from Pattimura University Ambon.

Keywords: Rawai; Longline; Gosepa; Seaweed farming; Mollucas

1. Introduction

Seaweed is a potential export commodity to be developed. Currently, Indonesia is still one of the important exporting countries in Asia because seaweed grows and spreads in almost all Indonesian area. The types that are widely used are red and brown algae because they contain agar, carrageenan, porpiran, and furcelaran whose end products play a very important role in the food, cosmetic and pharmaceutical industries [1].

Seaweed farming has an important role in efforts to increase fisheries production [2] to meet the needs for food and nutrition as well as meet the needs of domestic and foreign markets, expand employment opportunities, increase the income and welfare of fishermen/fish cultivators and maintain the preservation of aquatic biological resources. This condition strengthens seaweed with bright prospects as a trade commodity that has the opportunity to be developed in Indonesian waters area [3].

Seaweed farming in Indonesia can be a pillar of public hope in the present and in the future. Various types of potential seaweed are relatively easy to cultivate because the technology is simple and relatively inexpensive, does not require seed institutions, does not require feed for its cultivation, but is sufficient under conditions of water fertility and the ongoing process of photosynthesis [4].

Seaweed farming is one of the main livelihoods for fishing communities in West Seram Regency. This farming business has been engaged in by transmigration communities and local communities since 2006. Cultivation activities are carried out en masse by farmers without any studies on the suitability of the location, seeds, or technology used [5].

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2. Literature review

2.1. Seaweed Farming

Seaweed that is widely cultivated is the type *Eucheuma cottonii.* This type is widely used by the food, cosmetic and pharmaceutical industries in the world because it contains a lot *carrageenan* [6].

The selection of the location for seaweed cultivation is a very important thing to determine the success or failure of the cultivation business. In order to obtain satisfactory results from the seaweed business, a location that is in accordance with the requirements for growing seaweed should be chosen

2.1.1. Physical environmental conditions

Physical environmental conditions for seaweed cultivation activities consist of protection from the crashing waves, bottom water substrate from crushed coral or coral sand which is free of silt. Good water depth for growth *Eucheuma cottonii* is between 2 - 15 M at the lowest ebb for the float method. This will prevent the seaweed from drying out because it is exposed to direct sunlight at the lowest ebb and obtain (optimize) direct sunlight penetration at high tide. Water temperature that is good for seaweed cultivation is 20-28 °C with a maximum daily fluctuation of 4 °C, and a high level of brightness so that sunlight can penetrate into the water which is the main factor in the process of photosynthesis.

2.1.2. Chemical environmental conditions

Seaweed grows at high salinity. The decrease in salinity due to incoming fresh water will cause abnormal growth of seaweed. The recommended salinity for seaweed cultivation should be far from the mouth of the river mouth. Recommended salinity for cultivation *Eucheuma cottonii* is 28-35‰.

Contains enough food in the form of macro and micro nutrients. Phosphate content is very good when it is in the range of 0.10 - 0.20 Mg/l while Nitrate in sufficient conditions is usually in the range of 0.01-0.7 Mg/l. Thus it can be said, these waters have a good level of fertility and can be used for seaweed cultivation activities.

2.1.3. Biological environmental conditions

Table 1 Criteria for seaweed cultivation locations

No.	Parameter	(S1)	(S2)	(N)	Reference
1.	Depth (m)	1,0 – 5,0	0,5 - <1,0 atau >5,0 - <10,0	<0,5 atau >10,0	Aslan (1998); Utoyo (2000)
2.	Current (m/s)	0,20 – 0,30	0,10 – 0,19 atau 0,30 – 0,40	<0,10 atau >0,40	Aslan (1998); Sulistijo (1996)
3.	Nitrates (mg/l)	0,90 – 3,00	0,10 - <0,90 atau 3,00 – 3,50	<0,10 atau >3,50	Sulistijo (1996)
4.	Phosphate (mg/l)	0,02 – 1,00	0,01 - <0,02 atau <1,00 – 2,00	<0,01 atau >2,00	Sulistijo (1996)
5.	Brightness (%)	80 – 100	60 - <80	<60	Aslan (1998)
6.	Temperature (°C)	28 – 30	26 – 27 atau 30 – 33	<26 atau >33	Djurjani (1999)
7.	Salinity (‰)	28 – 33	30 – 37	<28 atau >37	Sanjaya (2011)
8.	Dissolved oxygen (mg/l)	>4,00	2,00 – 4,00	<2,00	Djurjani (1999)
9.	pH	7,00 – 8,50	6,50 - <7,00	<6,50 atau >8,50	Djurjani (1999)
10.	Turbidity (NTU)	<10,00	10,00 – 40,00	>40,00	Aslan (1998); Hidayat (1994)

S1: Perfect fit; S2: In accordance; S3: Inappropriate

Cultivation location*Eucheuma*selected waters that are naturally overgrown by a community of various macro algae such as*Ulva, Caulerpa, Padina, Hypnea* and others, where this is an indicator that the waters are suitable for cultivation

*Eucheuma*and preferably free from other water animals that are herbivores, especially *Siganus,* spp, *Chelonia midas* and *Salmacis war* which can eat cultivated plants.

2.2. Farming Technology

Aquaculture is an activity to create an artificial habitat suitable for the cultivated biota. At the level of commodity development, aquaculture is an economically oriented business where cultivators want as much profit as possible. It often happens that in the interest of making financial gains, the technical factors related to the principles of aquaculture are ignored [7].

2.2.1. Off-Basic Method

This method is generally used in locations that have a coral bottom substrate sand or sand with broken coral and protected from the waves.

The site for this method should be about 0.5 m deep at low tide and 3 m at the highest tide.

2.2.2. Floating Raft Method

The floating raft method is the cultivation of seaweed by tying the seaweed to a rope (as in the off-bottom method) tied to a floating raft made of bamboo.

The advantages of this method include:

- Widely applied to locations with deeper water conditions, but still protected from big waves; and
- Plants receive more intensity of sunlight and water movement which continues to renew the nutrient content in seawater which will facilitate the absorption of nutrients so that growth is faster.

The disadvantages of this method are:

- When the plant appears on the surface of the water it will be immediately stung sun or rain water which can cause the plant parts to turn white then die; and
- Higher production costs compared to the off-bottom method.

2.2.3. Longline Method

Longline method is the method most in demand by seaweed cultivators because apart from being flexible in site selection, it also costs less. Longline method in principle is almost the same as the raft method but instead of using bamboo as a raft, it uses plastic ropes and used bottles as floats.

The longline method was popularized because apart from being more economical it can also be applied in rather deep waters. The advantages of this method include: the plants receive enough sunlight, the plants are more resistant to changes in water quality, limited pests that usually attack from the bottom of the waters, growth is faster, the way it works is easier, the cost is lower, and the quality of the seaweed produced is good.

Longline method made of long stretched rope. Generally the rope used is polyethylene rope 0.5-0.6 cm with a rope length ranging from 50-100 m. Every 25 m is given a main (large) float. This float can be made of a plastic drum. Every 5 m is given an auxiliary buoy which functions to move the plants at any time. This float can be made from a mineral water bottle. For this method planting can be done horizontally or vertically. The method of planting horizontally is that the seaweed is tied to the long rope with a minimum distance of 4 cm and between these distances you can hang polyethylene rope 0.3-0.4 cm which has been tied to the seaweed seeds and hung vertically. The number of seeds that are tied and hung is three levels (up to a depth of 60 cm) [7].

The success of seaweed production can be achieved by optimizing the supporting factors in marine cultivation. These supporting factors include choosing the right location, using good quality seeds, as well as the right techniques and methods [8].

3. Material and methods

This study conducted a review through observation techniques, interviews and literature studies [9] [10] to obtain facts from existing phenomena and seek factual information in seaweed cultivation activities in West Seram Regency in the

areas areas that carry out seaweed cultivation activities, namely Kairatu Subdistrict covering Nuruwe village and Kamal village and in West Seram Regency which includes Kotania hamlet, Wael hamlet and Osi island in November 2022 - January 2023.

Table 2 Respondents

No	Respondent	Number
1	Chairman of Fisheries and Coastal Offices Maluku Province	1
2	Chairman of Fisheries and Coastal Offices West Ceram Regency	1
3	Head of Division Management and Resources Fisheries and Coastal Offices West Ceram Regency	1
4	Head of Division Facility and Infrastructure Fisheries and Coastal Offices West Ceram Regency	1
5	Head of Division Business Development Fisheries and Coastal Offices West Ceram Regency	1
6	Academics of the Faculty of Marine and Fisheries, Pattimura University	3
7	Seaweed Farmers	54
Total		62

Technique sampling of respondents is done by *purposive* namely a sampling technique that is determined deliberately based on certain criteria or considerations [11]. The sample consists of government agencies, stakeholders, and seaweed cultivators.

4. Results and discussion

4.1. Cultivation Location

Selection of a good location will greatly support the seaweed cultivation business. Seaweed cultivation locations in the district are spread over several areas, namely Kairatu sub-district (Nuruwe and Kamal villages) and West Seram sub-district (Wael hamlet, Kotania hamlet and Osi island). The choice of this location was based on suitable and relatively good water conditions, far from fresh water sources, because fresh water supplies can damage plants and sediment (mud) can cover the surface of plant talus, free from contaminants either by industrial or household waste and has good and open water circulation, and not a shipping lane.

According to information from Julius Hitipeuw, that cultivators in each village/hamlet do not have alternative locations for seaweed cultivation activities because the people of Maluku strictly adhere to customary law relating to petuanan rights both on land and at sea. Communities have customary rights over sea waters perpendicular to the coastline from their land area. Thus the people in Nuruwe village cannot carry out fish farming including placing bagan/FADs/ cages in Kamal's area and vice versa. This also happened to cultivators in the hamlets of Kotania, Wael and Osi island.

4.2. Seed Selection

Seed selection is selected from the best cultivation results to be re-sown when the plants are 25 days old. The seeds taken are usually 4 times from the parent seed weighing 100 grams. The characteristics of seaweed that are good as seeds are many branches, bright colors, *thallus* looks fresh and elastic, end of *thallus* straight and when bitten feels brittle.

Based on information from Wills Maail, that usually during the west season, seaweed cultivators in Kairatu District only plant seaweed to provide seeds and rarely for sale. Meanwhile, if sold, only in limited quantities. This is because in that season, the yield and quality of seaweed production is not good, so it can affect the selling price. Meanwhile, information from La Maha (interview on 2 January 2013) said that seaweed cultivation in West Seram District takes place every season, due to the condition of the waters that are always calm and semi-enclosed.

4.3. Cultivation Technique

4.3.1. Rawai technique

Seaweed production facilities can be grouped into 3 (three), namely cultivation infrastructure, seeds, and equipment for maintenance or cultivation and harvesting. Cultivation infrastructure equipment varies, depending on the method used and the size of the cultivation area.

Based on the results of interviews and direct observation, the use of the longline method (*long line method*), for an area of 1 Ha, 20 lines can be made 100 M long with a distance between each line of 1 meter and the distance between nodes is 25 cm. So for an area of 2 Ha the standard number of lines is 40 lines. Details of cultivation needs can be seen in Table 10.

Table 3 Materials for seaweed cultivation in the West Seram Regency *longline* method with a land area of 2 Ha measuring (200 × 100 M)

No.	Uraian	Description	Total
1.	Cultivated area	200 × 100 M	1 unit
2.	Anchor	2 sauh × 40 line	80 unit
3.	Anchor rope Polietilien Ø 8 Mm	45 – 50 M	10 bal
4.	Main rope Polietilien Ø 5 Mm	100 M	15 bal
5.	Knotted rope Ø 1 Mm	30 Cm × 300 utas × 40 line	10 bal
6.	Seaweed seeds with a quantity 300 ties per 100 M	35 ikat × 40 line	1400 ikat
	Seaweed seed requirement (Kg)	35 ikat × 40 line × 0,1 Kg/ikat	140 Kg
7	Buoy from jerrycan 5 L	2 gen × 40 line	80 unit
8.	Buoy from used bottle 1500 Ml	30 botol × 40 line	1200 unit
9.	Canoe	3 × 0,8 M	1 unit
10.	Tarpaulin	4 × 6 M	3 unit
11.	Waring	25 M	1 unit
12	Drying racks	2 × 8 M	1 unit

Based on information from respondent, the selection of the longline method vertically by them as cultivators, because it has been tested horizontally and diagonally it turns out that this method is suitable. This choice was based on the reason that when they conducted trials using horizontal and diagonal methods, all the seaweed seeds gathered together due to the strong currents.

4.3.2. Gosepa technique

Researchers from the Faculty of Marine and Fisheries, Pattimura University, Ambon, had tested the *Gosepa technique* namely using bamboo rafts where the seeds are arranged vertically with the aim of saving area and multiplying yields. However, this method was not followed up by seaweed cultivators because of the many obstacles they faced, including:

- Difficulties in cleaning seaweed from various disturbing impurities, because they have to dive,
- Seaweed plants will be intertwined if there is a marked change in the current pattern,
- The reproductive ability of the lower part will not develop properly due to sunlight problems.

5. Conclusion

Seaweed cultivation on Seram Island is still carried out traditionally. This condition is evidenced by the determination of the location and the use of technology which is still very simple. The use of technology is done by trial and error to find out the best technique to get optimal results.

The trial results by the cultivators showed that the longline technique still gave the best results compared to the gosepa technique which was an innovation from Pattimura University, Ambon.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors have participated in (a) the conception, analysis, and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content, and (c) approval of the final version.

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Statement of informed consent

All information obtained through interviews, surveys or observations with respondents during this research has been approved for writing in this manuscript.

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