Feasibility of *Kappaphycus alvarezii* seaweed farming using the longline method in Muna Regency

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Abstract. Seaweed is a major source of foreign exchange and a leading export commodity in the fisheries sector. Seaweed farming offers many advantages, it also involves high risks. Study aims to analyze the feasibility of farming green and red varieties of *Kappaphycus alvarezii*, both from financial and nonfinancial perspectives. Research was conducted in Kawite Wite Village, Kabawo District, Muna Regency, Southeast Sulawesi Province. Nonfinancial analysis employed descriptive methods, while the financial feasibility was assessed using investment criteria, NPV, Net B/C, IRR and PP. Results of the nonfinancial feasibility analysis indicate that nearly all treatments in the seaweed farming business are considered feasible to implement. In the financial analysis, G50 treatment cultivation of the green variety of K. alvarezii at a distance of 50 m from the coastline was found to be financially feasible. However, R50 treatment cultivation of the red variety at the same distance was deemed not feasible. Both G75 treatment (green variety at 75 m) and R75 treatment (red variety at 75 m) were found to be financially feasible. Likewise, G100 treatment (green variety at 100 m) and R100 treatment (red variety at 100 m) were also considered feasible. Among all treatments, G100 demonstrated the best performance.

Keywords: Financial analysis, green and red varieties, investment feasibility, seaweed

1 Introduction

Agricultural sector, which includes agriculture, forestry, and fisheries, plays a strategic role in Indonesia's economy. According to the World Bank, this sector contributed approximately 12.6% to Indonesia's Gross Domestic Product (GDP) in 2024, a decline compared to the early 1990s when it accounted for around 21.5% [1]. Specifically, the fisheries sector contributed about 2.77% to the GDP in 2021 and employed more than 12 million workers, the majority of whom are located in coastal areas [2].

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Fisheries sector not only plays a role in food provision and employment absorption but also serves as a source of foreign exchange through the export of various key commodities, one of which is seaweed. Indonesia is one of the largest seaweed producers in the world, with vast aquaculture potential, particularly in the eastern regions of the country [3]. Data from the Ministry of Marine Affairs and Fisheries (KKP) indicate that national seaweed production reached more than 9 million tons in 2022, making it the leading non-fish export commodity with high economic value [4]. Carrageenan is primarily derived from the red algae K. alvarezii, which is the commercial variety of choice due to its rapid growth and low production cost in tropical coastal waters around the world [5].

Financial analysis is a feasibility analysis from the producer perspective in conducting a seaweed cultivation business. Business feasibility analysis is crucial to assess the extent to which farming activities can provide sustainable economic benefits for farmers, including through the calculation of costs, revenues, and the benefit cost ratio [6]. Such assessment is also necessary to enhance the competitiveness of seaweed as a strategic commodity in both domestic and international markets.

One of the regions with significant potential is Kawite Wite Village, Muna Regency, Southeast Sulawesi. The village has relatively calm waters suitable for cultivating *K. alvarezii* of both red and green varieties. Most of the coastal community in this village relies on fisheries activities, particularly seaweed farming, as their main livelihood. However, despite the long-standing practice of seaweed cultivation, comprehensive studies on business feasibility and product value addition remain limited. Such information is crucial for improving business efficiency, supporting farmers' welfare, and strengthening the position of seaweed as a leading regional commodity.

So far, most research on seaweed in Indonesia has focused on biological aspects, cultivation techniques, and harvest quality [7, 8]. Meanwhile, studies on business feasibility at the local level, particularly in Muna Regency, remain limited. This condition has created an information gap that may hinder optimal business development. Therefore, research on the feasibility of cultivating *K. alvarezii* red and green varieties in Kawite Wite Village is essential to provide a comprehensive overview of the economic potential that can be developed. The findings are expected to serve as a basis for farmers, local governments, and other stakeholders in formulating development strategies that are more efficient, profitable, and sustainable

2 Materials and methods

2.1 Research location and site

Study was carried out from June to August 2024 in Kawite Wite Village, Kabawo District, Muna Regency, Southeast Sulawesi, which served both as the seed source and cultivation site. Subsequent sample analyses were conducted at the Laboratory of Fisheries and Marine Science, Halu Oleo University, Kendari. Randomized block design was applied, with two varieties of *K. alvarezii* green (G) and red (R) tested at distances of 50, 75, and 100 m from the coastline (**Table 1**). The cultivation area had sandy substrates interspersed with seagrass patches. According to local farmers, seaweed growth reaches its optimum between December and May. The water depth during the lowest tide ranged from 1 to 5 m. The seedlings used in this research were obtained directly from the site and selected based on their youth, health, and absence of pests or diseases (**Fig. 1**).

Table 1. Grouping of *K. alvarezii* seaweed cultivation in Kawite Wite Village, Muna Regency, Southeast Sulawesi [9].

Green (G) and Red (R)	Distance from castline (m)		
	50	**75**	**100**
G	G50	G75	G100
R	R50	R75	R100

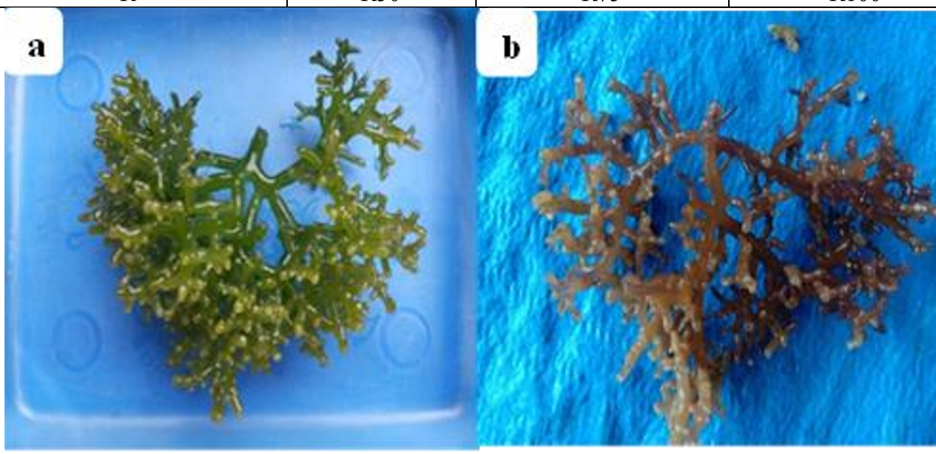

Fig. 1. Seedlings of *K. alvarezii* a. green varieties; b. red varieties [9].

2.2 Data analysis

Nonfinancial aspects examined in seaweed farming using the longline method in Kawite Wite Village, Muna Regency include market and marketing aspects, technical aspects, management and legal aspects, socio-economic and cultural aspects, and environmental aspects.

In the financial aspect analysis, calculations were carried out to determine the amount of capital required to establish and operate a seaweed-farming enterprise in accordance with the research design described above. For each treatment, the net benefits obtained from the business relative to the investment costs were assessed, including profitability and investment feasibility criteria. According to [6], the financial aspect of investment feasibility includes the Net Present Value (NPV), Net Benefit Cost Ratio (Net B/C), Internal Rate of Return (IRR), and Payback Period (PP), as well as a switching value analysis of the inflow and outflow components.

3 Results and discussion

3.1 Feasibility analysis of nonfinancial aspects

3.1.1 Demand and supply

Dried seaweed produced from longline cultivation is sold to collectors located in Kawite Wite Village, Muna Regency. The exact level of seaweed demand in Kawite Wite Village remains uncertain. At times, the quantity supplied does not match the demand, leading to periods of dried seaweed scarcity due to differences in planting seasons. The production capacity of cultivated seaweed is still limited. The total production of cultivated seaweed in this study was 1,965 kg with a total raw material input of 1,080 kg.

3.1.2 Marketing strategy

One of the commonly used marketing strategies is the marketing mix, which consists of 4Ps: Product, Price, Place, and Promotion. The product offered is the cultivation output, namely dried seaweed. The marketed seaweed is harvested at around 40–45 days of age and has undergone a drying process. Shipment of seaweed is also carried out after it is packed into sacks. In general, dried seaweed weighs about 90–100 kg per sack. The price of seaweed is determined by local collectors, who then distribute the supply to other regions, resulting in a relatively stable price of IDR 13,000 per kg.

Collectors of seaweed produced in Kawite Wite Village consist of local collectors and major collectors. Local collectors are those located within the village, while major collectors are based in Bau Bau City, Southeast Sulawesi. The distribution of dried seaweed to major collectors is carried out using the operational vehicles owned by local collectors, namely open-back trucks. The distribution process takes place once the capacity of the operational vehicle is fully loaded.

3.2 Feasibility analysis of the financial aspect

3.2.1 Profitability analysis

Seaweed cultivation produces dried seaweed ready for sale, which can be utilized in the food, pharmaceutical, and other industries. This business operates in six cycles per year. The research was scaled up into four cultivation system units based on the applied treatments. The results of the profitability calculation are presented in **Table 2**.

Table 2. Profitability analysis of seaweed (*K. alvarezii*) cultivation of green (g) and red (r) varieties at different farming locations during 40 days of cultivation.

Parameters	**Treatments**					
	G50	**G75**	**G100**	**R50**	**R75**	**R100**
Investment Cost (IDR)	13,855,000	13,855,000	13,855,000	13,855,000	13,855,000	13,855,000
Fixed Cost (IDR)	7,288,123	7,288,123	7,288,123	7,288,123	7,288,123	7,288,123
Variable Cost (IDR)	4,782,000	5,286,000	5,790,000	4,782,000	5,286,000	5,790,000
Total Cost (IDR)	12,070,123	12,574,123	13,078,123	12,070,123	12,574,123	13,078,123
Production (kg)	1,260	1,573	1,620	576	1,271	1,559
Price/kg (IDR)	13,000	13,000	13,000	13,000	13,000	13,000
Revenue (IDR)	16,380,000	20,451,600	21,060,000	7,488,000	16,520,400	20,264,400
Profit (IDR)	4,309,877	7,877,477	7,981,877	-4,582,123	3,946,277	7,186,277

Parameters	Treatments					
	G50	**G75**	**G100**	**R50**	**R75**	**R100**
BEP (IDR)	10,293,107	9,828,412	10,051,596	20,167,577	10,717,324	10,203,493
BEP (kg)	792	756	773	1,551	824	785
HPP (IDR)	9,579	7,993	8,073	20,955	9,895	8,390
PP (year)	3.21	1.76	1.74	-3.02	3.51	1.93

Difference in cultivation sites resulted in an increase in variable components, leading to the G100 treatment incurring the highest variable and total costs, amounting to IDR 5,790,000 and IDR 13,078,123, respectively. G100 treatment recorded the highest productivity with 1,620 kg, followed by H75 with 1,573 kg and M50 with 1,559 kg. Selling price of seaweed was the same across all treatments, namely IDR 13,000/kg, resulting in the three highest revenues being obtained from G100, G75, and G50 treatments, with IDR 21,060,000, IDR 20,451,600, and IDR 20,264,400, respectively. G75 treatment had the lowest break-even point in terms of cost and productivity, at IDR 9,828,412 and 756 kg, respectively. The cost of production for G75 (IDR 7,993) was the lowest compared to other treatments. The R/C ratio of the H75 treatment was the highest, with a value of 1.63.

Financial analysis requires an examination of variable costs in the calculation of total costs. Highest variable costs in this study were found in the G100 and R100 treatments, both amounting to IDR 5,790,000, which consequently resulted in the highest total costs compared to other treatments, namely IDR 13,078,123. The components that contributed to the higher total costs were the greater inputs of seedlings and fuel (diesel) in the G100 and R100 treatments compared to the other treatments. Highest profit was obtained from the G100 treatment, amounting to IDR 7,981,877, while the highest R/C ratio was recorded in the G75 treatment, with a value of 1.63. However, this was not significantly different from G100, which had an R/C ratio of 1.61. Thus, based on business performance, the cultivation of K. alvarezii generated higher profits under the G100 treatment, namely using the green variety cultivated at location 3.

3.2.2 Analysis of investment

Seaweed farming enterprise was evaluated using investment criteria analysis with the assumption of a 10 years business period. The calculation of investment criteria analysis employed cash flow analysis. The assessed components included net present value (NPV), Net B/C, internal rate of return (IRR), and payback period (PP). The results of the calculation are presented in **Table 3**.

NPV values of treatments G100, G75, and R100 met the feasibility criteria of >0, amounting to IDR 30,981,278, IDR 30,241,169, and IDR 25,219,521, respectively (**Table 9**). These values represent the benefits obtained over the 10 years business lifetime. In contrast, R50 treatment, which yielded a negative NPV, indicated that seaweed farming under this treatment did not provide any benefits over its business lifetime.

G100 treatment had the highest Net B/C value that met the feasibility criteria (≥1), at 5.07, compared to the other treatments. However, this value was not significantly different from the Net B/C of G75, which was 4.88. The meaning of the Net B/C value is that each additional unit increases the net benefit of seaweed farming by 1.27 (G50); 4.88 (G75);

5.07 (G100); 1.07 (R50); and 3.79 (R100). IRR represents the internal rate of return, which can be considered feasible if it is higher than the prevailing interest rate (8.9%; PT Bank Rakyat Indonesia (Persero), Tbk, May 2025). IRR of treatment G100 was higher than the interest rate, reaching 120.90%, although it was not significantly different from G75 with a value of 116.65%. The IRR of treatment R50 did not meet the feasibility criteria. Treatment G100 had the best payback period, requiring only 5.19 years compared to the other treatments.

Table 3. Investment criteria analysis of seaweed farming (*K. alvarezii*) green (G) and red (R) varieties under different cultivation sites over a 40 day culture period.

Components	**Feasibility**	**Treatments**		
		G50	**G75**	**G100**
NPV (IDR)	>0	4,420,467	30,241,169	30,981,278
Net B/C	≥1	1.27	4.88	5.07
IRR (%)	> discount rate	18.80%	116.65%	120.90%
PP (year)	≤ economic life	10.75	5.96	5.19
Components	**Feasibility**	**R50**	**R75**	**R100**
NPV (IDR)	>0	-59,975,649	1,771,307	25,219,521
Net B/C	≥1	-1.12	1.07	3.79
IRR (%)	> discount rate	-	11.28%	91.27%
PP (year)	≤ economic life	10.95	117.81	10.89

Values of NPV, Net B/C, and IRR that meet the feasibility criteria were found in treatments G50, G75, G100, R75, and MR100. Furthermore, only treatment G100 met the lowest PP value, which was 5.19. This is in line with the study by [10], which stated that a lower PP value in seaweed (*Gracilaria* sp.) cultivation using a polyculture system yielded the best results. Most feasible seaweed farming practice to be developed is the application of treatment G100, which involves cultivating the green variety at a distance of 100 m from the coastline. This is because the net benefit of the farming business, based on the present value, can recover the investment cost within 5.19 years.

Treatment G100 also achieved the highest Net B/C value, reaching 5.07, and is therefore considered feasible. This finding is consistent with [11], who reported that a Net B/C value of 1.08 in seaweed farming indicated feasibility. Similarly, the findings of [12] on catfish farming showed that the Net B/C value in all treatments was greater than 1, implying that the business is financially profitable. [13] reported that the highest Net B/C value among all treatments indicated better financial performance of the business. [14] stated that total productivity, total income, net income, and economic indicators reached their maximum values with the lowest break-even point at a 45 days growth period compared to other growth periods. This confirms the appropriateness of the cultivation duration applied in the present study.

4 Conclusion

Based on the feasibility analysis of the non-financial aspects, seaweed farming using the longline method in Kawite Wite Village is feasible to implement. In terms of demand and supply, this seaweed farming business has good market potential and marketing mix. Financial feasibility analysis of seaweed farming was divided into six treatments: G50, G75, G100, R50, R75, and R100. Based on the financial aspects, the G75 and G100 treatments were found to be feasible, as they yielded an NPV greater than 0, an IRR exceeding the discount rate of 8.9%, a Net B/C greater than 1, and a PP shorter than the 10-year business lifespan. Among these two treatments, G100 was identified as the most feasible option, as it generated higher net benefits compared to G75.

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