Socio-economic characteristics of seaweed farmers on Semau Island, Kupang Regency, East Nusa Tenggara, Indonesia

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Abstract. Seaweed is one of the primary commodities that has economic value for the communities around Semau Island, East Nusa Tenggara province. This research was conducted to identify the socio-economic characteristics of seaweed farmers and to examine the role of seaweed in promoting sustainable development on Semau Island. Research data were collected through interviews with 40 seaweed farmers, utilizing a technique to gather data from the seaweed farming community. The results showed that seaweed farmers are from varying levels of education and diverse cultural backgrounds. Seaweed farmers uphold values of cooperation, hard work, and respect, which foster strong social cohesion. The B/C ratio of 1.17 highlights the profitability of seaweed farming, contributing to household welfare. These social and cultural dynamics reinforce the sustainability of seaweed farming, which in turn supports broader sustainable development goals.
Key Words: social, economic, cultural, seaweed, Semau.

Introduction. Semau Island is located in Kupang Regency, in the western part of Timor Island, East Nusa Tenggara. There are two sub-districts on Semau Island: Semau Sub-district and South Semau Sub-district (Statistics Indonesia 2023). The island's biodiversity offers attractive destinations and areas for development, including seaweed cultivation.

Seaweed cultivation among the locals of Semau Island is performed through cooperation between family members and fellow seaweed cultivators. Such cooperation strengthens social values and fosters a sense of solidarity among individuals. The community also fosters a sense of mutual respect and maintains harmonious relationships in its daily lives, thereby avoiding conflicts of interest in social and economic activities. Arif et al (2024) found that social capital plays an important role in the rural habitat system, where access to livelihoods depends on social relationships.

Seaweed has become one of the primary commodities of the East Nusa Tenggara government (DKP 2018). The local community of Semau Island earns a living from the high economic value of seaweed. Baquedano-Rodríguez et al (2023) found that aquaculture development positively affects one's socio-economic status. Seaweed farming opens employment opportunities for the surrounding community, thereby increasing the income of seaweed farmers. Larson et al (2021) found that seaweed cultivation in South Sulawesi has a positive impact on women's welfare and household income. Specifically, seaweed cultivation opens up opportunities to earn money and support their role in the household.

Seaweed production in Semau District reaches an average of 65,212 tons, and 46,424 tons in South Semau District. Semau District has a total land area of 525 hectares, while South Semau District has a total land area of 591 hectares (Statistics Indonesia 2023). Based on this potential data, there is a need for the development of seaweed cultivation. Samonte (2017) reported that the cultivation of *Kappaphycus* spp. in coastal waters provides socio-economic benefits for the coastal community, as it offers the opportunity to earn more.

The population of Semau District is 7,874, comprising 1,985 households. Of the total population, 1,520 households make a living from seaweed cultivation. Meanwhile, South Semau District is inhabited by 3,040 people with 1,653 households. Currently, there are 1,562 seaweed farming households (Statistics Indonesia, 2023). Few studies have examined the socio-economic dynamics of seaweed farmers in Eastern Indonesia, particularly in Semau Island. Therefore, this study fills the gap in the socio-economic characteristics of seaweed farmers, aiming to comprehend the social and economic dynamics that impact their welfare. This research was conducted to identify the socio-economic characteristics of seaweed farmers and to examine the role of seaweed cultivation in promoting sustainable development on Semau Island.

This study aims to analyze socio-economic characteristics, assess profitability, and evaluate contributions to the Sustainable Development Goals(SDGs). The findings in this study contribute to the understanding of the socioeconomic characteristics of seaweed farmers.

Material and Method

Research sites and time. This research was conducted from July to August 2024 in seven coastal villages(Naikean, Akle, Uitiuh Ana, Onansila, Bokonusan, Uitao, and Huilelot) of Semau and Semau Selatan sub-districts, Kupang Regency. The location of this research was determined based on the consideration that the area is a centre for seaweed production (Figure 1).

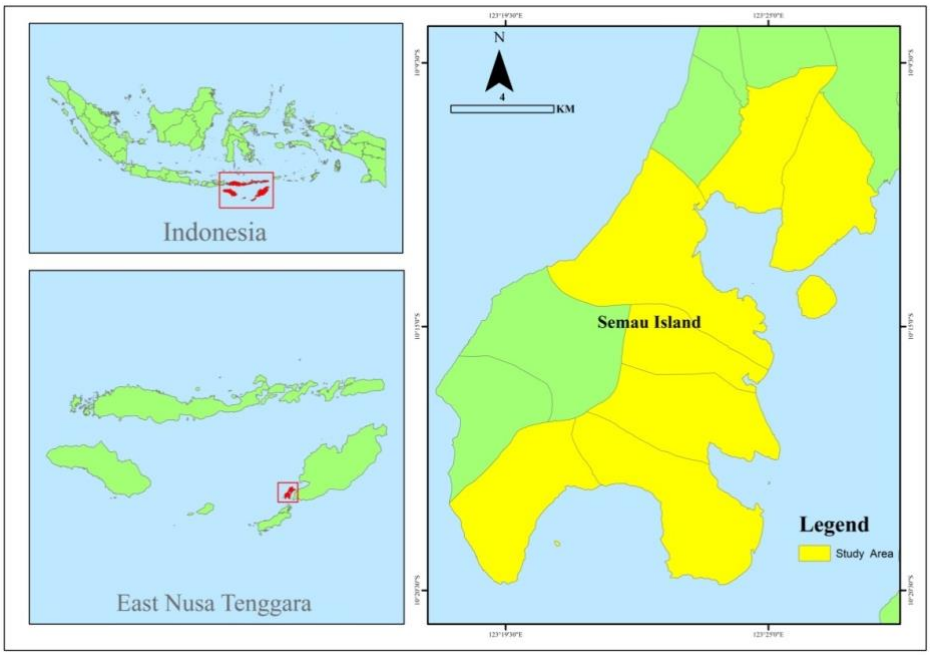

Figure 1. Map of study sites in the Semau Island, Kupang District, Indonesia.

Data collection. The primary data for this research were collected through interviews with 40 seaweed farmers from Naikean, Akle, Uitiuh Ana, Onansila, Bokonusan, Uitao, and Huilelot. Participants were randomly selected to represent various social characteristics, including gender, age, education, income, and geographical location, thereby providing a broader perspective on socio-economic conditions. This study uses semi-structured qualitative interviews with seaweed farmers to gather information on cultivation

techniques, challenges, and economic aspects. The interviews were conducted face-to-face, ensuring confidentiality and obtaining consent before the activity. Face-to-face interviews were conducted with two participants to gain more comprehensive responses based on personal experiences and knowledge. Meanwhile, secondary data were retrieved from relevant literature, including previous research and publications for comparison.

Data analysis. In this descriptive-quantitative research, thorough information on socioeconomic and cultural conditions of the local community working in seaweed cultivation was obtained and analyzed. The analysis revealed averages and percentages of gender, age, education, income, and geographical location. The benefit-cost ratio (BC) of seaweed cultivation was then measured using the following formula (Wijayanto et al 2023).

$$\Pi = TR\text{-}TC \quad (1)$$
$$BC = TR/TC \quad (2)$$

Note:
π = profit;
BC = Benefit-cost ratio;
TR = Total revenue;
TC = Total cost

Results and Discussion

General overviews of the site area. Semau District, located on Semau Island within Kupang Regency, encompasses an area of 143 square meters and is comprised of 8 villages. Semau District is adjacent to Sawu Sea in the north, Semau Strait in the south, Kupang Bay border in the east, and Sawu Sea in the west (Statistics Indonesia 2023).

Semau Island has the potential for marine waters and marine tourism, which can be further explored and developed. Seaweed cultivation in this area generates significant economic benefits for the community. Jaman et al (2023) stated that seaweed cultivation and production can enhance the economy of coastal communities. The sale of seaweed has a positive impact on living conditions, including access to building materials, sanitation facilities, and water.

Seaweed farmers in Semu Island mostly make a living from seaweed cultivation as the primary economic sector. According to Rimmer et al (2021), seaweed cultivation provides an important source of livelihood during times of economic hardship, as it offers greater resilience to coastal communities. Seaweed production in the area has sufficiently fulfilled the basic household needs, healthcare, food, and family nutrition.

Social-culture characteristics. Survey results indicate that seaweed farmers come from diverse social and cultural backgrounds, with varying education levels, ranging from elementary to senior high school. Despite these differences, they possess valuable experience in seaweed cultivation (Table 1). The research results show that 85.75% of seaweed farmers only completed elementary school. The study suggests the need for training to improve their knowledge and skills in more effective cultivation. Tubuet al (2021) note that low education levels and school dropouts in Takalar Village are influenced by employment, income, and parental education. Similarly, Bakarbessy (2023) highlights that education has a significant impact on the income and independence of seaweed farmers in South Maluku. Education plays a key role in enhancing the economic and social well-being of seaweed farmers by improving their ability to recognize market opportunities and strengthening their financial and decision-making skills.

Despite their formal education, seaweed farmers possess substantial knowledge and understanding of natural signs, such as weather, due to their strong ties to the natural environment. This socio-cultural character serves as local knowledge passed down through generations to determine the optimal time for seaweed cultivation. Hénocque (2013) stated that the Satoumi social-ecosystem in Japan provides local knowledge about the products

of wild plants and seaweed. Human activities influence rural agricultural ecosystems known as Satoumi. People engage in sustainable practices to maintain biodiversity and support the ecological health and livelihoods of local people.

The seaweed farmers in the coastal village of Semau Island come from various tribes, including the Helong, Rote, Timor, and Bajo tribes. The diversity of tribes, cultures, and languages also strengthens social integration and solidarity while fostering the development of their farming technologies. According to Oosterlynck et al (2016), solidarity in diversity is present in various literature, such as mutual dependence, shared norms, and struggles. Seaweed sales help families send their children to school or pay for school supplies for a better future.

Seaweed farmers in the Semau sub-district mainly adhere to the principle of cooperation in seaweed cultivation, which can reduce the labour rental costs while also strengthening cultural values. According to De Freitas et al (2019), cooperation is a coordination strategy that fosters mutual benefit in various social situations, leading to mutual advantage. Hence, cooperation is the key to achieving satisfaction in both the economic and social dimensions of a society's life. Furthermore, Payan et al (2019) stated that cooperation plays an important role in the components of action alignment (economic satisfaction) and social alignment (non-economic satisfaction). Effective collaboration among seaweed farmers can lead to stronger social ties, thereby enhancing cooperation in economic activities. The research results indicate that the community's social life is very strong; all respondents provided similar responses regarding the spirit of togetherness and cooperation in seaweed cultivation.

Table 1

Social and cultural aspects of seaweed farmers

No	*Characteristics*	*Percentage (%)*
1.	Education	
	Did not finish elementary school	12.50
	Elementary School	75.00
	Junior High School	7.50
	Senior High School	5.00
2.	Ethnic	
	Helong	37.50
	Timor	17.50
	Rote	37.50
	Bajo	7.50
3.	Tradition in work	
	Mutual corporation	100

The welfare of seaweed farmers. Seaweed farmers' earnings and welfare are significantly affected by the yield, sales, and market prices. Market prices fluctuate based on the market mechanism, which market makers influence. According to Mariñoet al (2019), seaweed cultivation on Rote Island is the only source of income for 50% of households. Mirera et al (2020) also stated that seaweed cultivation in Kibayuni has a positive impact on coastal welfare and development. The sale of seaweed allows farmers to meet their basic household needs (e.g., food, education, and healthcare) and improve their standard of living. As noted by Farhaduzzaman (2023), seaweed cultivation in Cox's Bazar, Bangladesh, is highly profitable, increasing the income of farmers. Seaweed cultivation presents a substantial economic opportunity for coastal communities to enhance their economic resilience and foster sustainable development.

The average monthly income of seaweed farmers on Semau Island is USD 276,82 (IDR 4,606,000), which is well above the minimum wage in the Kupang district of USD 127,65 (IDR 2,123,994) (Statistics Indonesia Nusa Tenggara Timur 2023). This figure suggests a significant potential for seaweed farming to improve local livelihoods. Comparatively, Geo et al (2020) reported an average income of USD 514,82 (IDR 8,566,000) per production season in Southeast Sulawesi, while Rahmawati et al (2023) found an annual average income of USD 1,137,39 (IDR 18,924,818) in Kolese village. For

many farmers, seaweed farming serves as a primary source of family income and contributes significantly to local welfare and economic development. These findings underscore the sector's potential to drive economic growth and improve the quality of life in coastal communities.

Income data from seaweed farmers (Table 2) show significant variation among respondents, influenced by factors such as the number of ropes or rafts deployed, market prices, and weather conditions. Despite this variability, most farmers earn enough to meet their families' basic needs. Aslan (2018) highlighted that seaweed farming in Lemo village is a major contributor to household income. Similarly, Tawakalet al (2019) found seaweed farming in Tual City to be highly profitable, with average incomes of USD 909,58 (IDR 15,134,275) for small-scale farmers and USD 17,986,64 IDR 29,927,120 for large-scale farmers. While profit levels differ by scale, seaweed farming remains a viable and profitable livelihood for both small-and large-scale farmers, supporting the broader economic development of coastal communities.

Table 2

Age and income of seaweed farmers

No.	*Category*	*Value*	*USD / IDR/month*
1	Age		
	Min	25	
	Average	45	
	Max	70	
2	Income	USD / IDR	USD / IDR
	Min	86,18 / 1,434,000	
	Average	415,24 / 6,909,000	276,82 / 4,606,000
	Max	524,92 / 8,734,000	
3	Profit		
	B/C Ratio	1.17	

Seaweed business. Most of the seaweed farmers were between 25 and 70 years old, indicating a wide age range of farmers. The population in the productive age brings benefits to the economy (Mastutiet al 2023). The average age of seaweed farmers on Semau Island is 45 years, an age at which farmers already possess considerable experience and skills, and have a relatively fit physical condition. Hassan & Othman (2019) mention that the ideal age of seaweed farmers is within the age of 31-49 years, where farmers have balanced capability that can support the successful and sustainable seaweed farming.

In this research, seaweed farmers primarily use the long-line method due to its affordability and practicality. Kaya et al (2023) reported that seaweed cultivation on Searam Island, using the long-line technique, yields excellent results. Muzahar et al (2023) state that the long-line method achieves the best growth rate and seaweed production (*Kappaphycus striatum*) in Pelakak village, Lingga district. The long line method is suitable for the local environmental conditions in Pelakak Village, such as water temperature, salinity, and wave patterns, which support the growth of *Kappaphycus striatum*.

The calculation yielded a BC ratio of 1.17, meaning that for every IDR 1 spent, farmers earn IDR 1,17 in profit (Table 2). The data demonstrates that seaweed farming in Semau is both profitable and viable, thereby contributing to the financial well-being of farmers. Similarly, Ghose & Hossain (2021) reported a BC ratio of 1.82 for seaweed farming on Saint Martin Island, Bangladesh, further highlighting the economic potential of this sector.

The research results indicate that seaweed cultivation in Semau has a B/C ratio of 1.17, meaning that for every Rp 1 spent, a profit of USD 0,01 (IDR 1,17) is obtained. Therefore, seaweed cultivation activities in the area are profitable and financially viable. Ghose & Hossain's (2021) research on Saint Martin's Island, Bangladesh, revealed a higher B/C ratio of 1.82. Various factors, such as market prices, production costs, market access, and infrastructure support, influence this difference. However, both findings equally

confirm the economic potential of seaweed cultivation as a source of income for coastal communities.

Based on the interviews, the initial capital for the seaweed cultivation business comes from the farmers' funds and their initiative. Seaweed-collecting traders often provide capital to farmers, with repayment deducted from business profits. Social capital also plays a crucial role in supporting seaweed farming; Fausayana et al (2018) found that it has a positive impact on the industry in Liya Mawi village. To further promote the sector, the government provides inputs such as seeds, ropes, and anchors, while NGOs offer support through business capital and training in environmentally friendly cultivation practices. Mustafa et al (2022) also emphasized that access to capital is a critical factor in the development of seaweed farming.

The contribution of seaweed to sustainable development goals. Observations of coastal communities in Semau show that seaweed farmers actively utilize marine resources to promote food security and economic growth. This practice supports the achievement of the UN SDGs, particularly SDG 14, which focuses on conserving and sustainably using marine resources. Cheng et al (2022) highlight that seaweed cultivation not only contributes to SDG targets but also offers economic and ecological benefits. Similarly, Lange et al (2020) note that seaweed biorefineries support nutrition, health, job creation, ecosystem services, and climate change mitigation and adaptation.

Environmental sustainability is a key goal of sustainable development, particularly addressing climate change. Seaweed cultivation contributes to this by absorbing carbon dioxide (CO_2) and helping to mitigate climate impacts. According to Duarte et al (2017), seaweed farming can both reduce CO_2 emissions and serve as a long-term carbon storage solution through deep ocean sequestration. As such, it represents a promising nature-based approach for climate change mitigation by capturing and storing atmospheric CO_2.

Seaweed farmers in Semau uphold a long-standing tradition of cooperation, fostering a sense of brotherhood and mutual support to overcome challenges in their cultivation efforts. This communal spirit enhances resilience and collective capacity. Hossain et al (2021) note that seaweed farming boosts community capacity, strengthens local institutions and civil society partnerships, and contributes to national Gross Domestic Product (GDP), aligning with SDG 17. Additionally, seaweed farming promotes skill development, improves livelihoods, and fosters entrepreneurship, creating valuable economic opportunities for coastal and rural communities.

Seaweed is a valuable commodity for consumption and holds economic value in both domestic and international markets. Nor et al (2019) reported that the export of dried seaweed for carrageenan processing to international markets varies in price based on the quality of the seaweed and demand. Saragih et al (2022) assert that factors such as Indonesia's GDP per capita, exchange rates, and economic distance influence Indonesia's seaweed trade. Seaweed has enormous potential to support the achievement of Sustainable Development Goal 14.7, while also enhancing the economic conditions of small island developing states and developing countries through sustainable fisheries processing, aquaculture, and sustainable tourism. Zamroni et al (2020) also mentioned that innovative business practices can enhance the economic sustainability of seaweed farmers' households in Teluk Serewe, West Nusa Tenggara.

Conclusions. The socio-cultural characteristics of the seaweed farming community indicate that varying levels of education do not necessarily determine the knowledge and skills required for seaweed cultivation. The majority of seaweed farmers (75.0%) only completed elementary school. This condition serves as a crucial basis for recommending targeted training to enhance practical knowledge and skills in cultivation. Despite their diverse backgrounds, seaweed farmers exhibit strong cooperation, hard work, and mutual respect, which significantly impact the yield. The B/C ratio of 1.17 reflects the profitability of seaweed farming, which enhances household incomes and contributes to overall welfare. Social and cultural interactions among farmers further strengthen the sustainability of these ventures. Moreover, seaweed farming communities increasingly recognize their potential to support sustainable development.

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