

C10 Turnitin Prof Agil

by Agil Al Idrus C10

Submission date: 23-Jul-2021 09:24AM (UTC+0700)

Submission ID: 1622942348

File name: 010 C10 Artikel Prof Agil.pdf (1.01M)

Word count: 3137

Character count: 17389

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To cite this article: A Syukur *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1098** 052001View the [article online](#) for updates and enhancements.

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Diversity of marine aquaculture as a strategy to protect the livelihood of small-scale and seagrass conservation on the south coastal region of Lombok Island, Indonesia

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Abstract. Small fishermen are those who have contributed to food security and social stability. The purpose of this research is to describe the development of marine culture as a complementary livelihood of small fishermen and the protection of the marine environment. The research method uses observation techniques, surveys, interviews, questionnaires and in-depth discussions. Data analysis uses descriptive statistical analysis and regression. The results of the study showed that marine culture that could be developed was *baronang* and cuttlefish. Both types of these seeds are available in the surrounding seagrass area. The results of the regression analysis showed that the length of cultivation had the highest R² compared to the other two independent variables, namely education and the number of family members. Meanwhile, farmers have internal regulations to protect the environment, especially in seagrass areas. The conclusion of this research is that aquaculture can be a solution for fishermen's livelihoods and has a strategic value from the ecological aspects for the sustainability of marine life. Therefore, marine aquaculture can be a model in a food security strategy at the local level and can contribute to regional food security.

1. Introduction

Small fishermen (SSF) are groups of fishing communities with characteristics of "local", "coast", "traditional", "small", "self-sufficiency", "non-industrial", "low-tech", "poor" [1,2]. Meanwhile, the concept inherent in it is the fisheries category, which is illustrated by the values of social justice and environmental sustainability, especially in response to changes [3]. But their presence, especially in developing countries, is a food security subsystem, although most still fall into the poor category [4]. In addition, they form a group of people with a very high economic vulnerability. This is because they have limited capacity to cope with the effects of changes such as climate change and other factors, such as damage to natural resources, fluctuations in the prices of fishing raw materials and conflicts between the use of natural resources [5]. An alternative to overcoming the problem of sedimentation that continues to decline is that they exploit marine biota such as *tripang*, sea urchins and seahorses [6]. Therefore, subsistence solutions appropriate to their capacity and new livelihoods, and can function to protect the marine environment [7].

The regarding to the livelihood of small fishermen, the most rational model is the livelihood that supports each other through their profession as fishermen in marine farming [8]. In this case, marine aquaculture can act as an additional source of livelihood. Meanwhile, cultivation has been proven to



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contribute to direct and indirect poverty reduction by providing food, income and employment to producers and households and other value chains [9], and to protect the environment and marine ecosystems [10]. In addition, environmental conservation on a local scale has proven to be a solution for the livelihoods of local communities around the study site [11], but the development of marine culture as a source of income for small fishermen is determined by: (1) availability of seeds and feed, (2) regulations and management, (3) economic aspects of capital and markets and (4) social aspects, including fairness in the use of local resources.

The practice of marine aquaculture carried out by small fishermen the study site is believed to have contributed to economic resilience, in particular fisheries farmers and the protection of the marine environment. However, there are no studies aimed at this. Therefore, the aim of this study is to assess the contribution of aquaculture to economic safety and environmental protection or seagrass conservation for the preservation of marine life. The results of this study can be used as benchmark in anti-poverty policies, which is still a major concern, especially in communities in the study area and West Nusa Tenggara.

2. Material and methods

The study was conducted from April to September 2019, and the location of the study (Figure 1). The coastal waters at the study site have the potential to develop the cultivation of highly economic marine raw materials such as pearls and squid [12,13], and local communities are currently developing lobster and seaweed cultivation. In addition, the environmental potential supporting the development of aquaculture is fertile sea water and the presence of mangrove vegetation [14].

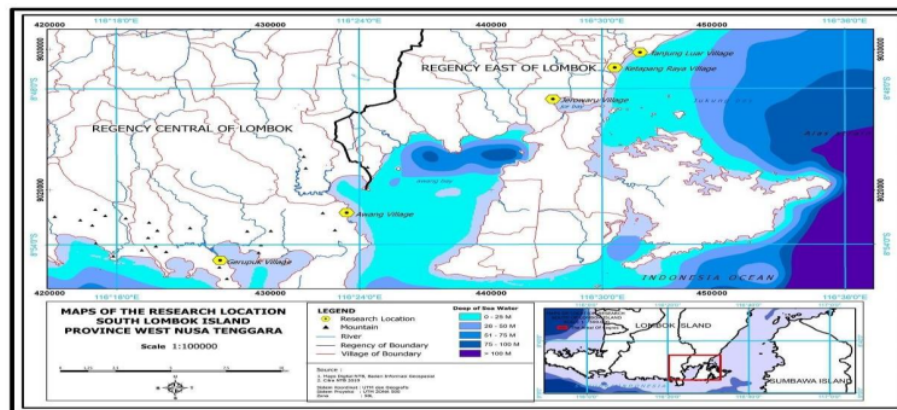


Figure 1. Research location.

This research is designed as an observation research. The research sampling technique was purposive sampling, and the number of research samples was 125 people. The criteria for each respondent as a sample are first as the first small fisherman, the second has a floating net (KJA) cultivation facility, and third is a minimum of 5 years of aquaculture. The research variables are income from cultivation, length of cultivation, education and number of family members. Other variables are the potential for the development of aquaculture other than seaweed and lobster and the implications of the existence of aquaculture for the protection of the marine environment. Furthermore, the research data was collected by observation, interview, in-depth discussion and questionnaire techniques. Meanwhile, all research data were analyzed using descriptive statistical data analysis. In addition, the regression analysis was carried out on the dependent variable, namely income from cultivation with an independent cultivation period, education and the number of family members.

3. Results and discussion

3.1. Cultivation in study location

The results of observations of marine aquaculture practices in the study location are the discovery that cultivation has become a major element in supporting the economy of aquaculture fishermen. Furthermore, the cultivation commodities that have been developed at each location are in Gerupuk Bay, the dominant seaweed culture and Awang Bay are fish and lobster cultivation. Meanwhile, in Tanjung Luar, Ketapang Raya and Jerowaru are lobster cultivation. Meanwhile, the development of aquaculture in the study location of 127 respondents stated that the types of fish that together could be cultured and had high economic value were baronang fish. In addition, respondents stated that cuttlefish is cultivable and the seeds can be obtained in all seagrass ecosystem waters. The benefits of aquaculture activities are to improve livelihoods and food security to communities around the coast. Cultivation helps the economic sector to increase as income of the fishermen themselves, increase food production, produce new job creations around the research location. Even small-scale cultivation also helps people to be independent without relying heavily on imports [15]. Sustainable livelihoods are developed to inform policy makers of the exact situation of fishermen, and are implemented in tandem with new fisheries such as the ecosystem approach to fisheries. Constructing development and conservation solutions. Supporting from appropriate regulations, policy makers must ensure long-term improvement in the livelihoods of coastal communities [16].

3.2. Cultivation as a complementary livelihood of small fishermen at the study site

The types of cultivation developed by fishermen to date are sand lobster (*Panulirus homarus*) and pearls (*Panulirus ornatus*). Both types of lobster can grow well in the coastal waters of the study location, the cultivation time is 7 months - 8 months. The economic value of aquaculture, especially lobster is the livelihood solution of small fishermen in the study location. This can be seen from the development of cultivation which increased by 139% from 2000 to 2019 or an average increase of 7.3% per year. The results of the average analysis of cultivator fishermen income based on the volume of cultivation is the volume of cultivation with an average of 125 seedlings - 150 heads, they get income between Rp. 17,500,000 - Rp. 21,000,000 and with a seed volume of 350 heads, the income is between Rp. 20,000,000 - Rp. 24,000,000. In addition, other contributions are for the purposes of health, education and social needs (e. g., Donations to build places of worship and child marriage costs).

Potential economical lobster and other fish farming potential in the study location, supported by several main variables in cultivation are: 1) lobster seedlings from sand lobster species (*Panulirus homarus*) and pearls (*Panulirus ornatus*) sourced from the environment around the cultivation area, 2) conditions the semi open coastal waters environment causes a mass circulation of water conducive to the growth and development of lobster and fish culture and 3), aquaculture feed can be obtained from the environment around the culture i.e. small fish that have low economic value

Cultivation results as described above are evidence of the contribution of cultivation as a source of income and sustainable livelihoods. In this regard, a number of variables have been identified for their contribution. The results of the analysis show that the R² value of income vs. the number of family members (Figure 2) is 31.47%. This explains the number of family members has a contribution that is not too large and even in the value below 50% of its contribution to the sustainability of cultivation as a source of livelihood with indicators of the amount of income from cultivation

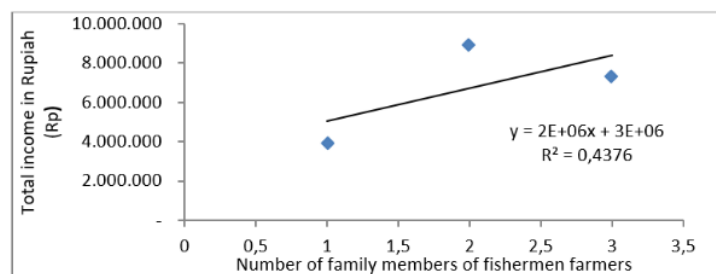


Figure 2. Relationship of the number of family members with income from cultivation.

The results of the regression analysis between length of cultivation and total income (figure 3) are obtained R^2 is 73.78%. In this case the old cultivation parameters can explain that has a large contribution to the amount of income. This can be explained from the results of interviews between farmers that the length of cultivation is an important factor in the cultivation process.

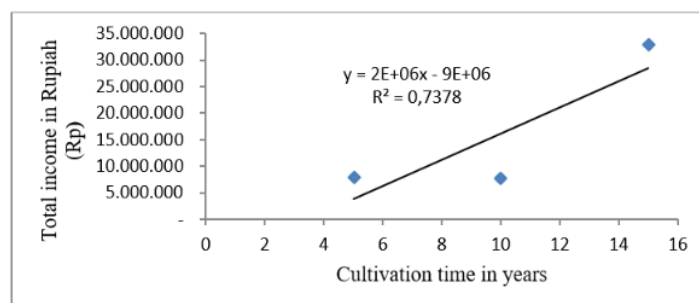


Figure 3. Relationship between cultivation duration and income from cultivation.

The other parameters are education that is grouped into five groups: 1) not completing elementary school with a grade of 1, elementary school with a grade of 2, junior high school with a grade of 3, high school education with a grade of 4 and education above a high school with a grade of 5. The analysis results (Figure 4) R^2 is 25.35%. Relating to cultivation, where community-based cultivation (CBA) can function as an important alternative source of income for coastal communities that depend on marine resources [17].

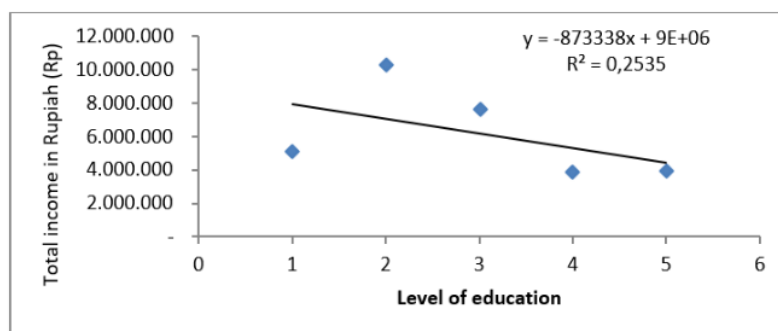


Figure 4. Relationship between education level and income from cultivation.

3.3. Aquaculture and seagrass conservation

The results of research on the existence of aquaculture against the protection of marine biota and its ecosystems, such as seagrass ecosystems of 125 respondents, 72% of respondents stated that aquaculture can prevent the habits of local people in utilization that is not environmentally friendly, especially the use of potassium and fish bombs. Furthermore, 23% of respondents stated that the existence of aquaculture was an inspiration in building togetherness among members of their farmers in overcoming problems that disturbed the safety of aquaculture, especially from theft, and 5% of respondents stated that marine cultivation had become an internal regulatory tool in securing the cultivation area and the surrounding environment cultivation. Meanwhile, another aspect stated by respondents was that marine cultivation had a positive impact on behavioral growth to preserve the environment, including seagrass ecosystems. In addition, marine aquaculture has caused many small fish to gather around the cultivation facilities and has caused many large fish of economic value to be located around the cultivation area. It can be explained that aquaculture can create habitat complexity to increase fish productivity and macro invertebrates [18]. Therefore, marine aquaculture can play a direct and indirect role in the sustainability of food availability or aquaculture as a trading system that has ecological value [19]. Other studies show that the impact of marine culture on the abundance and structure of demersal macro fauna (such as in Fitzgerald Bay) is that the average species abundance is higher in the area around the cultivation area [20]. Another aspect of the results of this study is that all respondents stated that the practice of marine cultivation has provided them with comfort, especially in overcoming the problem of the need for health costs and children's education costs. This proves that marine aquaculture acts as a household savings [21]. In addition, marine aquaculture has acted as a complementary livelihood solution [22].

4. Conclusion

Environmentally friendly aquaculture developed by small fishermen in the study location has contributed to prevent the rate of resource exploitation that can negatively impact ecosystems, especially seagrass ecosystems. In addition, environmentally friendly cultivation has relevance for local scale Imun protection. Other important aspects of environmentally friendly cultivation at the study site are: (1) small scale fishermen have alternative livelihoods, (2) increase the participation of fishermen and local communities in the protection of local scale seagrasses and (3) increase their awareness of the importance of togetherness values to create a sense safe and comfortable in people's social lives.

Acknowledgment

The authors thank the Directorate General of Research and Development Strengthening, the Directorate of Research and Community Service, Ministry of Research, Technology, and Higher Education in Indonesia for providing funds to carry out this research.

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