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Socio-Economic Assessment of Grouper Fishermen and Their Perceptions on Mariculture Development in Buleleng District, Bali, Indonesia

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Abstract

Various activities in the coastal area of Buleleng-Bali for many years affected to the sustainability of mariculture activities. This research aimed to 1) identify the problems of groupers farming in fish cages, 2) analyze the cost-benefit of grouper farming and 3) analyze fish farmer perceptions on mariculture development. Primary and secondary data were collected and analyzed by using descriptive, financial and Likert-type analyzes. The results show that the average production of grouper farming was 450 – 7500 kg per harvest. The main problems in groupers farming are related to uncertainty market demand in recent years, financial capital limitation, high price of fish feeding, and low productivity. Benefit-cost analysis revealed that the benefit-cost ratio is 1.92 (B/C ratio > 1) and the payback period (PP) is 2.3 years (project life assumption: 10 years) and the internal rate return (IRR) is 12%. It means that grouper farming is economically visible to develop in Buleleng District. Fish farmers as well as local stakeholders have positive perception and active participation in grouper farming using floating-fish cages. Fish farmers also needs special trainings related to disease management, seed selection, marketing, and good aquaculture practices. The main obstacles of price and capacity faced by farmers for using various sensors to reduce the risk of mass fish death and other climate change effects should be of special concern to local and central government to install a set of equipment to control and reduce the impact of environmental changes on all grouper floating cages.

Keywords: Mariculture; Socio economics; Groupers; Bali.

1. Introduction

Overfishing reduced the amount of fish catch. Thus, fishermen could not expect too much for capture fishing activity and started to shift to marine culture fisheries as alternative income sources (Zamroni and Yamao, 2014). The other issue was lack of awareness in the society as well as among policy makers on the potential of aquaculture for poverty alleviation and rural development. Although there are successful cases of aquaculture for poverty alleviation, the flow of information to stakeholders, decision makers, and fish farmers has not been carried out in appropriate ways. This has led to a rather poor perception among stakeholders and decision makers, resulting in weak supports for aquaculture developments from their side.

Mariculture is an important component of aquaculture production in Indonesia. In addition to sources of aquatic food production, mariculture has a great potential for the alleviation of poverty and the generation of wealth for the people living in coastal areas. Radiarta and Erlania mention that Pegametan Bay and Penerusan Bay in Buleleng Regency are the locations for the development of mariculture in Bali Province. The main commodities developed in these locations are grouper fish (tigers, rats, and several hybrid species), star pomfret and snapper.[7] In 2015, the total of production value of grouper in Bali was IDR. 18.895 millions, its around five hundred thousand rupiahs below the snapper (Marine and Fisheries Office of Bali Province (MFOBD), 2016). Many of the problems of mariculture are caused by its own expansion and also include competition with increased activity by other sectors and stakeholders. This could effectively be resolved through a comprehensive mariculture planning, zoning, and management information system that would facilitate the formulation of strategies and planning for mariculture development and would make existing mariculture systems sustainable. The Ministry for Marine Affairs and Fisheries of Indonesia (MMAF) has already developed a continuous water monitoring tool, namely, Buoy PLUTO, to measure water quality using temperature, salinity, pH, and dissolved oxygen (DO) sensors (Chandra et al., 2014). Unfortunately, the application of this system has recently been limited to inland water systems (reservoirs and lakes).

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Therefore, to monitor environmental changes, the technologies that can detect real-time environmental changes such as information and communication technology (ICT), should be developed.

Capacity building in decentralization is one of the ways to develop coastal communities that can participate in coastal management. Improved capacity can help coastal communities in tackling adverse socioeconomic pressures. Fishery and aquaculture management has shifted away from conventional production-based management to conservation and ecosystem-based management (Berkes *et al.,* 2001). Furthermore, fishery governance shifts a centralized system to market regulation, community-based management, and co-management. It was used to address the problems in centralized fishery management such as lack of participation and conflicts in coastal utilizations.

The impacts of climate change are generally seen in from the sea level rise and increasing sea surface temperature affected to stress on the coastal ecosystem. The drastic changes of environment and the declining of fisheries resources, the challenges on climate and its impacts to fisheries had been the serious problem in Buleleng water area. Indeed, there is no detailed study dealing with the impacts of climate variability and change to the strategy of marine resources management which may become necessary due to such impacts. On the other hand, the future challenge is the impact of climate change that needs to be addressed across societies and economies, involving private, public, and civil society agents that range from local and immediate action to long-term strategies. This climate change challenge is requires an ecosystem approach to fisheries and aquaculture.

On the basis of multidisciplinary activities in fisheries and aquaculture, an integrated approach to climate change impact, adaptation, and mitigation is necessary. This means the identification of current and potential challenges, particularly the most impactful, to improve the capacities of fish farmers and fishermen to respond to negative impacts of climate change and to profit from the opportunities that may emerge. In order to provide rapid and accurate data, it is also needed to improve the tools to collect the real time data for monitoring coastal and marine environments. Therefore, this research aimed to 1) identify the problems of grouper farming in floating cages, 2) analyze the cost-benefit of grouper farming and 3) analyze fish farmer perceptions on mariculture development.

2. Materials and Methods
2.1. Research Location
This research was conducted in November - December 2017 in Pegametan Bay, Buleleng District (Fig. 1).

Fig-1. Research Location in Buleleng District

2.2. Data Collection
The field survey was conducted during May – November 2017 through survey, observation, and discussions with local institutions, including the Fisheries Office of Buleleng District, Local Agency for Development Planning, Statistic Bureau and Research Institute. The collected data include fishery statistics (cultivation and capture), existing cultivation conditions, fishery problems, and socioeconomic conditions, and land use and problems. Primary data were obtained using a structured questionnaire with 35 grouper farmers, in-depth interview with key informants from group leaders, researchers, and the staff of fisheries office. Secondary data are traced using literature study techniques related to the socioeconomic development of fish farmers and its problems.

2.3. Perception Analysis
Perception is the process of finding information to be understood by using a Likert scale with a value of 1-5. Sugiyono (2006), mentioned that the Likert-type scale is a scale used to measure attitudes, opinions, and perceptions

of a person or group of people about social phenomena. High score means a high level of understanding and perception of the community on the related issues of fish farming in mariculture development.

2.4. Financial Analysis

Financial analysis is carried out to examine input and output components of business and how great the benefits of business using the following formula:

π = TR – TC.

Remarks:

π: benefit

TR : revenue

TC : total cost

If:

TR > TC: business is profitable

TR = TC: business is break even

TR < TC: business is loss

2.5. Net Present Value (NPV)

NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is used to analyze the profitability of a projected investment or project by using the following formula:

$$NPV = \sum_{t=1}^{n} = \frac{R_t}{(1 + i)^t}$$

Remarks:

Rt: the net cash flow at *t*

t: time of cash flow

i: discount factor

When:

NPV > 0: profitable investment.

NPV< 0: investment is loss

NPV= 0: investment is unprofitable but not loss

2.6. Internal Rate of Return (IRR)

IRR is the interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment is zero. IRR is calculated using following formula:

$$r = P_1 - C_1 \frac{P_2 - P_1}{C_2 - C_1}$$

Remarks:

r: IRR

P1: interest rate 1

P2: interest rate 2

C1: NPV-1

C2: NPV-2

If:

IRR >*rate of return*: investment approved

IRR = *rate of return*: investment approved

IRR <*rate of return*: investment refused

2.7. Benefit Cost Ratio (B/C Ratio)

B/C ratio is used to show the relationship between the costs and benefits of a proposed project.

B/C ratio = $\frac{Net\ income}{Total\ costs}$

If:

B/C ratio > 1: Business is profitable

B/C ratio = 1: Business is break even

B/C ratio < 1: Business is unprofitable but not loss

2.8. Payback Period (PP)

Payback period is the length of time required for an investment to recover its initial outlay in terms of profits or savings.

If:

PP < 3 years: quick return of investment.

PP 3-5 years: moderate return of investment.

PP > 5 years: slow return of investment.

3. Results and Discussion

3.1. Fishery Sector in Buleleng District

Buleleng District is located at 6^0 3' 00" - 8^0 23' 00" south latitude and 114^0 7' 28"- 115^0 27' 28" east longitude with an area of 1,365.88 km^2 and a coast length of ± 157.05 Km; thus, in a wide area of 4 mile radius, the area of sea waters of Buleleng District is 1,166.75 km^2, facing the Java Sea on fisheries management area of Indonesia (WPP RI) 713. Administratively, Buleleng District is divided into 9 sub districts, 7 of them are with coastal areas and 2 of them are not coastal areas, but there are lakes and rice fields. The rainy season is start from November to April while the dry season is from May to October. The climate conditions will directly or indirectly affect the development of fishery business in Buleleng District, especially since rainfall affects fishery production and cultivation and fishing business (Fisheries Office of Buleleng District (FOBD), 2016).

In 2016, the population of Buleleng District was recorded to be 650,100 with 323,800 men and 326,300 women. Population density in 2016 reached an average of 557.19 people per km^2. The number of residents who make a living as fishermen (sea and lake) is 5,768 or around 0.9% while that of residents who make a living as farmers (seaweed, fish cultivation in paddy fields, kola nut and cages) is 3,759 people or around 0.45%. Compared with the data in 2015, the number of fishermen is now 5,768 or increases by 13%, while the number of fish farmers is still 3,759 (Fisheries Office of Buleleng District (FOBD), 2016).

The fishery sector in Buleleng District is supported by fishing and aquaculture. The fishery production in Buleleng District in 2016 reached 19,949 tons, 16,509.6 tons of which came from the capture fishery. In the cultivation business, the grouper fish production was to 190.5 tons in 2016, thus, effort to increase production is still needed (Table 1).

Table-1. Fishery production of Buleleng District in 2016

No	Type of Business	Total (tons)
I	Catching	16,509.60
	Capture fishery	16,383.70
	Inland fishery	125.9
	- Lake	125.9
	- River	-
II	Aquaculture	3,439.40
	Sea cultivation	855.8
	- Grouper	190.5
	- Snapper	652.6
	- Seaweed	7.2
	- Pearl (Shell)	5.5
	Brackish water aquaculture	2,468.50
	- Fishpond	2,468.50
	Fresh water aquaculture	115.2
	- Pond	68.2
	- Floating Cage	47
	TOTAL	19,949.00

Source: *Fisheries office of Buleleng District, 2016*

The improvement of the fishery sector cannot be separated from the effort to improve the quality and quantity of human resources. The human resource in fisheries in Buleleng District includes fishermen in several categories, namely, fulltime fishermen, main part-time fishermen, and additional part-time fishermen. In 2016, the number of fishermen in Buleleng District was 5,465 and 3,756 people, were fulltime fishermen (Table 2).

Table-2. Number of fishermen in Buleleng District, 2016

No.	Subdistrict	Fishermen Category		
		Full-time Fishermen	Part-time Fishermen	Total
1	Gerokgak	860	411	1.271
2	Seririt	342	242	584
3	Busungbiu	-	-	-
4	Banjar	105	208	313
5	Sukasada	-	-	-
6	Buleleng	125	149	274
7	Sawan	348	164	512
8	Kubutambahan	800	140	940
9	Tejakula	1.176	395	1.571
Total		3.756	1.428	5.465

Source: *Fisheries office of Buleleng District*, 2016

According to Fisheries Office of Buleleng District (FOBD) (2016), the number of floating net cages cultivation business groups in Gerokgak Subdistrict is 7 with 145 members. Grouper farming in Gerokgak Sub-district produced grouper fish seeds from Gerokgak Subdistrict in 2016 up to 8,889,500 fish. The potential area of cages for grouper cultivation in Buleleng District is 450 Ha, while the utilization is only 30.5 Ha (6.78%).

3.2. Characteristics of Respondents

The characteristics of respondents are seen from several indicators, consist of; age, education, and number of family members. Interviews were conducted with 35 respondents who acted as fish cage owners and workers. Respondents reside in Buleleng District, the center of fish cage business cultivation in Bali Province. The majority of respondents are living in Gerokgak Subdistrict, and spread in various villages, including Sumberkima, Banyupoh, Pejatahan, Pamentaran, and Pejarakan. Their education level is still relatively low, dominated by junior high school graduates at 36.36%, high school graduates at 30.3%, and elementary school graduates at around 27.27%, and the rest are college graduates. This is because working in the fishery sector does not require a high level of education. Those with high educational background are managers.

Respondents come from various ages in the productive age range. Most respondents were in the age range <30 years old at around 42.42 % and >30 years old at 57.58 %. The youngest respondents were 17 years old and the oldest were 60 years old (Table 3).

Table-3. Characteristics of respondents

Age	Category	Total
	<30 (%)	42.42.00
	>30 (%)	57.58.00
	Youngest (yr)	17
	Oldest (yr)	60
	Average (yr)	34
Sex (%)	Male	91.43
	Female	8.57
Type of fishery business	Capture fishery	2.86
	Cultured fishery	82.86
	Marketing	2.86
	Others	11.43

Source: Primary Data Processed, 2017

Most of the respondents were male, or around 91.43 % since the work in the cultivation sector requires a lot of strength; hence, it is more suitable for male workers. Female workers in the fish cage are tasked with providing food for all workers and helping in a small part of the work field that does not require much strenght. The type of work carried out by most respondents in the aquaculture sector is 82.86%. Other types of work carried out by respondents are capturing fish, selling fish, and so forth. However, the work in the cultivation sector is the main source of income for respondents.

3.3. Mariculture and its Problems

According to Nurdjana, the fishery sector has an important and strategic role in its contribution to the gross domestic product (GDP) since it can increase job opportunities and improve the standard of living of businessmen (Nurdjana, 2006). Fish demand continues to increase year by year as a consequence of population growth and quality of life accompanied by changes in people's consumption patterns. Improving the quality of life causes people to consume foods that are healthier and more nutritious with high cholesterol and protein content. One source of fish production comes from aquaculture, which can be an alternative in anticipating the increasing demand for fish. Indonesia has a great potential in developing marine aquaculture, which can be optimally utilized. An important commodity from marine culture is grouper (*Serranidae* family). Grouper is a fish with high economic value because it is in great demand by the community.

One of the locations of floating net cage in Buleleng is in Pegametan Bay. The floating net cage is use to cultivate a groupers as majority and other fish such as baramundi and pomfret fish. According to Radiarta & Erlania, the number of the floating net cage was sharply increased during 2003 – 2014, but since end of 2014 the number of floating net cage slowly decreased (Radiarta and Erlania, 2015). In 2013, the number of floating net cage were 13 location points, and there was a significant increase in 2011 spread across 34 locations. In 2013, the expansion of the location of mariculture has led to an increase in the number of floating net cage locations to 54 points. A decrease in the number of floating net cage may also be caused by internal and external factors in the region (Radiarta *et al.*, 2014).

The method utilized in the cultivation business in Buleleng District was use floating cage system. The majority of farmers in Buleleng District still have little or only 2-8 years business experience. The community favors the method that has been carried out thus far because it is easy to run. Landings or sales of fish from aquaculture are obtained from several locations, namely, through collectors in Sumberkima, Sendang, Bangsal and Loba via shippings to Hong Kong. The majority of respondents are workers in grouper fish farming in cages. The sizes of the commonly used cage are 3x3 and 3x6 m^2. In carrying out its business, each of the coaches has a boat to operate. The

boat used varies in size, for example 5 x 2 x 1.5, 5 x 1.5 x 1, 8 x 1x 0.7, 4 x 2 x 1, 7 x 0.5 x 0.5, 8 x 3 x 1, and 6 x 0.6 x 0.7 m^3 (Fisheries Office of Buleleng District (FOBD), 2016).

The average fish farmers harvest fish in the range of 7-8 months, whereas some harvest in 270 and 360. When harvesting, sorting is done on the basis of similarity in size and weight of the fish. In running fish cage business, cage owners are assisted by 2 – 8 workers and 1 manager. However, this varies with each cage owner. The payment system is carried out per month with a bonus added at the time of sale. Bonus calculation is based on sales per kilogram starting from IDR1,000,- to IDR2,500,- per kilogram. However, there are also farmers who provide wages from the sale of fish to employees as much as 2%.

The types of fish cultivated are grouper (tiger, red, hybrid *cantang* or *epinephelus sp*, and hybrid *cantik* or *epinephelus microdon*, snapper, and pomfret). A total of 26 respondents focus on grouper cultivation business. The average production per cage box is between 50 and 250 kg and the total production per harvest is 450-7500 kg. The average respondents experience an increase in production compared with that in the previous year by using good quality seeds. They also experienced such an increase after the repaired their net that was broken in the previous year.

Some respondents experienced an increase in income (25%) and some experienced a decline (75%), which was due to the opening of tourism around fish cage that affected fish production. From interviews with fish cage owner respondents, on average, they get additional daily income of IDR 50,000 to IDR 160,000 outside the harvest season, from selling fish to residents. The average monthly income of respondents (worker) from the fishery sector is mostly in the range of IDR 1,000,000 to IDR 1,500,000.00, and a small number of respondents earn more than IDR 1,500,000.00.

The operational costs incurred by farmers include the purchase of small fish and fuel. On average, farmers use fish feed of up to 20 kg of small fish with a price of IDR6,000 per kilogram, and 2 of fuel for IDR 5,550 daily. The travel time from the coastline to the fish cage location is 5 to 40 min depending on the distance and location of floating net cage. The cultivation location since the start of business remains the same and has not changed. The equipment used is also the same.

3.4 Financial Analysis of Fish Cage Aquaculture

3.4.1. Investment

The investment used to conduct grouper cultivation business is used as follows: 1) in one year, one cycle is carried out every 7 months. 2) The survival rate (SR) is assumed to be 60%. 3) The distribution of seeds in the cage of 15 cm size with a weight of 30 g and the assumption that the seed price is IDR11,000/head are examined. 4) Harvesting is carried out when the raising time reaches 7 months (one cycle) and the average fish weight reaches 6 oz. In general, investment is used for making cages and guardhouses. The construction of a guardhouse requires an average cost of 60 million Rupiahs and the construction of one cage hole needs around 6-7 million Rupiahs. Investment is spent to buy wooden boards, buoys (styrofoam), nails, bolts, ropes, anchors, nets, and motorboats as means of transportation, spray machines, and working equipment. Financial analysis is taken from owner who have 60 units of cages or industrial scale. This is due to the industrial scale is more stable in annual production compared to small-scale farmers.

Table-4. Investment and cost of groupers farming (60 plots)

No	Description	Total Value (IDR)
1	Investment	728,290,000
2	Fixed costs	211,658,000
3	Variable costs	493,350,000
4	Revenue	1.019.520.000

Floating net cages with a 3 m^3 per unit are used. The net mesh is one inch with a net price of around IDR 2,000,000/unit. In addition to Floating net cages and nets, a guardhouse is required as a place for the owner, both temporary and permanent, which can also be used to store fish food. The amount of business investment required to conduct Floating net cages cultivation business is IDR728,290,000 (Table 4).

3.4.2. Operational Costs

Groupers are the main commodity of fish kept in cultivation. The seed size for the enlargement of groupers is 11 inch (300 g) and the price is around IDR11,000 per kilogram. Situbondo research institute usually supplies fish seeds. The types of feed used are pellets and small fish. According to the respondent, small fish can be raised the fish faster, a higher number of small fish is required than pellets. There was an increase in the price of small fish, which in 2012 was around IDR3,000/kg but became IDR5,000/kg in 2017. The pellets used are usually of *Megami* and *Matahari Sakti* brands. The structure of the operating costs of the cage cultivation business is still dominated by the need for seeds that amount to 54% while the feed reaches 35%. The amount of feed given during the fish rearing period affects the number of fish that are successfully harvested. The greater amount of feed is given, while the greater weight of fish that can be harvested. The high price of feed causes farmers to try to find a solution by possibly holding independent feed. With an independent feed production is around IDR14,000/kg. Meaning that, it is expected that the food expenditure can be minimized, and then profit may increase.

The intensity of cultivation in the majority of respondents has decreased owing to limited capital. High feed price and low productivity are the reasons for some farmers to reduce the intensity of their business. The floating net cage ponds are not filled optimally or many floating net cage plots are left empty, and only a small amount of feed is given. A grouper with a size of 30 g can grow to reach a consumption size of 500-600 g within 7 months. The average number of seeds required in the span of 7 months is 400 seeds/hole. It takes 50 kg of pellet feed and 300 kg of small fish per hole. Fixed costs are spent for employee salaries.

3.4.3. Production and Revenue

The average fish production in 7 months is 8 tons, with 70% of which sold abroad and the rest circulated domestically. Sugiyono (2006), explained that small-scale businesses generate adequate profits and that investment is profitable. The price of groupers abroad can reach IDR130,000 per kg, while it is IDR 90,000/kg in domestic market. Grouper marketed abroad are usually shipped to Hong Kong. As for the sales system, farmers usually contact buyers from Hong Kong who take the groupers directly from them and the pay them directly on the spot. Moreover, Indonesian grouper export rivals are from Vietnam; hence, strategic measures such as Indonesia good aquaculture practice (IGAP) are strictly apply to improve the competitiveness of Indonesian groupers and make their selling value higher. According to the financial analysis, the owner of 60 units floating cage net can get revenue about IDR 1 billion.

3.4.4. Cash Flow Analysis

Fish cage cultivation business activities in Gerokgak Subdistrict, Buleleng District can also be observe on financial and economic cash flow analysis. The assumptions underlying the analysis of costs and benefits of the calculation the following (1) project period of 10 years, (2) 7 months of work in one year, and (3) annual interest rate of 12% and predicted annual inflation of 3.79%. The financial feasibility is calculated using an NPV of IDR 670,059,813. NPV reflects investment in fish cage cultivation business activities, which will provide benefits equal to NPV. IRR is the maximum interest rate that can be paid by fishing business activities for the investment resources used. In Table 4, IRR shows a value greater than the 12% interest rate. This shows that the fish cage cultivation business will provide an average annual income of the invested capital of around 22%. The B/C ratio obtained at 1.92 indicates that every present's expenditure of IDR 1.00 provides revenue of IDR 1.92 with a payback period of 2.3 years (Annex 1).

Cultivation problems experienced by farmers are overseas marketing with uncertain prices, fluctuating demand, and the intensified influences from Vietnam and China in developing cultivation. This is because the main market share of grouper cultivation is the Hong Kong market. With the cultivation development in China and Vietnam, they only require 5 d of export delivery, in contrast to Indonesia's export shipments that take up to 10 d. This is the reason why Indonesian export products, especially groupers, become less competitive than Vietnamese and Chinese export products.

3.5. Perception to Fish Aquaculture Practice

Community perception assessment uses a Likert scale based on the questions asked. Each question has 3 choices, namely: agree (3), neutral (2), disagree (1). The questions raised to the community regarding the development of aquaculture consist of four aspects, namely, aquaculture, harvesting and postharvest activities, marketing, and aquaculture activities associated with coastal management. After scoring the respondents' answers, each question is assessed to put into one of the three categories available using a scale range, namely: agree (81,8-105), neutral (58,4-81,7), and disagree (35-58,3).

Cinner et al. (2010) stated that 'people who live in coastal communities have multiple levels of knowledge about the marine activities that evolved there'. The calculation results of community perceptions on aquaculture activities, the community stated their agreement on several activities including that cultivation provided benefits compared with capture fisheries. The interview results with the respondents indicated that business activities in capture fisheries are more expensive than cultivation. In addition, the selling price of cultivated fish is more stable than that of fish caught by fishermen, which tends to fluctuate. The production process in the cultivation business run by the cultivator uses a method that is believed to still provide benefits to increase production. In addition, farmers also use production inputs in the form of seeds that are ready to be shown. The seeds are obtained from seed cultivators living around the cultivation site, shortening the trip/transportation time and guarantees good seed or high quality. Rochet et al. (2008) emphasized that 'fishermen's perceptions have great potential to serve as early warning signals of recent changes in the environment'. The majority of respondents also stated that environmental conditions are still suitable for cultivation as the location is in the bay that is far from high waves. However, in some variables, the respondent express disagreement under the cage condition. The respondents stated that cage at the study location did not experience stocking density as most cultivators already understand the correct method of cultivation so that the amount of solid seed stock is adjusted to the pond area in the cage. The respondents also expressed their disagreement if a review was made about the cage location. This is because the current cage location is considered appropriate with its good water conditions for fish growth.

In general, respondent perception to mariculture activities in Buleleng District is good. According to them, monsoon seasonal changes have a negative impact on yields. This is a serious problem against grouper aquaculture in Buleleng. In term of environmental control, almost all respondent argued that a set of water environment monitoring, particularly for water temperature, current, turbidity, and diseases is very important to manage grouper farming on floating cage. Currently, the grouper farmers are mostly using only a sensor for water temperature. There

are several main reasons for farmers not to use various sensors to measure the water environment, namely; 1) the price of these tools is expensive for farmers, 2) the ability to operate, read and analyze sensor data has not been mastered. However, the need for various sensors is very important for tides in these waters to reduce the risk of mass fish death. The respondents expect the local government to provide these sensors to be installed in these waters area. This is to reduce the impact of environmental changes on all grouper floating cages. However, the most important problem is how to change the mind set of grouper farmers to use sensors to monitor water environment quality in grouper farming business.

The respondent perception on aspects of harvest and postharvest in cultivation with cage is good. There are several factors that must be considered in this aspect. Respondents sort out fish before they are sold. This is what causes them not to always harvest fish on time or at three months of age. Perez-Sanches and Muir (2003) explain that production scarcity affects the way by which people adopt alternative opportunities. Respondents often make sales based on consumer demand asking for a certain size. In the rainy season, farmers claim to have experienced a decline in profit owing to the decreasing quality. However, there were also respondents who stated that the rainy season did not affect the decline in profit or quality. Badjeck *et al.* (2010) predicted that 'climate change will bring new challenges to fisheries in the coming decades', and the local communities should promptly adapt to this situation. Ju *et al.* (2010) argued that the prices serve as the high and low boundaries for the asking and bidding prices of middlemen when the capacity cost is sufficiently high. Respondents know the prevailing fish market prices and keep sorting fish so that only high quality fish are sold to keep the profit during the rainy season. Gaillard *et al.* (2009) explained that the concept of sustainability implies that basic requirements are met on a quotidian basis. Respondents stated the need for postharvest technology because the cultivated fish are more intended for export so that the presence of postharvest technology can keep the quality of the fish until the fish reach the hands of consumers.

The respondent perception on the currently applicable mariculture fish marketing system is still favored by farmers. The system is deemed not to be evaluated because it is in accordance with what most farmers want. Through the current system, farmers have the power to bid to meet the desired fish selling price by the cultivator. Respondents said that they currently have a balanced bargaining position with fish buyers because they do not have ties in any form as experienced by fishermen or capture fishery businessmen. Most farmers stated that they did not agree to add market players since would result to the unstable fish market price. Cultivators prefer the currently stable price. In connection with marketing through cooperatives, most farmers expressed their disapproval if cooperatives were formed to market fish. Some respondents argue that with the existence of cooperatives, a longer distribution chain is required to sell the fish, which is feared to raise the fish selling price and eventually lead to the decline in sales. Thus, farmers have been selling directly to consumers and exporters. However, some respondents also stated that there is a need for fishery cooperatives so that farmers do not need to find harvest-ready fish buyers.

According to respondent perception on the impact of mariculture to coastal management, fish cultivation activities in floating net cage are close-related to the management of coastal ecosystems. This is a concern because the presence of mariculture in the sea is feared to affect the sustainability of the coastal ecosystem; hence, the assessment of community perceptions is considered important. The majority of respondents agreed that the cultivation of cage would not damage the ecosystems in the coast such as coral reefs, mangroves, seaweedbeds, and so forth because the cultivation business run by the cultivator uses an environmentally friendly system. Feeds are used in accordance with the need to reduce the amount of fish feed residue. Fish farming activities also do not cause conflict with fishermen because they already have their own fishing areas. With cage cultivation, cultivators feel that they participate in the protection of the aquatic ecosystem since the sustainability of the cultivation business requires good water quality for fish to grow. Factors that should be considered with the cultivation business include the seemingly increasing amount of waste on the beach.

The respondent perception on the role of Buleleng fisheries office and Institute for Marine Research and Fisheries Extention (IMRAFE) on developing aquaculture business in Buleleng District is good. The participation is expected by the farmers is assistance during infection of fish with an unidentified disease. Other stakeholders who play a role in the cultivation business development are collectors, who have an important role in marketing cultivation products so that harvests can be sold to consumers and importers. Most of the farmers still rely on the role of collectors in marketing postharvest results.

As for the results of fish cultivation, most of the respondents stated that a large amount of harvested fish was sold, while some respondents stated that some of the harvested fish were sold and some were consumed or given to friends and families. The harvesting process for cultivation results could not be carried out simultaneously. Only fish with certain age and size were considered for selling. The payment system applied by the owner to the worker does not adhere to a percentage system of results, but with a payroll and bonus system. Workers earn salary that starts from IDR1,100,000 and bonuses from sales of IDR1,000 to IDR 2,500 per kilogram. In aquaculture activities, the majority of farmers earn income from cultivation activities and also other side jobs. Family involvement in cultivation is carried out by the head of the family who have cage cultivation business. The child and wife focus on education and taking care of the household.

Fish farmers in Buleleng District require trainings on cultivation business. The topic of concern is obtaining knowledge on how to maintain fish health and how to produce high quality and standard seeds. Thus, the obstacles faced by cultivators are unidentified diseases. There is a small number of business experience results in the higher need of business owners to know the factors that can support their business development. Most farmers in Buleleng District have run their businesses for less than 10 years, while there are also businessmen who have 17 years of experience.

In running their business, cultivators use a certain technology to develop their businesses, ranging from seed selection, size of floating net cage, stocking density, water management, feeding, and disease control to increase productivity. However, the use of such a technology is self-taught and based on the experience of fellow cultivators. Thus, the constraints faced by farmers are very diverse with various resolutions. From the constraints faced by grouper farmers, the type of training required by farmers is determined to be that on pest and disease control, technical enlargement in fish cage according to standards, good cultivation methods, seed selection training, marketing training, and water monitoring system.

5. Conclusions

According to the describtion and discussion above, there are several main problems in grouper farming. The current problems are related to the uncertainty of market demand in recent years, the limitation of financial capital, the high price of fish feeding, and the low productivity.

However, grouper aquaculture can still be developed in the future. This is due to financial analysis for one unit of fish cage, which NPV is more than 0, an IRR of more than the standard value, a B/C Ratio of more than 1, and PP is less than 3 years. The average production of grouper farming was 450-7500 kg per harvest.

The respondents have positive perception and active participation in mariculture development using floating cages for grouper. However, fish farmers require several trainings related to disease management, seed selection, marketing, and good aquaculture practices. The monitoring of socioeconomics data that include business activity, marketing, and livelihood should urgently be carried out for sustainable business activity, finance, and household economy. The main obstacles of price and capacity faced by farmers for using various tools to reduce the risk of mass fish death and other climate change effects should be of special concern to local and central government to install a set of equipment to control and reduce the impact of environmental changes on all grouper floating cages. Good water monitoring system can also avoid product losses, improve productivity, and improve household economy.

Acknowledgments

References

Badjeck, M. C., Allison, E. H., Halls, A. S. and Dulvy, N. K. (2010). Impacts of climate variability and change on fishery based livelihoods. *Marine Policy,* 34(3): 375-83. Available: https://doi.org/10.1016/j.marpol.2009.08.007

Berkes, F. R., Mahon, P., McConney, R., Pollnac and Pomeroy, R. (2001). *Managing Small-Scale Fisheries: Alternative direction and methods.* (International development Research Center (IDRC): Canada. 309. https://www.idrc.ca/en/book/managing-small-scale-fisheries-alternative-directions-and-methods

Chandra, H., Sianturi, D. S. A. and Firdaus, Y. (2014). Performance examination of PLUTO Buoy for early warning water pollution (in Indonesian). *Jurnal Kelautan Nasional,* 9(3): 153-62. Available: http://ejournal-balitbang.kkp.go.id/index.php/jkn/article/view/6212

Cinner, J. E., McClanahan, T. R. and Wamukota, A. (2010). Differences in livelihoods, socioeconomic characteristics, and knowledge about the sea between fishers and non-fishers living near and far from marine parks on the Kenyan coast. *Marine Policy,* 34(1): 22-28.

Fisheries Office of Buleleng District (FOBD) (2016). Statistical data of marine and fisheries of buleleng district. Annual report of FOBD. Buleleng district. Unpublished. (translated).

Gaillard, J. C., Maceda, E. A., Stasiak, E. L. B., I. and Espaldon, M. V. O. (2009). Sustainable Livelihoods and people's vulnerability in the face of coastal hazards. *Journal of Coastal Conservation,* 13(2-3): 119-29. Available: www.jstor.org/stable/25622751

Ju, J., Linn, S. C. and Zhu, Z. (2010). Middlemen and oligopolistic market makers. *Journal of Economics and Management Strategy,* 19(1): 1-23. Available: https://doi.org/10.1111/j.1530-9134.2009.00243.x

Marine and Fisheries Office of Bali Province (MFOBD) (2016). Statistical data of marine and fisheries of bali province. Annual report of mfobd. Bali province (translated).

Nurdjana, M. L., 2006. "Indonesian aquaculture development." In *Delivered on RCA International Workshop on Innovative Technologies for Eco-Friendly Fish Farm Management and Production of Safe Aquaculture Foods, Bali.*

Perez-Sanches, E. and Muir, J. F. (2003). Fishermen perception on the resources management and aquaculture development in the Mecoacan estuary. *Tabasco, Mexico: Ocean and Coastal Management,* 46(6-7): 681-700. Available: https://pmpc.hevra.haifa.ac.il/images/Reasearch_Projects/SPAMA/Perez-Schancez__Muir_2003.pdf

Radiarta, I. N. and Erlania, 2015. "Mapping of floating cage of marine fish in pegametan bay and penerusan bay – buleleng district, Bali." In *Proceeding of Aquaculture Technology Inovation Forum, 2015.* pp. 675 –82.

Radiarta, I. N., Erlania, K., Sugama, H., Yudha, T. and Wada, M. (2014). Frequent monitoring of water temperature in Pegametan Bay, Bali: a preliminary assessment towards management of marine aquaculture development. *Indonesian Aquaculture Journal,* 9(2): 185-93. Available: http://dx.doi.org/10.15578/iaj.9.2.2014.177-185

Rochet, M. J., Prigent, M., Bertrand, J. A., Carpentier, A., Coppin, F., Delpech, J. P., Fontenelle, G., Foucher, E., Mahe, K., Rostiaux, E. and Trenkel, V. M. (2008). Ecosystem trends: evidence for agreement between fishers' perception and scientific information. *ICES Journal of Marine Science* 65(6): 1057-68. Available: https://doi.org/10.1093/icesjms/fsn062

Sugiyono (2006). *Research method of quatitative, qualitative, and research and development.* CV. Alfabeta, 2006, Bandung.

Zamroni, A. and Yamao, M. (2014). *Livelihood strategy in coastal villages in indonesia: Case study on seaweed farming in laikang bay, south sulawesi province. In mohamed b, kirit s, and kiyotada h (eds). Vulnerability of fisheries, agriculture, and water to climate change: Toward sustainable adaptation strategies.* Springer. 289-300.

Annex-1. Cash flow analysis of one unit groupers farming in Gerokgak Subdistrict, Buleleng District

Year	Discount factor (Df) 12%	Cost (*Outflow*)		Benefit (*Inflow*)		M-B (*Net cash flow*)	
		Value	PV	Value	PV	Value	PV
0	1	728,290,000	728,290,000	0	0	-728,290,000	-728,290,000
1	0.89285714	705,008,000	705,008,000	1,019,520,000	1,019,520,000	314,512,000	314,512,000
2	0.79719388	747,406,730	747,406,730	1,096,799,616	1,096,799,616	349,392,886	349,392,886
3	0.71178025	768,606,095	768,606,095	1,135,439,424	1,135,439,424	366,833,329	366,833,329
4	0.63551808	789,805,460	789,805,460	1,174,079,232	1,174,079,232	384,273,772	384,273,772
5	0.56742686	1,677,305,780	1,677,305,780	1,212,719,040	1,212,719,040	-464,586,740	-464,586,740
6	0.50663112	832,204,190	832,204,190	1,251,358,848	1,251,358,848	419,154,658	419,154,658
7	0.45234922	853,403,555	853,403,555	1,289,998,656	1,289,998,656	436,595,101	436,595,101
8	0.40388323	874,602,920	874,602,920	1,328,638,464	1,328,638,464	454,035,544	454,035,544
9	0.36061002	895,802,285	895,802,285	1,367,278,272	1,367,278,272	471,475,987	471,475,987
10	0.32197324	1,921,313,560	1,921,313,560	1,405,918,080	1,405,918,080	-515,395,480	-515,395,480
Total		10,793,748,575		12,281,749,632		1,488,001,057	
		NPV	670,059,813		IRR	22%	
		Net B/C	1.92		Payback Period	2.30	

Remark: Project life - 10 years