Study of Grouper Cultivation Integrated with Salt Production in Crystallization House

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Abstract-This research was conducted to determine the effectiveness of integrated innovations of salt production and grouper cultivation in crystallization houses on the quality and quantity of grouper fish cultivated in the coastal area of Lekok District, Pasuruan Regency. Grouper cultivation is carried out in a 3×2×1 meter pond using the cyclic aquades system (CAS). The CAS system in innovation is supported by a filter composed of natural ingredients that are easy to obtain to filter pond water as a cultivation medium. CAS system aims to filter impurities in the water so that the water quality in the pond is maintained to support the life of groupers. In 12 months, grouper fish are harvested twice, averaging 120 kg. From the Cost Benefit Analysis, the ROI (Return on Investment) is about 100.76%, and the payback period is about six months. The results of the Cost-Benefit Environment Analysis show that grouper cultivation with this innovation is environmentally friendly because the CAS system supports it. Thus, grouper cultivation using this innovation is feasible to continue to increase the income of coastal communities in Lekok District, Pasuruan Regency.
Keywords: Grouper Cultivation, Cyclic Aquades System, Sea Water Filtration, Integrated Innovation

1. Introduction

The poverty rate in the coastal area of Pasuruan Regency is the highest compared to the poverty rate outside the coastal area. Based on BPS (Badan Pusat Statistik) data for Pasuruan Regency, in 2019, there were 141,000 people in Pasuruan Regency, or 8.68% living in poverty. The number of poverties in coastal areas is evidence that managing marine resources is not optimal. If appropriately managed, marine resources have enormous potential and can have high economic value. Poverty is influenced by many factors, including natural, structural, and cultural factors [1]. Natural factors are natural conditions at sea that are very unpredictable such as high waves, strong winds, and storms. Structural problems of coastal communities include weak capitalization, being trapped by intermediaries and loan sharks, and technology limitations [2]. The cultural factor is that coastal communities often hold rituals at great expense.

Development of coastal areas, such as the procurement of beach tourism, management of mangrove forests, and cultivating with a pond system, affect the welfare of coastal communities [3]. Pond cultivation is carried out in an artificial pond. Ponds are usually associated directly with raising shrimp, milkfish, tilapia, grouper, barramundi, and so on. However, along with the knowledge and technology development, fish farming can be integrated with other activities. Integration of tilapia cultivation and aquaponics for growing vegetables was done by utilizing the house yard to overcome limited land and water resources in Sayang Village, Jatinangor [4]. Catfish and silkworm farming have also been successfully integrated using a bio floc system to optimize catfish farming waste as silkworm feed [5]. Even research on integrating multi-tropical fish farming with clam, shrimp, and seaweed cultivation on the north coast of Karawang shows high productivity and good environmental stability [6]. Similar integration was also carried out in research [7], [8], [9], [10], [11].

Meanwhile, intercropping comprises integrated activities between fish farming and planting, maintenance, management, and preservation of mangrove forests [3]. The pattern of the intercropping approach is mainly carried out in coastal areas with mangrove forests. [12]researched tiger grouper (*Epinephelus fuscoguttatus*) intercropping cultivation in mangrove areas. In comparison, [13] developed intercropping in the coastal area of Arakan Village, Tatapaan District, South Minahasa Regency. However, these activities are only sometimes successful in some coastal areas because the local potentials are different.

According to [14] and [15], apart from being based on local potential, the development and management of coastal areas must align with the coastal communities' actual conditions. The strategy needed in the management of coastal areas is community-based management. Based on identification in coastal areas in Indonesia, including in the District of Lekok, grouper fish farming is a potential business. Fish farming in Lekok District uses a pond system, requiring extensive land areas and intense maintenance. Fish ponds must be cleaned frequently because of accumulated fish dung, food residue, and dirt from the surrounding environment. Fish farmers in Lekok District generally only manage their ponds and cannot do odd jobs.

As the condition of the pond area in Lekok District continues to decrease, there is a high need for salt and a lot of fish farming; therefore, in this study, an assessment was carried out on the intercropping model of grouper cultivation with salt production in crystallization houses.

2. Materials and Methods

Experimental site

The research location was in the coastal area of Lekok District, Pasuruan Regency. During the dry season, the people in the coastal area of Lekok District carry out salt production traditionally. However, during the rainy season, people can only farm as a livelihood due to weather constraints.

The research was conducted from May 2022 to December 2022 by creating a cultivation innovation model with an intercropping system for salt production. Model grouper pond measuring 6 m^2. The water in the pond is made from a mixture of bittern, coarse salt and groundwater.

Experimental design

Figure 1 Experimental design of grouper cultivation

The fish farming water included in the pond is artificial seawater made from a mixture of bittern, coarse salt, and groundwater. Furthermore, the water in the pond for fish cultivation media will be processed according to the cyclic aquades system (CAS) to maintain water quality. Filtration aims to filter out impurities to protect fish from the danger of poisoning. The filter consists of (1) coconut and palm fibre as an anti-bacterial purifier. (2) coconut shell charcoal to remove taste and odour in water, (3) coral fragments to reduce impurities and metal content, (4) small river stone to reduce Ca and Mg content, and (5) sponge as a filter with a minor cavity that functions to filter out particles that pass from the previous layer.

Sampling

Water parameter data used as a fish culture medium was collected from the first time it was filled, and after three months, it was filled with fish. The salinity, temperature, pH, and water cleanliness (TDS) tests were carried out to see the effectiveness of CAS on pool water quality. Furthermore, the growth of cultivated fish is also monitored for the first three months. The parameters observed from the fish were weight and absolute weight growth every week for three months. In addition, fish density is also considered to be within the maximum limit, so that fish growth is not disturbed.

Data analysis

Data analysis was done using quantitative and qualitative data from research. Qualitative methods are carried out to measure the quality of water in ponds, including temperature, salinity, pH, dissolved oxygen, and impurities. The quantitative method is carried out to measure the quantity of grouper fish cultivated to increase income. Measurement of the feasibility of fish farming with a model is carried out using the method of cost-benefit analysis and cost-benefit environment analysis.

3. Results

The ground water content in Lekok District needs to be measured to consider the percentage of the most suitable mixture for pond water as a medium for grouper cultivation. Groundwater parameters taken from the nearest source from the research location, which is usually used, are presented in the following table.

Table 1 Parameters of the ground water

No	Parameter	Unit	Optimum Value	Observation Value
1.	Temperature	^{0}C	27-30	27,5
2.	Salinity	PPT	0-5	0,645
3.	PH	-	6,5-9	8,21
4.	TDS	m/L	<1000	612

Groundwater parameter values at the study site are within normal limits and are safe to use as a mixture for artificial seawater. The manufacture of artificial seawater has been carried out in several trials, described in the following table.

No	Parameter	Unit	Ground water	Bittern	Observation 1 Value	Observation 2 Value	Observation 3 Value
1.	Temperature	^{0}C	27,5	27,3	27,2	27,5	27,6
2.	Salinity	PPT	0,645	149	15,6	17,1	19,8
3.	PH	-	8,21	6,77	8,17	8,03	7,71
4.	TDS	m/L	0,612	38,6	10,24	13,45	17,1

Table 2 Parameters of the seawater

Experiment 1: 100 litres of ground water, 1 litre of bittern, and 1 kg of gross/coarse salt

Experiment 2: 100 litres of ground water, 1.5 litres of bittern, and 1 kg of gross/coarse salt

Experiment 3: 125 litres of ground water, 2 litres of bittern, and 1 kg of gross/coarse salt

Of the three experiments, the best composition is in experiment 3. In experiments 1 and 2, the pH value of the water is still above 8, so it still needs to meet the optimal pH value that has been determined. While the other parameters are already within safe limits, the water salinity, in this case, will be considered satisfactory because this artificial seawater will go through a filter process expected to increase water salinity and meet the optimal value of 30 ppt.

Parameters measured for fish farming water based on Government Regulation Number 82 of 2001

(Class II) include temperature, salinity, pH, dissolved oxygen content, nitrate content, phosphate content, Electrical Conductivity and Water Cleanliness presented in the following table:

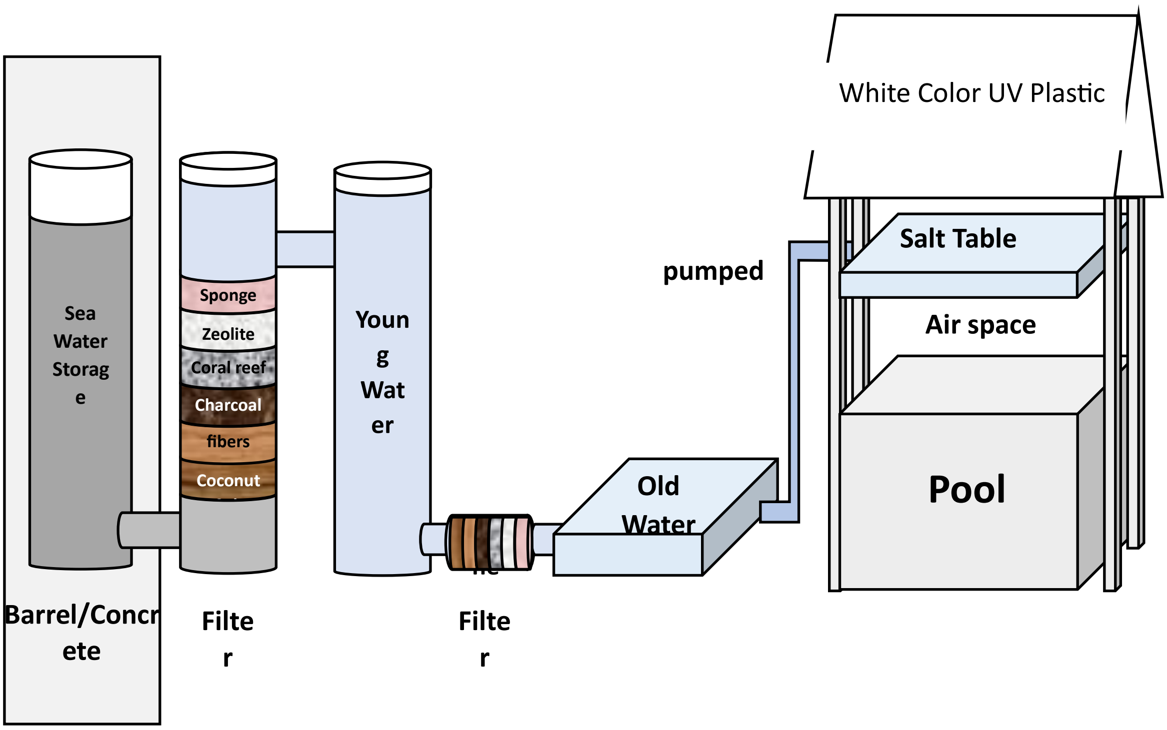

Table 3 Parameter of water in the pool

Parameter	Standard Value (PP No. 82 2001)	Parameter value of the water in the pool when filling (	Parameter value of the water in the pond, after three months filled with fish	Parameter value of the water in the pond, after six months filled with fish
Dissolved oxygen (ppm)	> 4 mg/L	4,9	5,2	4,7
Nitrate	≤ 0,2 mg/L	0,16	0,16	0,24
Ammonia	≤ 0,2 mg/L	0,11	0,11	0,25
Phosphate	≤ 0,2 mg/L	0,07	0,06	0,08
TDS	≤ 1000 mg/L	$22,9x10^{-9}$	$17,6 x10^{-9}$	$19 x10^{-9}$

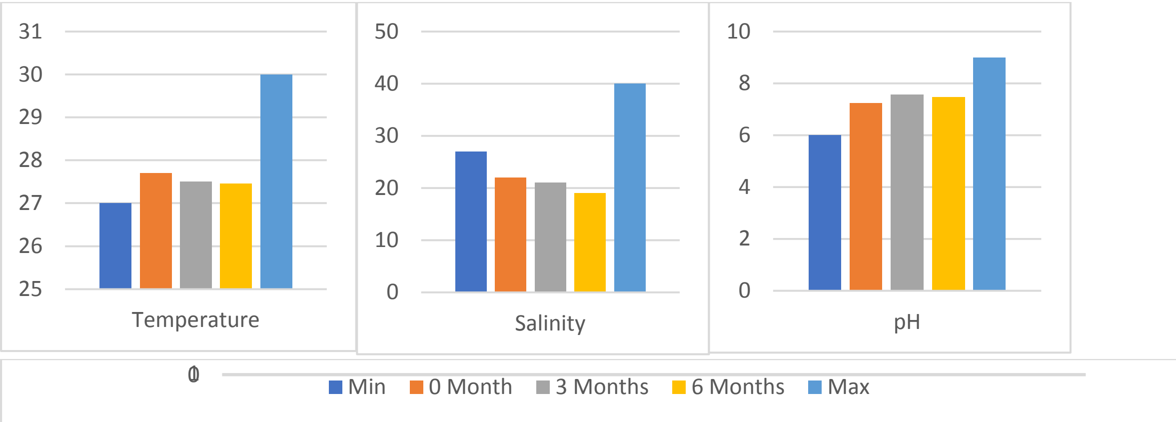

Figure 2 Graph of water parameter

The value of the water parameter is presented in table 3 and to comply with safety standards. The table shows that the pond water parameters after three months of being filled with fish are still under control. The stability of the pond water parameter shows that the application of CAS to the water circulation of grouper aquaculture ponds has succeeded in maintaining water quality for the survival of grouper fish.

Cycling in artificial sea ponds is an activity to ensure that the marine pond system is adequate for the biota that will live in it. The system can be run after installing the facilities and infrastructure for making ponds and gradually adding groundwater, bittern, and gross salt to the composition. The recommended initial water temperature is less than 29 Celsius. Pay attention to changes that occur during the cycling process (temperature, pH, salinity, and physical condition of water) during cycling. If the pond water level decreases during cycling, add fresh water gradually until it reaches the previous level. The recommended time for the cycling process has yet to be determined, which will take 4-8 weeks. The appearance of thin, coarse brown moss on the pond walls usually begins to appear after 2-3 weeks. The appearance of moss-like green Algae is a natural thing in this process. At this stage, it is recommended to dose bacteria in tanks to accelerate bacterial colonies that will process waste. Do tests on Ammonia, Nitrite, Nitrate, and Phosphate periodically. Cycling is said to be complete when Nitrate and Ammonia are not detected. Besides that, it was also marked by the emergence of many Copepods and Amphipods.

Grouper Growth

The density of grouper fish measured grouper growth in the pond per m2 and measurements of the length and weight of the fish. Measurements were carried out within three months and were carried out three times.

Table 4 The growth of the grouper fish

Month	Week	Weight	Absolute growth
1	I	50	-
	II	65	15
	III	76	11
	IV	87	11
Average			12.33
2	I	97	10
	II	109	12
	III	122	13
	IV	135	13
Average			12

3	I	148	13
	II	156	8
	III	174	18
	IV	187	13
Average			13

The results of grouper growth analysis for three months showed that the average grouper weight growth per week ranged from 12-13 grams shown as figure 2. The final weight of the grouper for three months is about 180 grams/head, with growth reaching 360%. Based on the results of grouper growth analysis, as in the study of [12], grouper growth is average. The growth of this grouper is at a density of 55 individuals/m^3. Fish density is close to the optimal density, which was concluded in [16] for marine fish, which is 60 individuals/m^3.

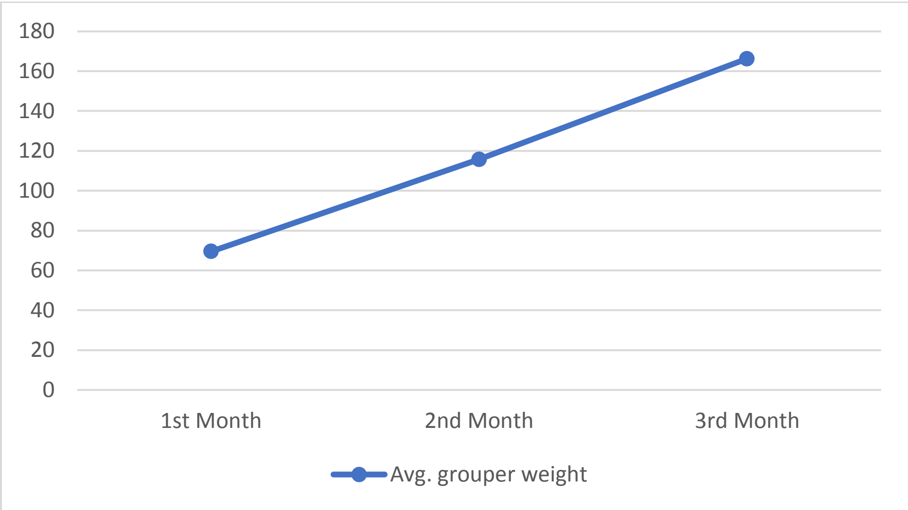

Figure 3 Graph of Average Grouper Weight

Cost Benefit Analysis for grouper cultivation.

- *Benefit Value Cost*

In order to carry out a grouper cultivation business by intercropping the production of crystallization houses salt, business actors need to collect information regarding the fixed costs and variable costs required to run the business. Business investment capital can adjust the size of the pond to be made and the human resources available to process it. Investment capital from a salt production business using a crystallization house with intercropping of grouper cultivation in general with an added size of 6 m2 with one crystallization houses is presented in the table below.

Table 5 Table of cost benefits of grouper cultivation

No	Tool's name	Unit Price (IDR)	Amount	Total Cost (IDR)
1.	Concrete pool 2x3 meters	1,800,000	1	1,800,000
2.	Warring net	15,000	6	90,000
3.	Pipe	200,000	1	200,000
4.	Sea water pump	750,000	1	750,000
5.	Salinometer 5 in 1	450,000	1	450,000

6.	Scales	75,000	1	75,000
7.	Bucket	15,000	2	30,000
8.	Aerator	540,000	1	540,000
9.	Little hose	1,000	30	30,000
10.	fibers	25,000	2	50,000
11.	Cotton	15,000	4	60,000
12.	Pumice	10,000	10	100,000
13.	Clamshell	15,000	10	150,000
14.	Zeolite	10,000	10	100,000
15.	Coconut Charcoal	10,000	10	100,000
				4,545,000

The table above shows that the required investment capital is IDR 4,545,000 for grouper cultivation.

- *Fixed cost*

Fixed Costs are costs that do not change as long as the business runs, whether during production or not. These costs will still be incurred even if not carrying out production activities. The fixed costs incurred in grouper cultivation can be seen in the table below.

Table 6 Fixed cost of grouper cultivation business

No.	Fixed cost (Per Harvest Period)	amount of costs)
1.	Water pump maintenance	200,00
2.	Electricity	1,800,00
Total		2,000,000

The table above shows that the fixed or maintenance costs for grouper cultivation within one year are around IDR 2,000,000.

- *Variable cost*

Variable costs change throughout the production process, complement fixed costs, and are dynamic. This cost follows the number of production results or activities carried out. For variable costs incurred in the grouper cultivation business can be seen in the following table.

Table 7 Variable cost of grouper cultivation business

No	Variable	Unit Price (IDR)	The amount Required	Total cost (IDR)
1.	Grouper seeds	9,000 /head	330	2,970,000

2.	Feed	3,000 /kg	1000	3,000,000
3.	Vitamins	125,000	2	250,000
4.	Coarse salt	6,000 /kg	100	600,000
5.	Bittern	10,000	100	1,000,000
Total				**7,820,000**

Based on the table, it is obtained that the total variable costs or operational costs incurred in the salt production business using crystallization houses with intercropping grouper cultivation are around IDR 7,820,000.

- *Marketing / Sales*

According to the model, out of 330 fish cultured with a mortality rate of 1%, harvesting is done every six months. In 1 harvest, the total weight of cultivated grouper fish is around 120 kg for IDR 120,000 per kilo. So that the income derived from grouper cultivation is IDR 14,400,000, and the harvest takes about 5-6 months or can be harvested twice a year.

- *Calculation of Cost Benefit Analysis*

Table 8 ROI calculation

Tangible Benefits	
Sales of crops (72 periods/year)	28,800,000
Total cost of year 1	14,345,000
Payback Period (PP)	0.49 years
Year 1 progress	28,800,000
NPV (Net present value)	10,061,779
ROI (Return of Investment)	100,76%

The investment costs for grouper cultivation will be covered in time 5,97 months. The total net profit from grouper cultivation in 1 year is IDR 10,061,779 and the closing rate of investment costs is 100,76%. With the results of this CBA analysis, it can be concluded that grouper cultivation with an intercropping system is feasible. This business has great potential to generate profits and improve the economy of coastal communities in Lekok District, Pasuruan Regency.

Cost-benefit Environmental Analysis

Then the types of losses calculated based on the impact caused by grouper cultivation with the intercropping of crystallization houses salt production are as follows.

- Calculation of the Cost of Losses for the Community's Economic Losses

Table 9 Societal loss costs

No	Description	Information
1.	Number of households	123
2.	The price of production salt before any research(P_o)	5,000
3.	Price of production salt after research(P_1)	11,000
4.	Number of fish consumed before the study(Q_o)	55 kgs

5.	The number of fish consumed after the research(Q_1)	60 kgs
6.	Impact severity	1% (applying CAS)
7.	Sk_o	$0{,}5 \times RT \times P_o \times Q_o$
		$0{,}5 \times 123 \times 5{,}000 \times 55 = 16{,}912{,}500$
8	SK_1	$0{,}5 \times RT \times P_1 \times Q_1$
		$0{,}5 \times 123 \times 11{,}000 \times 60 = 40{,}590{,}000$
9.	Change SK	$SK_o - SK_1$
		$23{,}677{,}500$
10	Loss value	Impact severity × change SK
		$236{,}775$

The community loss value with the assumption that for 1 year is equal to
Community loss = 236,775 x 12 months = IDR 2,841,300

- Calculation of Loss Costs and Ecological/Environmental Recovery

1. *Water System Function Recovery Costs*

Table 10 Water System Function Recovery Costs

National cost of water system function recovery	40,500,000/ha
Pond area	6m^2
Total	$\frac{6}{10000} \times 40{,}500{,}000 \times 1 = 24{,}300,-$

2. *Water Arrangement Costs*

Table 11 Water Arrangement Costs

National cost of water arrangement	22,810,000/ha
Pond area	6m^2
Total	$\frac{6}{10000} \times 22{,}800{,}000 = 13{,}686,-$

3. *Land Formation Costs*

Table 12 Land Formation Costs

National cost of land formation	500,000/ha
Pond area	6m^2
Total	$\frac{6}{10000} \times 500{,}000 = 300$

4. *Nutrient Loss Costs*

Table 13 Nutrient Loss Costs

National cost of nutrient loss	4,610,000
Pond area	6m^2

Total	$\frac{6}{10000} \times 4{,}610{,}000 = 2{,}766$

5. *Biodiversity Recovery Costs*

Table 14 Biodiversity Restoration Costs

National cost of biodiversity restoration	2,700,000
Pond area	6m^2
Total	$\frac{6}{10000} \times 2{,}700{,}000 = 1{,}620$

6. *Genetic Recovery Costs*

Table 15 Genetic Recovery Costs

National cost of genetic recovery	410,000
Pond area	6 m^2
Total	$\frac{6}{10000} \times 410{,}000 = 246$

7. *Carbon Release Costs*

Table 16 Carbon Release Costs

National cost of carbon release	32,310,000
Pond area	6 m^2
Total	$\frac{6}{10000} \times 32.310{,}000 = 19{,}386$

Based on the calculated environmental profit and loss analysis simulation results, the total environmental loss is IDR 62,304.

Comparison of results of CBA and CBEA of domestic salt production activities

The estimated Value of Economic Benefits and Losses Received by the Community from grouper cultivation with intercropping of crystallization houses salt production are as follows:

Table 17 Total net benefits

No	Value Type	Value Estimation
1.	Total Benefit Value (CBA) (Rp/year)	10,061,779
2.	Total Value of Losses (CBEA) (Rp/year)	62,304
	Total net benefit value (Rp/year)	9,999,475

It found that the benefits from this innovation were good enough to support the community's economy. In addition, this advantage is also offset by the results of the Cost Benefit Environmental Analysis which show that this innovation results in minimal environmental losses.

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