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Gadingsari maritime village: Empowerment of Gadingsari coastal communities through cultivation saline tilapia fish using biofloc technology

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ABSTRACT

The community empowerment program in Gadingsari Village through saline tilapia cultivation with biofloc technology aims to improve the skills and knowledge of the local community. This village has great maritime potential, but challenges related to education levels and lack of employment limit economic development. This program involves socialization, provision of biofloc equipment, distribution of fish seeds, and assistance in fish maintenance until harvest. Biofloc technology was chosen because it can optimize water and nutrient efficiency, and increase the yield of saline tilapia that is resistant to salinity conditions. R/C ratio analysis shows that the Biofloc system with a ratio of 1,38 is more profitable than the conventional system with a ratio of only 1,05. This program has succeeded in introducing new technology, increasing fisheries production, and providing a positive impact on the economic welfare of the local community.

Keywords: Biofloc, Community empowerment Ratio analysis, Salin tilapia, Gadingsari Village, Farmers empowering

INTRODUCTION

The potential of aquaculture in Indonesia is estimated to reach 15.59 million hectares, consisting of 2.23 million hectares of freshwater aquaculture, 1.22 million hectares of brackish water aquaculture, and 12.14 million hectares of marine aquaculture. Currently, the utilization of this potential has only reached 10.1% for freshwater aquaculture, 40% for brackish water aquaculture, and only 0.01% for marine aquaculture. Given the low utilization of this potential, concrete efforts are needed to increase fish production where the market demand is very large, both in the domestic and international markets (Yunianto & Suryandari, 2022).

Gadingsari Village is one of the four villages in Sanden Sub-district, Bantul Regency. Gadingsari village is located approximately 1 km to the west of Sanden sub-district. With an area of about 811.7430 hectares or 30% of the area of Sanden Sub-district and about 1.5% of the area of Bantul

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Regency (Edy et al., 2019). Gadingsari Village administratively consists of 18 hamlets and 92 RTs. Among the 18 hamlets in Gadingsari, 2 hamlets have marine areas, namely Patihan and Wonoroto. Based on this profile, Gadingsari Village has potential maritime resources that can be developed.

The education level of the Gadingsari Village community is mostly dominated by residents who only completed their education up to the elementary school level with a total of 2,964 people, based on the Gadingsari Village RPJMDes 2017-2022. Education plays a role in increasing a person's knowledge, which is then useful for learning the skills needed in the world of work (Susanto & Pangesti, 2019). The low education level of the people of Gadingsari Village makes it difficult for them to obtain decent work, limiting their opportunities to improve their standard of living. This also has an impact on the level of absorption of technology that will be used by the community in the cultivation process in Gadingsari Village.

One of the Gadingsari Village programs implemented by the PPK Ormawa Team in 2023 is the food security program. Seeing the potential of resources that can be developed, the low level of community education, and limited employment opportunities, a milkfish farming program using the Recirculating Aquaculture System (RAS) was implemented. Recirculating Aquaculture System (RAS) is one of the sustainable aquaculture technologies that can control waste disposal in the environment and maintain water quality in aquaculture ponds (Fauzia & Suseno, 2020). In Gadingsari Village, this system is starting to be used to cultivate milkfish because milkfish takes approximately 4 months to enter the harvest period and has economic value and market demand that continues to increase every year.

However, the community is still unable to enlarge fish to reach consumption size due to the ineffective growth of milkfish in RAS due to limited space for movement, while milkfish tend to have the habit of swimming far (Syamsunarno et al., 2019). Therefore, the Ahmad Dahlan University PPK Ormawa team 2024 implemented a sustainability program to overcome the problems faced by the Gadingsari Village community. Through empowerment programs for the community, the team is expected to be able to provide the best solution to the problems faced (Mandasari & Shaleh Z, 2022). This program includes the socialization of saline tilapia with biofloc technology and mentoring for the village community. The biofloc system is a method of converting toxic inorganic waste such as ammonia into bacterial proteins that can then be consumed again by fish (Saridu et al., 2023). Meanwhile, saline tilapia is one of the fish that can adapt to both freshwater and brackish water which has a salinity of up to 20 ppt (Angriani, 2020). The purpose of this empowerment program in Gadingsari Village is for the community to raise fish using biofloc technology, understand the types of fish that are suitable for biofloc technology, and facilitate feeding in the cultivation process. The benefits of this program include:

1. Expanding villagers' knowledge and skills in tilapia rearing.
2. Provide opportunities for students to share knowledge and experience in solving problems in the community.
3. The village head can increase the number and quality of people who can raise fish properly, so it is hoped that tilapia farming in Gadingsari Village can develop, making this village a center for tilapia production, and creating more jobs for the community.
4. Strengthening the role of universities in community service and providing opportunities for students to apply knowledge directly in a real context.
5. Build a closer relationship between cooperation partners and the Gadingsari Village community, and expand the reach of empowerment programs that can have a sustainable positive impact.

METODS

This program was carried out through several stages, including socialization with the Gadingsari Village community with BPTP DIY regarding the procurement of biofloc equipment and materials, preparation, pond cleaning, pond water filling, pond media making, purchase and stocking of saline tilapia seeds, and maintenance of saline tilapia until harvest time.

The equipment required for biofloc farming includes five sets of 2 m diameter round tarpaulin ponds (including tarpaulin ponds, Wiremesh iron frame, outlet pipes, ropes, and hoses), three aerator units with power backup, biofloc-forming materials (probiotics, dolomite lime, and molasses), aerator hoses, aerator stones, electrical cables, and plugs.

In this program, Gadingsari Village was provided with all the necessary equipment for aquaculture, including fish feed during the program where the cost was borne by the HMTP Ormawa PPK team in 2024. As a contribution, the people of Gadingsari Village are expected to donate their time and energy for the success of this program.

RESULTS

A. Socialization to the Community

Before the program was implemented, the first step we took was to conduct socialization with the Gadingsari Village community, especially with youth groups from Patihan and Wonoroto hamlets. The event was hosted by Mr. Diduk K. Hendra, S.Pi., M.M., an expert from the DIY Aquaculture Technology Development Center (BPTPB) who gave a presentation on biofloc technology. Figure 1 shows the socialization from BPTPB.

Figure 1. Presentation of Socialization Materials

This socialization was conducted to provide the community with an understanding of the basic concepts of biofloc, how it works, and the benefits that can be obtained through this technology. In this activity, it was explained in detail how biofloc works in optimizing the use of water and nutrients that can increase the efficiency of saline tilapia farming. The selection of tilapia as the focus of aquaculture was also emphasized due to its advantages in adaptation to biofloc technology, including high durability, rapid growth, and stable market demand.

Discussions that took place during this socialization showed the enthusiasm of the community, especially from members of the youth organization who showed great interest in understanding more about the potential of tilapia farming using biofloc technology. The liveliness of the community in asking questions and discussing indicates that this socialization succeeded in achieving its objectives, namely building awareness and initial knowledge that will be the foundation for the successful implementation of the program in the next phase.

B. Preparation

On July 16-21, 2024, the PPK Ormawa HMTP 2024 team together with Karang Taruna Padukuhan Patihan purchased the equipment and materials needed for the saline tilapia farming program using biofloc technology. This step is an important part of the preparation stage before program implementation. The equipment and materials purchased included an air pump machine (aerator), aeration stone, aeration hose, molasses, dolomite lime, Bacillus subtilis, and others. Examples of equipment and materials purchased can be seen in Figure 2.

Figure 2. Biofloc Technology Cultivation Equipment and Materials

C. Pond Cleaning

On July 21, 2024, the HMTP Ormawa PPK team in 2024 cleaned the tarpaulin pond at the cultivation site, namely Wonoroto Padukuhan. This activity involved the Wonoroto Padukuhan youth organization, the HMTP 2024 Ormawa team, and the HMTP 2024 Ormawa PPK implementation team. This cleaning is the first step in preparation before filling brackish water into the pond. A clean tarpaulin pond is essential to ensure an optimal environment for tilapia farming (Admin, 2024), as pond cleanliness affects water quality and fish health. This cleaning activity can be seen in Figure 3.

Gambar 1. Pembersihan Kolam Budidaya

D. Pond Water Filling

On July 25, 2024, the PPK Ormawa HMTP 2024 team collaborated with the Wonoroto Padukuhan youth organization and the Ormawa HMTP 2024 team in carrying out brackish water-filling activities into biofloc ponds. The brackish water was obtained from ponds located near Pandansari beach. Using a pickup truck, the water was transported and flowed into four biofloc ponds. The brackish water filling process lasted for 5-7 hours until the four ponds were filled to 2/3 of their capacity. After the four biofloc ponds were filled with brackish water, the ponds were left for 3 days before undergoing special treatment to form flocs, which is an important step in preparation for tilapia farming. According to Fransisca et al (2021) in their research, the most optimal tilapia length growth occurs at 10-15 ppt salinity compared to 15-20 ppt and 20-25 ppt salinity. This is because in 15-20 ppt salinity, tilapia is still able to grow, but the growth is not as big as in 10-15 ppt salinity. Meanwhile, at 20-25 ppt salinity, tilapia length growth is the worst among the three salinity levels. Therefore, at this stage, the pond salinity was set to 10-15 ppt salinity to create optimal conditions for the fish. The pond-filling process can be seen in Figure 4.

Figure 4. Brackish water filling

E. Pond Media

Three days after filling the brackish water, the biofloc pond media processing was carried out. This activity was carried out on August 5, 2024, starting with the installation of aerators, aerator hoses, and aeration stones that function as an aeration system in biofloc ponds. Aeration is important to maintain adequate oxygen supply for microorganisms and fish in the pond (Nurul Achmadiah et al., 2023).

After the aerator system is installed, the next step is the application of dolomite, Bacillus subtilis, and molasses into the pond. According to Sinaga et al (2022), dolomite is used to stabilize the pH of the water, while Bacillus subtilis serves as a probiotic bacterium that helps the decomposition of organic matter and the formation of bioflocs (Ikbal et al., 2022). Molasses is added as a carbon source to support the growth of bacteria and microorganisms that form biofloc (Fujiana et al., 2020).

After all components of the pond media have been processed, the pond is left for approximately one week to ensure that the bioflocs are well formed (Kurniaji et al., 2021). After this period, saline tilapia fingerlings can be stocked into the pond, starting the optimal fish farming process. The process of making pond media can be seen in Figures 5 and 6.

Figure 5. Aeration Hose Installation

Figure 6. Pond water media treatment

F. Purchase and Stocking of Salinized Tilapia Seedlings

On August 8, 2024, the PPK Ormawa HMTP 2024 team purchased and collected saline tilapia fingerlings from the Aquaculture Technology Development Center (BPTPB) Cangkringan, Sleman, Yogyakarta, which can be seen in Figure 6. A total of 35 kg of fish fingerlings with a size of 9-12 cm were transported to the cultivation site.

Upon arrival, each bag of fingerlings was doused with water to neutralize the increased temperature during the trip to reduce stress in the fish. The seedling stocking process is done carefully, with each biofloc pond filled with 300-330 saline tilapia seedlings. Stocking is done by directing the bag so that the fish comes out towards the seed stocker, as shown in Figure 7.

During the stocking process, the Head of Wonoroto Hamlet was present to witness and support the activity. The participation of the Head of Dukuh confirms the local support for this fish farming program and strengthens the cooperation between the PPK Ormawa HMTP 2024 team and the local community.

Figure 7. Tilapia purchase

Figure 8. Tilapia Seedling Stockingenebaran Bibit Ikan Nila

G. Salinized Tilapia Farming

Raising saline tilapia involves several important aspects, including feeding, water management, and disease control. Tilapia are fed twice a day using Hi-Pro Vit and adjusted to the size of the fish (Yunianto & Suryandari, 2022). In the early stages, fingerlings are fed size 371-2 for one month, then switched to a larger size feed following the growth period of the fish until harvest. Proper feeding aims to support optimal fish growth.

Water management is also a crucial part of rearing (Andik Sudirman et al., 2023). The community receives a mentor who regularly checks the ponds and discusses fish rearing. However, a few weeks after stocking the fingerlings, significant problems arose that affected the health of the fish. As the fish grew in size, an increase in fish waste caused the pond to turn a deep green color. This indicated an increase in algae in the pond, which caused the water quality to deteriorate. Salinized Tilapia farming is shown in Figure 9.

Figure 9. Salinized Tilapia Farming

The discoloration of the pond to green can result in a decrease in dissolved oxygen levels and an increase in ammonia levels. This has an impact on fish health by reducing fish appetite and making fish often float on the surface in search of oxygen (Djaelani et al., 2023). If this problem is not addressed immediately, poor water quality can lead to increased fish mortality.

To overcome this problem, the PPK Ormawa HMTP 2024 team collaborated with BPTPB Samas to check and provide solutions. This includes evaluating the filtration system, manure management, and recommendations for water quality improvement. Implementation of the suggested solutions is expected to improve pond conditions and support fish survival.

H. Harvest

Harvesting of saline tilapia is done after a cultivation period of about 3-4 months (Wulandari et al., 2023). The harvesting process begins by reducing the volume of water in the pond to facilitate fishing. After the water recedes, the fish are collected and transferred to a container before being marketed or consumed.

I. Cost Analysis of Saline Tilapia Farming with Biofloc Technology

The simulation of economic improvement is calculated by comparing the capital and profit between saline tilapia farming with biofloc technology and conventional farming systems. The calculation of capital and profit is based on market prices in August 2024 and refers to the conventional aquaculture capital used by the target group. The following are details of capital and profit comparisons between saline tilapia farming systems with biofloc technology and conventional farming systems:

1. Conventional Cultivation System

a. Production revenue of 5 ponds

The production revenue of 5 ponds with conventional cultivation system can be seen in Table 1.

Table 1. Production Revenue of 5 Ponds with Conventional Cultivation System

Stocking	SR	Harvest Tonnage (kg)	Price	Revenue	Description
750	85%	160	IDR27,000	IDR4,320,000	3-5 fish/kg

Note: stocking density 54 fish/m^3

b. Investment cost

The amount of initial investment costs required for the conventional cultivation system can be seen in Table 2.

Tabel 1. Investment Costs with Conventional Cultivation System

Description	Total	Unit price	Total
Kolam terpal full set (pcs)	5	IDR 800,000	IDR 4,000,000

c. Fixed costs

Fixed costs are costs that remain constant and are not affected by changes in activity levels within a certain relevant range (Putri et al., 2022). The amount of initial investment costs required for conventional cultivation systems can be seen in Table 3.

Table 3. Fixed Costs with Conventional Cultivation System

No	Description	Total (IDR)
1	Fixed Cost (Investment cost x 10%) * Depreciation rate 10%/year	400,000
	Total	400,000

d. Operating costs

Operational costs include costs related to the company's operational activities, such as sales and administrative costs, advertising costs, depreciation costs, and repair and maintenance costs (Hindi & Yasa, 2023). The following is the amount of operational costs required for the conventional cultivation system can be seen in Table 4.

Table 4. Operational Costs with Conventional Cultivation System

No	Description	Total	Unit price (IDR)	Total (IDR)
1	Fish feed (kg)	210	14,000	2,940,000
2	Molasses (liter)	1	13,000	13,000
3	Probiotics (1 Pack)	1	150,000	150,000
4	Fish fry	750	675	506,250
5	Dolomite chalk (Pack)	1	102,000	102,000
	Total			3,711,250

e. Total price

The total costs incurred for the conventional cultivation system can be seen in Table 5.

Table 5. Total Cost with Conventional Cultivation System

Elements	Total (IDR)
Fixed cost	1,136,372
Operating costs	3,947,000
Total cost	5,083,372

f. R/C ratio

R/C ratio analysis is a balance analysis with the amount of revenue and costs obtained based on the division between total revenue and total costs (Subecty et al., 2022). The following is the ratio analysis obtained for the conventional cultivation system.

Total *Revenue* (TR) = IDR 4,320,000

Total *Cost* (TC) = IDR 4,111,250

R/C ratio analysis = 1.05

g. Benefits

From the data obtained, the profit for the conventional cultivation system is as follows:

Benefits = TR-TC

= IDR 4,320,000 - IDR 4,111,250

= IDR 208,750

2. Cultivation System with Biofloc Technology

a. Production revenue of 5 ponds

The results of the production revenue of 5 ponds with biofloc technology cultivation system can be seen in Table 6.

Table 6. Results of Production Revenue of 5 Ponds with Biofloc Technology

Stocking Quantity	Survival Rate	Harvest Tonnage	Price	Revenue	Description
1400	93%	260	27,000	7,020,000	4-6 fish/kg

Note: stocking density 100 fish/m3

b. Investment cost

The amount of initial investment costs required for the biofloc technology cultivation system can be seen in Table 7.

Table 7. Investment Costs with Biofloc Technology

No	Description	Total	Unit price (IDR)	Total (IDR)
1	Tarpaulin pond full set (pcs)	5	800,000	4,000,000
2	Aerator machine	2	900,000	1,800,000
3	Hose (m)	50	3,000	150,000
4	Aeration stone	25	5000	125,000
5	Slap Rope	5	10,000	50,000
6	Electrical Terminals and Cables	2	40,000	80,000
7	Solar panel	1	1,000,000	1,000,000
	Total			7,205,000

c. Fixed costs

The following is the amount of initial investment costs required for the biofloc technology cultivation system can be seen in Table 8.

Table 8. Fixed Costs with Biofloc Technology

No	Description	Total (Rp)
1	Fixed Cost (Investment Cost x 10%) * depreciation rate of 10%/year	720,500
2	Electricity 1 cycle * 60 days x 24 hours x 100 watts x Rp. 1444/kwh	415,872
	Total	1,136,372

d. Operational costs

The following is the amount of operational costs required for the biofloc technology cultivation system can be seen in Table 9.

Table 9. Operational Costs with Biofloc Technology

No	Description	Total	Unit price (IDR)	Total (IDR)
1	Fish feed (kg)	150	14,000	2,100,000
2	Molasses (liter)	5	10,000	50,000
3	Probiotics (Pack)	5	150,000	750,000
4	Fish fry (kg)	1400	675	945,000
5	Dolomite chalk (Pack)	1	102,000	102,000
	Total			3,947,000

e. Total cost

The total costs incurred for the conventional cultivation system can be seen in Table 10.

Table 10. Total Cost with Biofloc Technology

Description	Total (IDR)
Fixed costs	1,136,372
Operating costs	3,947,000
Total cost	5,083,372

f. R/C ratio

R/C ratio analysis is a balance analysis with the amount of revenue and costs obtained based on the division between total revenue and total costs (Subecty et al., 2022). The following is the ratio analysis obtained for the conventional cultivation system.

Total *Revenue* (TR) = IDR 7,020,000

Total *Cost* (TC) = IDR 5,083,372

R/C ratio analysis = 1.38

g. Benefit

From the data obtained, the profit for the conventional cultivation system is as follows:

Benefit = TR-TC

= IDR 7,020,000 - IDR 5,083,372

= IDR 1,936,628

Based on the above calculations, cultivation with biofloc ponds is more profitable when compared to conventional ponds with an R/C ratio of 1.38: 1,05. A comparison graph of the R/C ratio of ponds using the biofloc system and conventional ponds can be seen in Figure 9

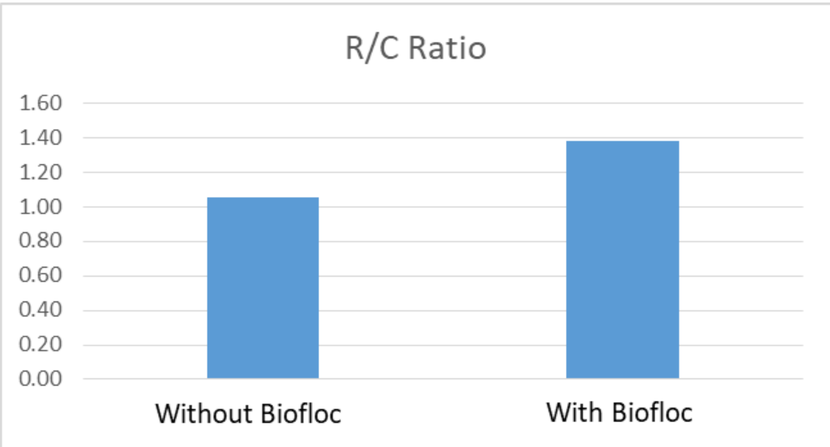

Figure 10. Comparison Chart of R/C Ratio of Ponds with and without Biofloc System

CONCLUSIONS

Based on the results of the community service that has been carried out, activities that have been carried out from June to November include socialization of the program to the community, pond preparation, pond cleaning, pond water filling, making pond water media, purchasing & stocking saline tilapia seeds. The success of this program is inseparable from close cooperation with BPTPB DIY, which provides significant support in providing technical guidance related to the procurement of biofloc equipment and materials as well as pond preparation and cleaning, water filling, pond media making, to the purchase and stocking of saline tilapia fingerlings. This collaboration also includes mentoring throughout the process of raising saline tilapia until harvest, ensuring the implementation of best aquaculture practices. Then, during the program, the community has gained knowledge about saline tilapia farming using bioflocs. Then, based on the results of the R/C ratio analysis, which clearly shows the economic advantages of applying the biofloc system in saline tilapia farming. With an R/C ratio of 1.38 for biofloc farming, compared to 1.05 for conventional methods, the program proved that the adoption of biofloc technology is not only technically feasible but also financially profitable. These results indicate a great potential for improving the economic welfare of the community through widespread adoption of this technology.

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