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Enhancing ornamental marine fish farming through advanced water management with protein skimmers in Lembar, West Lombok

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Abstract

The coastal area of Lembar District, West Lombok, has great potential in cultivating marine ornamental fish such as clownfish and blue tang, but water pollution due to Lembar Port activities has caused a decline in water quality and low fish survival. This community service aims to increase the capacity of farmers in managing water quality through the application of protein skimmer technology, a tool that can remove dissolved organic particles from seawater. The activity was carried out in six stages, namely location survey, socialization, training, technology application, mentoring and evaluation, and program sustainability. The results of the activity showed that partners experienced an increase in understanding of the importance of water quality and skills in using protein skimmers. In addition, the condition of the cultivation environment became more stable and supported the growth of ornamental fish. With a participatory approach and the application of appropriate technology, this activity was able to provide a positive impact. This program is expected to be a pilot model for other coastal areas in the development of sustainable marine ornamental fish cultivation.

Keywords: Protein Skimmer, Marine Ornamental Fish, Water Quality, Aquaculture

Abstrak

Wilayah pesisir Kecamatan Lembar, Lombok Barat, memiliki potensi besar dalam budidaya ikan hias laut seperti ikan badut (*clownfish*) dan ikan dori (*blue tang*), namun pencemaran air akibat aktivitas Pelabuhan Lembar menyebabkan menurunnya kualitas air dan rendahnya kelulushidupan ikan. Pengabdian kepada masyarakat ini bertujuan untuk meningkatkan kapasitas pembudidaya dalam mengelola kualitas air melalui penerapan teknologi *protein skimmer*, yaitu alat yang mampu menghilangkan partikel organik terlarut dari air laut. Kegiatan dilakukan melalui enam tahap, yaitu survei lokasi, sosialisasi, pelatihan, penerapan teknologi, pendampingan dan evaluasi, serta keberlanjutan program. Hasil kegiatan menunjukkan bahwa mitra pembudidaya mengalami peningkatan pemahaman terhadap pentingnya kualitas air dan keterampilan dalam menggunakan protein skimmer secara mandiri. Selain itu, kondisi lingkungan budidaya menjadi lebih stabil dan mendukung pertumbuhan ikan hias. Dengan pendekatan partisipatif dan penerapan teknologi tepat guna, kegiatan ini mampu memberikan dampak positif. Program ini diharapkan menjadi model percontohan bagi wilayah pesisir lainnya dalam pengembangan budidaya ikan hias laut yang berkelanjutan.

kata kunci: Protein Skimmer, Ikan Hias Laut, Kualitas Air, Akuakultur

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1. Introduction

Coastal areas are transitional areas between terrestrial and marine ecosystems. The coast is an area rich in natural potential that has long been utilized by humans. Coastal areas are used for settlements, transportation, industry, mining, agribusiness, recreation and tourism (Ramena et al., 2020). One of the potentials in coastal areas is marine ornamental fish. Indonesian waters have an abundant and unique diversity of ornamental fish, marine ornamental fish in Indonesia are more than 3600 species, of which more than 70% of the species are types of fish associated with coral reefs. Examples of marine ornamental fish commodities include paddle-flap scorpionfish (*Rhinopias eschmeyeri*), yellowface angelfish (*Pomacanthus xanthometopon*) and longnose butterflyfish (*Forcipiger longirostris*). The types of Indonesian marine ornamental fish that have high selling value on the international market are clownfish (*Amphiprion ocellaris*) and Banggai cardinal fish (*Pterapogon kauderni*) (Fendjalang et al., 2024). Coastal areas have great potential for the cultivation and trade of marine ornamental fish due to Indonesia's rich biodiversity, especially species associated with coral reefs that are highly valued in the international market.

Ornamental fish have the potential to be developed because of the large market opportunities and abundant resources. Their attractive colors, unique shapes and different behaviors for each species are business opportunities for export businesses for the community. Indonesia is known as a country that has a variety of ornamental fish species. Several types of marine ornamental fish such as clownfish, Banggai cardinal fish and blue tang are species that are in great demand by ornamental fish enthusiasts abroad. The clownfish (*Amphriprion percula*) which is commonly called the clownfish has the characteristic of three stripes on its body with an orange color. The three stripes on its body are divided into the head, body and tail. The Banggai cardinal fish (*Pterapogon kauderni*) has a unique shape because its tail is split into two and forked, its dorsal fin is long and there are white spots on its body. The blue tang fish (*Paracanthurus hepatus*) is called Letter Six, bright blue in color and has a number 6 pattern, black fins and a yellow tail (Renitasari & Ihwan, 2021).

The total volume of ornamental fish production in Indonesia in 2021 reached 1,606,820.07 tons, with West Nusa Tenggara contributing 2,697.29 tons. Ornamental fish production continues to increase in 2022 due to high demand in the global market for ornamental fish from Indonesia, as well as the recovery of conditions after the COVID-19 pandemic which has had a significant positive impact on ornamental fish cultivation (Rahmadani et al., 2023; Sumsanto et al., 2024). Ornamental fish trade in West Nusa Tenggara (NTB) has begun to develop. Ornamental fish traders in NTB can be seen on sidewalks along highways, in shopping complexes, or in front of schools. So far, freshwater ornamental fish production in Indonesia has only been centered in the Jabodetabek area, especially in Java, so that a number of regions including West Nusa Tenggara (NTB) in meeting the demand for ornamental fish markets always import from these areas. West Nusa Tenggara (NTB) is not only famous for its developing marine fisheries cultivation area but also suitable for developing marine ornamental fish cultivation (Dinda & Aminullah, 2024). Ornamental

fish production in Indonesia continues to grow due to rising global demand, and West Nusa Tenggara holds strong potential to become a key center for marine ornamental fish cultivation beyond its current reliance on imports from Java.

Lembar, located in West Lombok, has great potential in the marine fisheries sector, especially in marine ornamental fish cultivation. With fairly good water conditions, Lembar is an ideal habitat for various types of high-value marine ornamental fish, such as angelfish, clownfish, and various other species. This marine biodiversity not only supports fishing activities but also opens up opportunities for increasingly developing ornamental fish cultivation. In addition, Lembar has the potential to become a center for marine ornamental fish production that can meet domestic and international market demand. Therefore, there needs to be a transfer of knowledge so that marine ornamental fish farmers in the Lembar area can manage optimal water quality for marine ornamental fish cultivation. This aims to ensure a healthy environment and support the growth of ornamental fish optimally, thus producing high-quality products.

The utilization of the coastal area of Lembar District is currently in the form of the Lembar Port area as an entry route to Lombok Island from the West side. In addition, there is currently a port development with coastal reclamation for the construction of Gilimas Port in Labuan Tereng Village which can have an impact on the decline in the quality of the waters around the Lembar area (Sari et al., 2022). Lembar Port is one of the active ports on Lombok Island and has been operating since 1977 located in West Lombok Regency. Lembar Port activities have the potential to pollute the environment with a ferry capacity of ±37 per day for crossing activities between provinces, shipping and loading and unloading of goods of ±685 tons/day, or equivalent to ±250,000 tons/year, and Dead Weight Tonnage (DWT) of ships with an average size of 1,000-1,500 tons. The negative impact of Lembar Port activities to date can be seen from the disruption of biota around the port (Rahman et al., 2022). The development and operation of Lembar Port, including coastal reclamation, have the potential to degrade water quality and disrupt marine life in the surrounding coastal area.

One of the main problems faced in marine ornamental fish farming in Lembar, West Lombok, is the low survival rate of fish due to poor water quality, especially because of its proximity to Lembar Port. Dense port activities, such as ship traffic and waste disposal, can pollute the surrounding waters and cause high levels of pollutants in the water, such as fuel residue, organic waste, and heavy metals. This condition risks increasing stress on fish and affecting the health and endurance of fish. To overcome this, the application of protein skimmer technology can be an effective solution. This tool can help reduce water pollution by filtering organic particles, such as leftover feed and fish waste, so that the water quality becomes cleaner and supports better survival of marine ornamental fish. Thus, protein skimmer technology can increase fish survival and support the success of marine ornamental fish farming in areas affected by port pollution. The purpose of this community service activity is to improve the understanding and skills of marine ornamental fish farmers in managing the quality of cultivation water. With a focus on reducing water pollution due to activities at Lembar Port, the main objective of this activity is to increase the survival of cultivated marine

ornamental fish, so as to increase the production results and quality of the ornamental fish produced. This community service activity differs from others by specifically addressing water pollution caused by port activities through the application of protein skimmer technology to improve the survival rate of marine ornamental fish in areas affected by Lembar Port.

2. Method

This community service activity is carried out through various activities that are structured (Figure 1). The preparation of this activity is based on the results of coordination and consultation between the entire activity implementation team and partners. The methods that have been mutually agreed upon include the following:

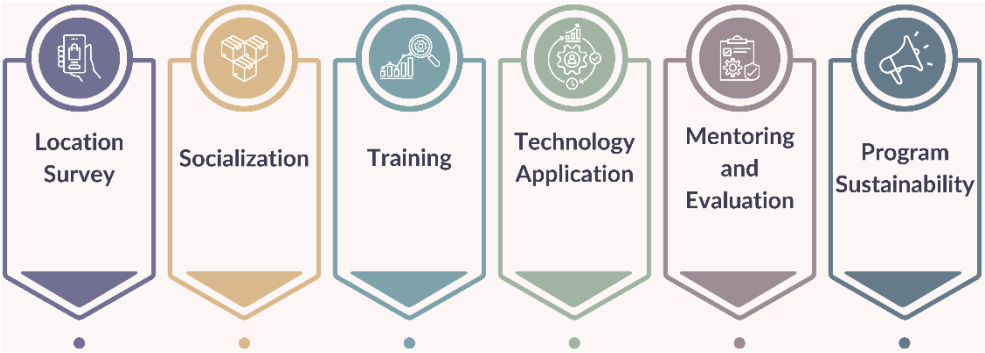

Figure 1. Work Steps of Community Service

1. Location Survey
   An initial survey at the location of the activity is needed to find out the real conditions of the partners (Affandi, Diniariwisan, et al., 2024; Affandi, Scabra, et al., 2023, 2024). Survey activities are absolutely necessary so that activities can run well, namely achieving high effectiveness values (Asri et al., 2023, 2025; Diamahesa et al., 2022). The initial survey is also a moment to get to know the partners (marine ornamental fish farmers) and related stakeholders such as village officials or local governments at the location where the activity is carried out.
2. Socialization
   Socialization is carried out to introduce community service programs that include program objectives, benefits of improving water quality management, and the technology to be implemented (Azzahra et al., 2024; Diamahesa, Marzuki, et al., 2023). The methods used are presentations using visual media, interactive discussions, and distribution of printed materials related to the importance of water quality in marine ornamental fish cultivation.
3. Training
   Training is carried out to equip marine ornamental fish farmers with knowledge and technical skills about water quality management (Affandi, Setyono, et al., 2023; Muahiddah et al., 2024). Training materials include measuring water quality parameters such as pH, temperature, salinity, and dissolved oxygen, as well as an introduction to filtration and protein skimmer technology. Farmers are also taught

how to detect early signs of stress or disease in marine ornamental fish due to poor water quality.

4. Technology Application
   This stage involves the direct application of water management technology, such as the installation of protein skimmers at the cultivation site. Farmers are involved in the installation, operation, and maintenance of the technological tools provided, accompanied by assistance from the community service team. The technology applied is designed to suit local conditions and is easy for farmers to operate (Setyono et al., 2023).
5. Mentoring and Evaluation
   Mentoring is carried out periodically to ensure that the implementation of the technology runs well and provides optimal results (Asri et al., 2024; Azhar et al., 2023). Evaluation includes measuring the survival rate of fish before and after the application of the technology, as well as assessing the level of understanding and skills of participants (Affandi, Abidin, et al., 2023; Diamahesa, Andriyono, et al., 2023; Diamahesa et al., 2024). Feedback from farmers is collected to improve the implementation of the program in the future.
6. Program Sustainability
   The program is designed so that it can be continued independently by the marine ornamental fish farmer community. The community service team provides written guidelines, video tutorials, and contacts to help farmers if they experience difficulties. The sustainability of the program can be supported by further efforts in the form of establishing partnerships with related agencies or private parties at the location of community service activities (Cokrowati et al., 2024).

3. Results

Location Survey

This community service was conducted in Puyahan Hamlet, South Lembar Village, Lembar District, West Lombok Regency. Puyahan Hamlet, located in South Lembar Village, Sheet District, West Lombok Regency, is a coastal area blessed with abundant marine resources. The existence of a sea rich in biota makes the local community depend on the marine and fisheries sector for their livelihood. The majority of the population works as traditional fishermen who catch fish in the surrounding waters, as well as as crab shell peelers which are a high-value commodity. In addition, some residents also develop marine ornamental fish farming businesses that are increasingly in demand by the local and export markets, making Puyahan Hamlet one of the potential marine resource-based economic centers in the West Lombok region.

Examples of ornamental fish species cultivated in Puyahan Hamlet are clownfish or known as Nemo fish (*Amphiprion* spp.) and letter six/blue tang or known as Dory fish (*Paracanthurus hepatus*). According to Pardede (2024), clownfish are a type of tropical marine ornamental fish from the Pomacentridae Family that live in protected coral reefs. Clownfish have an attractive shape and color pattern, namely orange, the head is striped white, body, base of the tail, and there is a black silhouette on the upper part

of its body. This fish is suitable for filling special fish aquariums or coral reef aquariums. Clownfish are one of the leading commodities of marine ornamental fish that live in coral reef waters that are symbiotic with anemones and have high economic value. Clownfish are a type of marine aquarium ornamental fish that have quite a lot of fans. There are 28 types of clownfish that have been identified, found in shallow to deep waters and on coral bottoms. In general, clownfish have basic color patterns with a combination of red-white, red-black, and black-yellow-white. Color patterns and variations in color combinations are used as characteristics in identifying types of clownfish. This fish lives in groups. Its habitat in nature is always side by side/symbiotic with sea anemones. This specific symbiosis makes this clownfish get the nickname Anemone Fish. In addition, it is also known as the clownfish because of its bright color appearance and funny and interesting movements.

Paracanthurus hepatus which has the local name letter six in Indonesia and the market name palette surgeonfish, is included in the Acanthuridae family with a dominant color pattern of bright blue with black in the shape of the number 6 on both sides of its body and yellow with black lines on its tail. Its habitat is in coral reef areas with a depth range of 2-25 m and its distribution area covers the Indo-Pacific region including East Africa to Indonesia, Micronesia, Samoa, New Caledonia, and Southwest Japan to the Great Barrier Reef (Kusumawati et al., 2015). The blue tang (*Paracanthurus hepatus*) is the only member of the genus Paracanthurus. This fish is an inhabitant of reef waters in subtropical and tropical marine areas. The blue tang is considered one of the most common and most popular marine ornamental fish worldwide. This fish has a behavior of living in pairs, or in small groups of 8 to 14 individuals. This fish generally matures at the age of 9–12 months (Sang et al., 2019).

Marine ornamental fish farming activities in Puyahan Hamlet face serious challenges in the form of declining seawater quality used in the process of raising and maintaining fish. Water polluted by household waste and other coastal activities causes stress to fish, increases the risk of disease, and reduces the survival rate of ornamental fish seeds such as clownfish and blue tang. This condition raises concerns because it can threaten the sustainability of the cultivation business which is one of the main sources of income for the local community. To gain a deeper understanding of the condition of water quality in Puyahan Hamlet and how to handle it, the community service team collaborated with a local partner, namely Reefer Lombok, an ornamental fish cultivation and conservation business managed by Mr. Salman who has been actively assisting farmers in the area.

Partners in Puyahan Hamlet said that the water quality at the cultivation location had decreased, especially due to coastal activities such as the disposal of household waste and plastic waste that pollutes the surrounding waters. This condition has a direct impact on the health and survival of marine ornamental fish, such as clownfish and blue tang which are sensitive to changes in environmental quality. Upon hearing this information, the community service team immediately conducted a field visit to review the condition of the waters directly. Partners also said that some people do not yet understand the importance of maintaining water quality for the success of

ornamental fish cultivation. In response to this, it was decided to hold a socialization activity on how to improve and maintain the quality of cultivation water and the application of protein skimmer technology as a filter. This activity involved Reefer Lombok's service partners, marine ornamental fish farmers in Dusun Puyahan, and lecturers from the Aquaculture Study Program.

Socialization

The socialization was carried out at one of the houses of marine ornamental fish farmers in Puyahan Hamlet. The participants of the socialization were partners (Reefer Lombok) marine ornamental fish farmers in Puyahan Hamlet, and lecturers of the Aquaculture Study Program. The material provided was related to the importance of maintaining the coastal environment, how to improve and maintain the quality of cultivation water, and how to apply protein skimmer technology as a filter in marine ornamental fish cultivation. This socialization activity is useful for conveying information related to how to improve the survival of marine ornamental fish through improving the management of the quality of cultivation water to partners and all participants present (Figure 2).

Figure 2. Socialization Activities

After the delivery of the material, it was continued with a question and answer/discussion session. The question and answer/discussion activity were carried out after the material delivery session ended, which was still located at one of the houses of marine ornamental fish farmers in Puyahan Hamlet. The participants remained the same as the socialization activity, namely partners (Reefer Lombok) marine ornamental fish farmers in Puyahan Hamlet, and lecturers of the Aquaculture Study Program. The question and answer/discussion session were useful for participants to convey their curiosity or problems to the speakers related to how to maintain the quality of aquaculture water. In addition to getting information from the material delivery session, participants also obtained additional information from this question and answer/discussion session which was useful for increasing knowledge and insight regarding how to maintain the quality of aquaculture water. Synergy activities with partners and marine ornamental fish farmers such as this socialization

are very important to do. The community service team in this activity tried to build communication with partners and marine ornamental fish farmers as an initial stage before reaching a wider community.

Training

The training was conducted after the knowledge transfer process through socialization. The training materials included measuring water quality parameters such as pH, temperature, salinity, and dissolved oxygen, as well as an introduction to filtration and protein skimmer technology. The farmers were also taught how to detect early signs of stress or disease in marine ornamental fish due to poor water quality. This training aims to provide understanding and practical skills to farmers in managing water more effectively, especially in reducing the accumulation of organic matter, leftover feed, and metabolic waste that can reduce water quality. Protein skimmer technology works by lifting dissolved organic particles before they break down into toxic compounds such as ammonia and nitrite, thus creating a more stable and healthy cultivation environment for marine ornamental fish such as clownfish and blue tang. With the application of this technology, it is hoped that fish survival will increase significantly, while supporting the sustainability of local community cultivation efforts.

Figure 3. Training

Technology Application

Protein skimming is a technology used to remove microparticles and dissolved organic matter. This method relies on a basic process known as adsorptive bubble separation, and the device used is called a protein skimmer. Studies investigating the performance of protein skimmers have revealed significant total suspended solids and protein removal, reduced microbial activity, and positive contributions to dissolved oxygen concentration and carbon dioxide gas removal. Protein skimming has shown greater effectiveness in seawater due to its higher surface tension compared to freshwater (Kovács et al., 2023). The protein skimmer device in this community service is presented in Figure 4.

Figure 4. Protein Skimmer

The installation of a protein skimmer in a marine ornamental fish farming system is done by placing this tool in the sump or filter tank, so that water from the cultivation pond can flow through the skimmer before returning to the main pond. The installation position must pay attention to the water level and circulation so that the air bubbles produced are maximized in capturing dissolved organic particles. It is also important to ensure that the air hose and water pump are properly installed and that there are no leaks that interfere with the performance of the tool. The installation of the protein skimmer is carried out together with marine ornamental fish farmers with technical assistance from the Reefer Lombok service team and partners, so that it can be adjusted to the conditions of the local cultivation system.

Figure 5. Handover of Protein Skimmer Equipment

The operation of the protein skimmer is relatively easy, but requires regular monitoring to work optimally. When operated, this tool will start to produce foam in the neck of the tube and collect it in a waste collection cup. Farmers need to check the volume and color of the foam regularly—dark brown foam indicates that the removal of dirt is effective. For maintenance, the main parts such as the pump, air duct, and foam container need to be cleaned regularly (at least 1-2 times a week) so that they do not become clogged with mucus or salt deposits. This routine maintenance is important to maintain the efficiency of the protein skimmer in the long term and ensure that the water quality remains optimal for the growth and survival of marine ornamental fish.

Protein skimmer technology is one of the effective mechanical and chemical filtration methods in marine ornamental fish farming, especially to control water quality in closed or semi-closed systems. The use of protein skimmers is the right solution to increase the efficiency of marine ornamental fish farming such as clownfish and blue tang which previously experienced problems due to declining water quality. This technology has been proven to be able to reduce stress levels in fish, increase survival rates, and support sustainable cultivation productivity. In addition, the application of protein skimmers is also the first step in building a more environmentally friendly and adaptive cultivation system to coastal challenges in the West Lombok region.

Mentoring and Evaluation

Mentoring and evaluation in this community service activity are carried out continuously to ensure that the technology and knowledge that have been provided are truly implemented and have a positive impact on marine ornamental fish farmers in Dusun Puyahan. The community service team together with Reefer Lombok partners routinely monitor the use of protein skimmers, evaluate water quality, and assess the increase in the survival rate of marine ornamental fish. In addition, open discussions are held with farmers to identify technical and non-technical obstacles faced in the field. This evaluation is the basis for designing further improvement strategies and ensuring the sustainability of the program, while encouraging community independence in implementing more efficient and environmentally friendly cultivation management.

The results of this community service showed a significant increase in the survival rate of clownfish and blue tang after the application of protein skimmer technology in the cultivation system. Previously, the survival rate of clownfish only reached around 80% and blue tang reached around 81%, which was caused by less than optimal water quality due to the accumulation of organic waste and toxic substances such as ammonia. After training and implementation of the use of protein skimmers, which function to remove dissolved organic particles and improve water quality, the survival rate of clownfish increased to 95% and blue tang to 94%. This increase shows that protein skimmer technology plays an important role in creating a healthier cultivation environment and supporting the optimal growth and survival of clownfish and blue tang.

Program Sustainability

The sustainability of this community service program is designed so that it can be continued independently by marine ornamental fish farmers in Dusun Puyahan while still prioritizing the principles of independence and empowerment of local communities. The community service team has also provided written guides and video tutorials containing steps for installing, operating, and maintaining protein skimmers, as well as opening communication access through contacts that can be contacted if farmers experience technical difficulties. Through this support, it is hoped that farmers will not only be able to maintain the technology and cultivation practices that have been introduced, but also develop their businesses sustainably and adaptively to the challenges of the coastal environment.

4. Conclusion

The conclusion that can be drawn from this community service activity is that information, knowledge, and science have been conveyed to partners (Reefer Lombok) and marine ornamental fish farmers in Puyahan Hamlet, South Lembar Village, Lembar District, West Lombok Regency on how to maintain the quality of cultivation water to improve the survival of marine ornamental fish through the application of protein skimmer technology. Protein skimmers are important in marine ornamental fish cultivation because they are able to remove dissolved organic particles before they decompose into toxic compounds such as ammonia and nitrite. The main benefits are maintaining stable water quality, reducing stress on fish, and increasing the survival rate and overall success of cultivation. The role of Reefer Lombok is very good as a partner for the implementation of technical actions in the field and the dissemination of knowledge. Future community service activities should focus on continued technical assistance and expanded training on integrated water quality management to support sustainable marine ornamental fish cultivation.

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