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Original Article

Application of Appropriate Technology in Optimizing Tilapia Hatchery in Fish Farmer Groups in Pudak Payung Village, Semarang

Beata Ratnawati[1]✉, Ayutyas Sayekti[2], Andi Early Febrinda[3], Cecilia Eny Indriastuti[4], Sandy Satria Wicaksono[5]

[1,2,3,4,5]IPB University

Correspondence Author: beata@apps.ipb.ac.id✉

Abstract:

This program aims to implement appropriate technology, specifically, the Recirculating Aquaculture System (RAS), to optimize tilapia breeding in the fish farmer groups in Pudak Payung Village, Semarang. The RAS technology is applied to improve efficiency, effectiveness, and productivity in the breeding process, hoping to enhance fish seed quality and survival rate. The results show that this technology has reduced water usage, and decreased seed mortality rates. The training provided has also improved the knowledge and skills of farmers in managing the RAS system and water quality. The level of satisfaction among the served community is extremely high, although challenges related to excellent seeds, access to capital, marketing, and harvest management still pose some obstacles. In conclusion, RAS technology has great potential to improve the welfare of tilapia farmers, but further support from the government, academics, and stakeholders is needed for the sustainability and development of the program.

Keywords: Recirculating Aquaculture System (RAS), tilapia breeding, appropriate technology, and fish farmer.

Introduction

*T*ilapia (*Oreochromis niloticus*) is a widely-cultured freshwater fish with high adaptability on various environmental conditions (Sibagariang et al., 2020). Tilapia culture possesses great potential in improving the community welfare in Indonesia, including in Semarang City. In Pudak Payung Village, numerous fish farmer groups have been operating for a long time. Although the potential for natural resources and available labor exist, the level of productivity and quality of tilapia seed production is still suboptimal, due to various factors, such as limited knowledge, low technology access,

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and inefficient resource management.

A way to increase the productivity and quality of tilapia seeds is through the application of appropriate technology, like the Recirculating Aquaculture System (RAS) technology. RAS is a fish culture system that allows efficient use of water by recirculating the waste water through a filtration, that soon can be reused as a water source (Susanti et al., 2021). This technology is highly suitable for application in areas with limited water resources for further land and water uses efficiency. This community service was carried out in Pudak Payung Village, Semarang. The application of RAS to fish farmers in Pudak Payung Village is expected to increase production results in terms of quantity and quality, with more efficient water use and better water quality control. By using this technology, the condition of the aquatic environment can be well-maintained, so the tilapia growth can be more optimal and minimize the fish disease risk. In addition, RAS also allows for a more consistent production throughout the year without being too dependent on external environmental conditions. The application of RAS technology can also support environmental sustainability, because this technology reduces wastewater produced from fish culture to ensure that the breeding and cultivation practices remain sustainable in the long term without polluting the environment.

Through this community service, an in-depth study and implementation of RAS technology will be conducted in fish farmer groups in Pudak Payung Village. This study aims to provide practical solutions that can be adopted by local fish farmers to increase the production efficiency for tilapia fish breeding activities. Thus, this study not only aims to improve the economic aspect, but also to strengthen food security and maintain environmental sustainability in the area.

Methods

The implementation of community service in assisting the tilapia fish farmers in Pudak Payung Village, Semarang, through Recirculating Aquaculture System (RAS) technology will be performed through several strategic stages. The first stage is a needs analysis and initial survey, which aims to identify the needs and problems faced by tilapia fish farmer groups in the area. This survey will collect data related to the existing conditions of the culture process (Figure 1), existing technology, and the capacity of human and natural resources.

Figure 1 Culture process before the application of RAS

Furthermore, the RAS system is designed in accordance with local conditions, based on the results of the needs analysis from the initial survey. The system design will consider various factors, such as land area, production capacity, water resources, technical and financial capabilities of the farmers. Training and workshops will be held to equip farmers with the necessary knowledge and skills to operate and maintain the RAS system. Training materials include water quality management, breeding techniques, fish maintenance, and risk management to overcome problems in using the RAS system.

The RAS technology is implemented after training, where the RAS system will be installed at the selected culture location. The community service team will accompany the installation process and provide supervision to ensure that the system runs according to design (Figure 2). Furthermore, mentoring and monitoring activities are carried out periodically to monitor the performance of the RAS system, identify obstacles, and provide solutions and recommendations for further improvement. This monitoring also includes an evaluation of RAS technology implementation impact on productivity, efficiency, and sustainability of culture business.

Figure 2 RAS system circuit

The final stage is an overall evaluation of the RAS technology implementation effectiveness. The results of this evaluation will be used to improve the system and provide input for further development. In addition, the results and experiences of RAS technology implementation will be disseminated to other fish farmer groups in Semarang and its surroundings through seminars, publications, or further training with the aim of replicating successful models in other areas.

Results

Sub 1 Fish farmer problems

The process of tilapia breeding and culture in Pudak Payung Village faces numerous significant challenges, related to seed quality, capital, market access, and harvest management. According to (Hermawan et al., 2019) that local conditions, market demand, and other factors should be considered more broadly, before making major investment decisions in agricultural businesses. One of the main obstacles is the quality of tilapia seeds. Farmers often have difficulties in obtaining high-quality seeds

consistently. Low-quality seeds present low survival rates, slow growth, and high susceptibility to diseases. In addition, the unstable supply of excellent seeds often prevents farmers from starting the hatchery cycle on time, which disrupts the production cycle and affects harvest yields. These seed-related problems show that although Recirculating Aquaculture System (RAS) technology is applied, long-term success still depends heavily on the availability of excellent seeds. The government and related institutions need to provide support to ensure the supply of excellent seeds, either through the development of local hatcheries or seed subsidy programs to assist farmers.

In addition to the seed problems, limited business capital is also a major obstacle. Although RAS technology is helpful to increase the cultivation efficiency, the initial investment required to purchase equipment and infrastructure is fairly high. Many farmers have no access to adequate financing sources, so they rely on personal capital or loans that often limit the scale of their businesses. Daily operational costs, such as feed, system maintenance, and fish treatment, also cause the capital burden. In addition to technology to emphasize this challenge, financial support becomes a highly important to support the sustainability of farmer businesses. The role of the government and financial institutions is needed to facilitate financial access, either through the people's business credit (KUR) scheme or capital grant programs for farmers.

The market access is also a major challenge for farmers in Pudak Payung Village. Although tilapia production has increased, farmers often face difficulties in selling their harvests consistently. Fluctuations in market prices and competition with products from other regions often reduce the profits. This problem shows the importance of strong and sustainable marketing network. The government and related parties need to help farmers build wider market access through cooperation with distribution companies or the development of digital markets that allow farmers to sell their harvests directly to consumers.

The harvest period of tilapia is highly dependent on environmental conditions, such as water quality, feed quality, and fish health. Irregular harvest periods often occur, due to RAS system disruption or fish health problems, which ultimately impacts the farmer's income. Irregular harvest periods indicate that better management is necessary to maintain the production consistence. Further training in RAS system management, water quality maintenance, and disease prevention is essential for farmers to optimize their harvest period and increase their income.

Overall, the problems faced by tilapia farmers in Pudak Payung Village reflect a further support from the government, academics, and other stakeholders. The RAS technology has great potential to increase productivity and efficiency, but its success depends on a holistic solution to address challenges related to seeds, capital, markets, and harvest management. With a high support, farmers in Pudak Payung Village can be more independent and successful in developing their businesses.

Sub 2 Program Implementation

The implementation of Recirculating Aquaculture System (RAS) technology in tilapia fish farmer groups in Pudak Payung Village showed that the majority of participants were satisfied with the program. RAS technology is considered to provide more efficient and more effective action for fish farming, especially in the breeding activity, based on the significant increase in seed survival rates, which has a positive impact on overall production results. In addition, water savings and better environmental management are

aspects that are highly appreciated by farmers. This high level of satisfaction proves that the implementation of RAS technology effectively supports the long-term success of tilapia breeding efforts.

In implementing this program, the role of the government is extremely important, especially in providing policy support and facilities to optimize the program results. Local governments, especially the Fisheries Service, are expected to assist in providing infrastructure and regulations for farmer groups to easily access the RAS technology. In addition, the government can also provide incentives in the form of equipment subsidies or advanced training to strengthen the adoption of this technology among other tilapia farmers. RAS technology can be applied more widely and effectively in various fish farming communities with fully support from the government.

Academics also play an important role in the development of this program, especially in terms of providing the knowledge and technology to improve cultivation results. Academics from universities play a role in conducting research and innovation related to RAS technology, besides facilitators in transferring knowledge to farmers through training and mentoring (Figure 3). Collaboration between academics and tilapia farmers can produce more effective solutions in overcoming technical problems during the cultivation process, such as water quality management and selection of superior seeds. The role of academics is also important in evaluating the results of the program and providing recommendations for improvements for future implementation.

Gambar 3 Fish culture training

Other stakeholders, such as investors, suppliers of farming equipment, and financial institutions, also have an equally important role. They can provide the financial and logistical support to expand the use of RAS technology among tilapia farmers. Investors can see a large market opportunity from developing tilapia breeding businesses with RAS technology, considering the increased production results and better fish quality. Financial institutions, such as banks or cooperatives, can provide easy access to financing for farmers who want to adopt this technology, so that they can grow their business scale more quickly.

In terms of market opportunities, RAS technology opens wider access for tilapia farmers to penetrate domestic and international markets with better fish quality and

higher production levels. According to (Jandu and Sudirman, 2024), farming subsystem development efforts are carried out through production activities, such as the use of quality seeds, proper fertilization, efficient harvesting techniques, and good post-harvest handling. Tilapia products from Pudak Payung Village have the potential to meet the increasing market demand, both in the retail sector and the food industry. In addition, the global trend towards environmentally friendly fishery products also provides added value for tilapia culture with RAS technology. This system is more efficient in the use of water resources and is more sustainable, than the conventional cultivation methods.

The training and workshop conducted as part of the community service program succeeded to improve the knowledge and skills of tilapia fish farmers, especially in breeding activities. Before the training, most participants were unfamiliar with RAS technology. After the training, they became more knowledgeable about water quality management, selecting excellent seeds, and good management practice in breeding using RAS technology. This improvement is highly important, as breeding stage is a critical phase in the tilapia production cycle. A better understanding is expected to increase the seed production, which will then have an impact on the sustainability of the overall cultivation business.

The sustainability of this community service program is clearly observed from the ability of the fish farmer group in Pudak Payung Village to operate and maintain the RAS system independently, after the program completion. This technology allows for better water quality control to maintain the successful breeding activity. Monitoring results indicate that this group can maintain high quality if tilapia seeds and successfully reduce the mortality rate of seeds. Some farmers even consider expanding the scale of their breeding business by utilizing the RAS system. This condition presents that the technology can integrate well into breeding practices, opening up opportunities for economic independence for farmers.

This community service program has also succeeded in creating a learning resource that is useful for other communities around Semarang. Documentation of best practices in the application of RAS technology in tilapia fish seeding has been disseminated, and the farmer group in Pudak Payung Village is recently a model for other communities interested in adopting similar technology. Follow-up workshop programs and training between farmer groups are continuously conducted, so that knowledge about RAS technology can continue to be disseminated, strengthening the sustainability of this program at the regional level. Moreover, the implementation of RAS technology has also succeeded to overcome social problems related to the low survival rate and low productivity level of tilapia seeds. This technology has increased seed production significantly, providing economic stability for farmers. The success of this program has also been conveyed to the local government as an example of the appropriate technology implementation, worthy of being expanded to other communities. Some policy recommendations suggested are the provision of incentives for farmers who are willing to adopt RAS technology and the development of sustainable training programs that focus on fish breeding. A right policy support will also facilitate RAS technology as a strategic solution in increasing the productivity and welfare of fish farmers in other regions. Broad market opportunities, especially from better fish quality and environmentally friendly technology, can further strengthen the competitiveness of local fishery products nationally and globally.

Conclusion

The application of Recirculating Aquaculture System (RAS) technology has successfully increased the efficiency and productivity of tilapia fish breeding in Pudak Payung Village. This technology helps improve seed quality, fish survival, and save water usage. Participants were satisfied with the program, based on their increased knowledge and skills to enable performing the independent business sustainably. However, challenges related to seeds, capital, marketing, and harvest time require further support from the government and stakeholders, so this program can develop more widely.

Suggestion

This useful technology can be applied in other fish culture activities. In addition, this technology can be applied in people's homes to use land more efficiently.

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