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Developing Nila Larasati Aquaculture for Economic Strengthening of the Muhammadiyah Farmers' Congregation in Sedayu

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Abstract

The cultivation of Nila Larasati tilapia in Argorejo Village, Sedayu, Bantul, was carried out through a multiyear community service program by Ahmad Dahlan University in collaboration with the Rejo Ayu Fish Farmers Group. The program included pond construction, seed selection, stocking, and maintenance. Two ponds (4×5×2 m^3 and 3×7×2 m^3) were built on a 100 m^2 backyard, protected by a 2-meter galvanized fence and shading nets to prevent predators. A total of 3,000 fingerlings were stocked at around 200 fish/kg and fed twice daily. After three months, the fish reached market size (8–9 fish/kg), producing 300–320 kg per cycle and generating IDR 8.4–9.6 million in gross income at prices of IDR 28,000–30,000/kg. This shows successful adoption of aquaculture technology and improved community capacity. However, issues like predation by Varanus salvator and limited stocking due to financial constraints remain. To improve productivity and sustainability, future programs should enhance biosecurity and expand access to micro-financing.

1. INTRODUCTION

Argorejo Village, located in Sedayu District, Bantul Regency, Special Region of Yogyakarta, is currently experiencing significant demographic transformations due to urban expansion and increased population mobility. With an area of approximately 7.23 km² and a population of 14,361 in 2020, the village reaches a population density of 1,986 individuals per km², placing it among the most densely populated rural settlements in the region (Afrianto, & Purnamasari 2019). The age structure shows a dominance of the productive age group (15–64 years), accounting for 69.05% of the population, followed by children aged 0–14 at 21.35% and elderly citizens (65 years and above) at 9.60% (Alviodinasyari, et.al, 2019). However, a significant rate of outward migration, especially among the youth, poses a threat of demographic imbalance and decreasing productivity of the local labor force (Asikin, 2017).

In terms of educational attainment, most residents have limited formal education. In 2019, data indicated that out of 11,383 individuals, 8,765 had no schooling experience, 833 had completed primary school, 1,307 had graduated from junior secondary school, 417 had completed senior secondary school or vocational training, and only 61 had accessed higher education (Asikin, et.al. 2018). These disparities limit access to formal employment, reduce information literacy, and restrict participation in development programs. Similar rural education patterns have been linked to persistent poverty and vulnerability in social and economic transitions (Azizah, & Wahyuni, 2021; Daryanto, & Nuraini, 2020).

Agriculture remains the main source of livelihood in Argorejo, with 1,401 people working as farmers and 332 as agricultural laborers (Dewi, & Lestari, 2022). However, agricultural land is increasingly being converted into residential and small industrial areas, resulting in a shift from agrarian-based to non-agrarian livelihoods. This transformation, observed across many rural parts of Java, has disrupted traditional food systems and weakened rural socio-cultural resilience (Fera, et.al., 2019; Hidayat, & Wulandari, 2021). The conversion of farmland threatens food security and leads to the fragmentation of social cohesion and the

erosion of community-based cultural values Kurniawan, & Astuti., (2020).

To address these challenges, a multi-year Community Service Program (PkM) by Universitas Ahmad Dahlan (UAD) introduced a community empowerment initiative centered on tilapia (Oreochromis niloticus) aquaculture. This program aims to enhance economic self-sufficiency and reduce dependence on unstable informal sectors. It is implemented in collaboration with the local fish farmers group Rejo Ayu (Pokdakan), which has foundational experience in small-scale aquaculture management (Mulyani, & Fauzan, 2020).

Tilapia farming was selected for its several advantages: a relatively short harvest cycle of 3–4 months, low operational costs, and stable market demand. The village's proximity to consistent water sources and river flows offers a natural advantage for aquaculture (Prastari, et.al., 2017; Putri, & Setiawan, 2021). According to global and national trends, tilapia has become one of the most important freshwater fish in supporting food security, especially in Asia (Tajerin, et.al., 2000).

In Klaten, Central Java, the Ecosystem Approach to Aquaculture (EAA) has been implemented in tilapia farming. This approach emphasizes ecological sustainability and the strengthening of local institutions. Although not yet fully optimized, this model underscores the importance of integrating social and environmental dimensions into aquaculture practices (Nugroho, et.al., 2022).

Meanwhile, conventional tilapia farming in Pondok Mekar, North Minahasa, has demonstrated economic success, achieving a cost-benefit ratio (R/C) of 1.37. This outcome is primarily attributed to efficient feed management and the utilization of local labor (Kaunang, et.al., 2024).

In Vietnam, the conversion of rice fields into tilapia farming ponds has made a substantial contribution to food security and improved household income among smallholder farmers. Government involvement and technical support have been key success factors in this program (Freshwater Aquaculture's Contribution to Food Security in Vietnam: A Case Study of Tilapia in Hai Duong Province. 2010).

In Timor-Leste, a public-private partnership model focusing on the production of genetically improved farmed tilapia (GIFT) seed has proven

effective in enhancing seed production capacity and broad distribution. This model offers a viable replication pathway for small-scale aquaculture communities in Indonesia (Pant, et.al., 2024).

In the Philippines, collaborations between public and private sectors in research and development have reinforced the sustainability of tilapia aquaculture systems and accelerated the achievement of national fisheries development goals (Acosta, et.al., 2006). This empowerment model is designed not only to generate sustainable income but also to enhance the community's economic resilience. In addition to providing technical training and technology transfer, the program also supports business management mentoring, institutional capacity building, and market access facilitation (Toifur, et.al., 2023). It specifically addresses key structural challenges such as the limited economic participation of women, low engagement of youth in productive enterprises, and the shift of labor from agriculture to non-agrarian sectors without adequate re-skilling [6], Fera, et.al., 2019; Tajerin, et.al., 2000).

2. METHOD

The community service program (PkM) employed various methods, including outreach, training, hands-on field practice, mentoring, and evaluation. Each phase aimed to equip the community with the essential knowledge and practical skills needed for sustainable tilapia cultivation, specifically Nila Larasati (Pedrazzani, et.al., 2020).

a. Outreach

The outreach phase aimed to provide foundational information on fish farming techniques, suitable fish species for cultivation, pond construction, feeding methods, and water management. This was accomplished through presentations, discussions, and Q&A sessions to ensure participants thoroughly understood aquaculture practices (Radosavljevic, et.al., 2025). The outreach activities took place from July 1, 2024, to May 30, 2025.

b. Training

The training phase focused on enhancing participants' practical skills in fish farming. It covered topics such as pond construction, seed handling, feeding practices, and pest and disease control. A hands-on, learning-by-doing approach was utilized, allowing

members of the Rejo Ayu fish farmers group (Pokdakan) to directly practice the techniques taught during the sessions (Hossam, et.al., 2024; Aljehani, et.al., 2023).

c. Field Practice

Field practice was implemented to apply the knowledge and skills gained in real Nila Larasati cultivation activities. This component occurred at the designated fish farming site and included practical tasks such as pond construction, seed selection and purchase, fish stocking, feeding, and monitoring fish growth (Mathisen, et.al., 2016).

d. Mentoring

Mentoring was provided to offer ongoing guidance and technical support to the Rejo Ayu fish farmers group. This included regular visits to monitor progress, assist with troubleshooting, and provide technical advice to enhance cultivation practices (Njuki, & Gopal, 2024).

e. Evaluation

Evaluation was conducted using both quantitative and qualitative approaches to assess the success of tilapia (*Oreochromis niloticus*) rearing based on technical, economic, and environmental indicators (Suresh, & Bhakta, 2023). The evaluation process included monitoring of technical parameters such as stocking density, considering pond size and the number of fish, growth performance based on average body weight at harvest, and feeding practices, including feeding frequency and recorded fish response (Torell, et.al., 2023). Production performance was evaluated through post-harvest fish biomass, while economic aspects included gross income and estimated profit margins. In addition, qualitative assessment was carried out to evaluate partner empowerment, focusing on the level of engagement, capacity building, and adoption of aquaculture practices by the local fish farming group (Belton, et.al., 2011; Alviodinasyari, 2019).

The stages of Nila Larasati cultivation are illustrated in Figure 1.

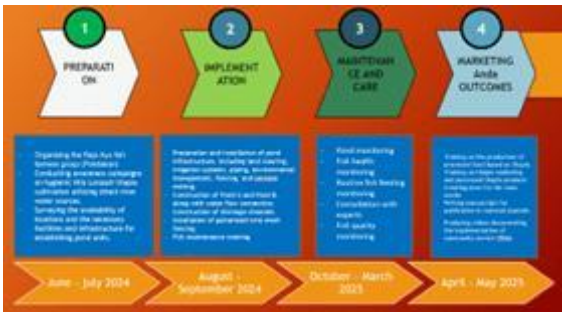

Figure 1. Stages of Tilapia Larasati Cultivation Implementation

3. RESULTS AND DISCUSSION

Results

a. Preparation Stage

The cultivation of Larasati tilapia was carried out in collaboration with the Jamaah Tani Muhammadiyah Sedayu. During the preparation stage, we provided training on tilapia Larasati farming in ponds. This included an introduction to Larasati tilapia, which is a hybrid of black and red tilapia.

Larasati tilapia offers several advantages over other types, including a growth rate similar to red tilapia and a strong response to feeding like black tilapia. Additionally, these fish have a high meat yield and excellent durability.

For optimal farming conditions, the ideal pond size should accommodate 12-15 m^3 for every 1,000 fish, with a minimum depth of 75 cm. This depth helps maintain stable water parameters, such as temperature, pH, ammonia levels, and the balance of the micro-ecosystem in the pond.

Before introducing the fish, the pond bottom should be sprinkled with lime at a rate of 25 grams to 1 kg per m^2 and manure at ½ kg per m^2. The pond should then be filled with water and allowed to settle for 5-7 days to encourage plankton growth, which supports optimal fish development.

We also introduced alternative feeds to enhance the fish's growth, including rice bran, leftover rice, and coconut pulp, in addition to pellets. For 1,000 fries over a maintenance period of 68-70 days, approximately 203 kg of feed is required. At a feed price of Rp10,000 per kg, the total cost comes to about Rp2,030,000.

Figure 2. The Land Designated for Larasati Tilapia Cultivation

Figure 2 illustrates the land designated for the cultivation ponds of Larasati tilapia. The tilapia Larasati cultivation activities were carried out with the Jamaah Tani Muhammadiyah Sedayu partner. Extension on tilapia Larasati farming in ponds was conducted during the preparation stage. At this stage, the definition of Larasati tilapia, a hybrid of black and red tilapia, was introduced. Several advantages of

Larasati tilapia compared to other types include fast growth similar to red tilapia and responsiveness to feeding like black tilapia. In addition, fish have a large amount of meat and high durability. The ideal pond size can accommodate 12-15 m^3 for every 1000 fish. The minimum depth should be 75 cm. It is related to the stability of water parameters, such as temperature, pH, ammonia levels, and the balance of the micro-ecosystem in the pond. The pond bottom is sprinkled with lime at 25 grams – 1 kg per m^2 and manure at ½ kg per m^2, then filled with water. This condition is allowed to stand for 5-7 days until plankton grows. With this condition, the fish can develop optimally. Alternative feed was also introduced, supporting the fish's growth rate besides pellets, including rice bran, leftover rice, and coconut pulp. The estimated cost for 1000 fry, with a maintenance period of 68-70 days, is approximately 203 kg of feed. With the feeding price of Rp10,000/kg, the total cost required is about Rp2,030,000.

b. Implementation Stage

During the implementation stage, preparations were made for the pond, tilapia fry, irrigation system, water drainage, and pond edge protection. Two ponds were constructed: Pond A, measuring 8 x 3 x 1 meters, and Pond B, measuring 4 x 5 x 1 meters. There were no specific specifications for the two ponds, except that Pond A was positioned near the water inlet, while Pond B was located near the water outlet. Water was channeled between the two ponds through a 3-inch PVC pipe. The pond, tilapia fry, irrigation system, water drainage, and pond edge protection were prepared during the implementation stage.

Figure 3. Ponds Prepared for Larasati Tilapia Cultivation

The pond edges were provided with a 1-meter-wide path, and the perimeter of the land was enclosed with a 2-meter-high galvanized wire mesh fence, 35 meters in length (Figure 4), to prevent otters from entering. The top of the pond was covered with paranet to prevent storks, which are fish predators, from entering.

Figure 4. Installation of galvanized fence and paranet netting

Pond A was stocked with 1500 fry measuring 5-7 cm. The same stocking was applied to Pond B. Fish maintenance was carried out by monitoring several water quality parameters, such as water surface height, clarity, and water health. To ensure optimal water quality, pH, ammonia (NH_3), and temperature sensors were used. The ideal pH for fish maintenance ranges from 6 to 7, ammonia levels should be between 0.01-0.03 mg/L, and the temperature should be between 26°C and 30°C (Universitas Ahmad Dahlan. 2024). The fry was introduced on January 19, 2025 (Figure 5).

Figure 5. Delivery of Larasati Tilapia Fry to the Rejo Ayu Fish Farmer Group for Pond Stocking.

Based on observations made on February 5, 2025, the pond water temperature was recorded at approximately 27°C, with a pH of 6.2 and ammonia levels at 0.007 mg/L, indicating favorable conditions for fish growth. Similar checks conducted on April 15, 2025, showed consistent results, with a temperature of 27°C, pH of 6.2, and ammonia levels of 0.007 mg/L. Maintaining the water temperature within the optimal range is crucial for supporting fish metabolism and accelerating growth [32].

Figure 6. Condition of the fish after 3 weeks of maintenance.

Table 1. Task Distribution for Larasati Tilapia Cultivation by Pokdakan Rejo Ayu, Kalurahan Argorejo, Sedayu, Bantul.

Pokdakan Rejo Ayu	UAD PkM Team	Task
Syamsuri	Dr. Moh. Toifur, M.Si.	- Surveying fish fry, - Checking the smoothness of activity organization, - Holding meetings
Hepnu Danarto	Okimustava, M.Pd., Alhawarizmi (student)	- Feeding, - Measuring temperature, pH, and NH_3, - Providing technical consultation on fish farming environmental safety and quality
Ismanto	Listiati Budiutami, M.Sc.	- Feeding, - Providing consultation services on issues
Iin Solihin	Dr. Dian Artha Kusumaningtyas, M.Pd.Si.	- Feeding, - Liaison between Pokdakan and PkM UAD
Sarjiman	Puji Lestari (student), Indra Budi Kurniawan	- Feding, - Documentation of activity data
Sarjono	Nini Subini (student)	- Feeding, - Documentation of activity data
Sarjilah	Eko Susanto, M.Pd. (laboratory assistant)	- Feeding, - Provision of facilities, documentation, and media processing for activities

The pond conditions were good, with smooth irrigation, the fence effectively deterring otters, and the netting preventing storks. However, the fence was unable to stop monitor lizards. The partner community remained cohesive throughout the preparation, pond construction, maintenance, and care stages. The fish were in normal condition, healthy, and growing rapidly. Upon fry stocking on January 25, 2025, the fish count was 200 fish per kg. With feeding twice daily, by April 16, 2025 (or 3 months later), the fish size had grown to 8-9 fish per kg. The pond conditions were favorable, featuring smooth irrigation, a fence that effectively deterred otters, and netting that prevented storks from accessing the area. However, the fence was not effective against monitor lizards. The partner community remained united throughout the preparation, construction, maintenance, and care phases of the pond. The fish were healthy, in normal condition, and growing rapidly. After stocking the fry on January 25, 2025, the fish count was 200 fish per kilogram.

Discussion

By the third month of Larasati tilapia maintenance, several aspects related to the empowerment of Pokdakan Rejo Ayu in Larasati tilapia cultivation can be reported, as shown in Table 2.

Table 2. Empowerment of Pokdakan Rejo Ayu Partner

No	Evaluation Indikator	Average Score
1	How clear is your understanding of Larasati tilapia cultivation?	2.86
2	Skill transfer process in Larasati tilapia cultivation	3.00
3	Larasati tilapia cultivation has advantages compared to other tilapia types	3.00
4	Knowledge increase after participating in the Larasati tilapia cultivation training	2.86
5	Skills improvement after participating in the Larasati tilapia cultivation training	2.86
6	The target community benefits from the Larasati tilapia cultivation training	3.14
7	Commitment to Larasati tilapia cultivation	3.00
8	Larasati tilapia cultivation can increase residents' income	2.71
	Average Empowerment Score	**22.75**

Some challenges faced during the maintenance and suggestions for improvement include:

a. The current number of fish stocked in the pond remains insufficient to achieve optimal production levels. However, increasing the stocking density without an adequate supply of feed would result in stunted growth and reduced product quality. Therefore, in the second year of program implementation, it is necessary to allocate additional capital specifically for procuring high-quality and sufficient feed to support the healthy and sustainable growth of the fish population.

b. Although the pond area is already equipped with a 2-meter-high fence, monitor lizard (Varanus spp.) intrusions continue to occur, as these animals are capable climbers. To mitigate this issue, specialized technologies or methods need to be implemented, such as the installation of electronic pest repellents or the addition of protective netting that effectively deters monitor lizards without harming the surrounding environment.

c. The earthen ponds require intensive maintenance after each harvest to prevent damage caused by erosion and bank collapse. This condition prolongs the preparation time for the next cultivation cycle. Consequently, construction techniques or bank protection measures should be developed, such as applying soil stabilizers, planting erosion-controlling vegetation, or adopting semi-permanent wall systems (e.g., asbestos panels) to minimize damage and accelerate the maintenance process.

From a qualitative perspective, obtained through observations and evaluations of the partner, the pond and infrastructure

conditions showed that the galvanized wire fence and paranet netting were effective against otters and storks but not monitor lizards. Moreover, the partner demonstrated high commitment to the activities, reflected in task schedules, work distribution, and empowerment scores (majority scoring 3 out of 3). The process of knowledge and skill transfer was deemed successful. Technical improvements for the next stage include the lack of capital to increase fish population and the limitations of earthen ponds that require maintenance after every harvest.

From quantitative perspective, the units of analysis can be divided into two types: the number of fish and fish size, both used in the report.

a. Based on the number of fish.
   - Pond A and B each contained 1,500 fish fry.
   - Total fry: 3,000 fish with an initial size of 200 fish/kg.
   - Estimated initial total weight: 3,000 fish / (200 fish/kg) = 15 kg of total fry.

b. Based on fish size.

   After 3 months, the fish size reached 8-9 fish/kg, which is equivalent to:
   - 1 fish ≈ 111-125 grams.
   - Estimated current total weight (if all fish grew well):
     3,000 fish / 8.5 fish/kg average ≈ 353 kg.

c. Feed Efficiency.
   - Total feed provided over 3 months: 203 kg per 1,000 fish.
   - Total feed for 3,000 fish: 203 kg × 3 = 609 kg.
   - Harvest weight ≈ 353 kg, so the FCR (Feed Conversion Ratio) is: 609 kg feed / 353 kg harvest ≈ 1.73.

Based on Table 2, the Feed Conversion Ratio (FCR) of 1.73 indicates relatively good efficiency in the cultivation activities. Growth from an initial size of 200 fish/kg to 8-9 fish/kg in three months shows that the cultivation environment supports optimal growth. From an economic perspective, assuming a market price of Rp32,000/kg, the gross income potential from the harvest is estimated at Rp11,296,000, indicating that Larasati tilapia farming could serve as an alternative income source for the partner community.

4. CONCLUSION

The community service program (PkM), implemented through a series of

outreach, training, field practice, mentoring, and evaluation phases, effectively enhanced the knowledge and practical skills of the Rejo Ayu fish farmer group in the sustainable cultivation of Nila Larasati tilapia. Technically, the program improved participants' understanding of seed selection, pond management, optimal feeding practices, and disease control, which directly contributed to better fish growth and higher yields.

From a socio-economic perspective, the program significantly increased farmers' income through improved production performance. With the application of appropriate methods and continuous mentoring, participants were able to optimize their harvest, contributing to household income and empowering the local community. Additionally, qualitative evaluations revealed notable improvements in group capacity, self-reliance in aquaculture management, and active adoption of introduced aquaculture innovations.

The program's success was influenced by several key factors, including the consistency of mentoring, the quality of hands-on training sessions, and the active engagement of participants at each stage. Challenges such as fluctuations in water quality and changing weather conditions were also noted and addressed as part of sustainability considerations. Hence, the integrated approach combining knowledge transfer, field-based application, and comprehensive evaluation proved effective in building community capacity and generating positive technical and economic impacts.

Overall, this PkM initiative not only met its primary objective of enhancing tilapia farming skills but also made a tangible contribution to improving the socio-economic well-being of the local population. The approach demonstrated in this program can be recommended for broader implementation with necessary adjustments to accommodate specific local contexts.

To sustain and expand the impact, future steps include scaling the program to other groups, integrating digital monitoring tools, strengthening market access, providing ongoing training, and involving academic partners. These recommendations aim to enhance long-term sustainability, empower local communities, and

support innovation in rural aquaculture systems. This study lacks long-term sustainability evaluation, insufficient statistical analysis of yields, and minimal exploration of external variables influencing aquaculture productivity.

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