# Analysis of the impact of Tilapia Aquaculture Village Development (*Oreochromis niloticus*) on the welfare of fish farmers in Ponoragan Village, Loa Kulu District, Kutai Kartanegara Regency

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**ABSTRACT**

*This study aims to analyze the impact before and after the implementation of Ministerial Regulation of Marine Affairs and Fisheries (Permen-KP) No. 16 of 2022 on the Tilapia Aquaculture Village in Ponoragan Village on household income, employment absorption, and to identify the main challenges faced by fish farmers. The sampling method used was purposive sampling, with a total of 30 tilapia farmers as respondents and two key informants. The data were analyzed using income analysis, average income difference analysis with a T-test, and labor absorption analysis. The study results show that the average income of tilapia farmers before the implementation of the aquaculture village policy was IDR 120,569,272 per month, increasing to IDR 606,954,928 per month after implementation. This indicates a rise in the average income of fish farmers by IDR 486,385,656 following the policy's implementation. The implementation of the aquaculture village policy also had an impact on labor absorption, both from within and outside the family. Before the policy was implemented, the percentage of labor from within the family was 0.01228 percent, increasing to 0.01283 percent after implementation. Meanwhile, the percentage of labor absorption from outside the family increased from 0.01283 percent to 0.01897 percent. This increase reflects the additional workforce employed, both from within and outside the family, in response to increased production, income, and the farmers' commitment to involving the surrounding community. The main challenges faced by tilapia farmers include extreme weather conditions that often cause harvest failures, river water intrusion into ponds, which increases water volume and leads to fish escaping, and the use of pesticides by farmers to control fish pests and predators. These findings illustrate that the aquaculture village policy has great potential to improve farmers' welfare, but it must be accompanied by mitigation efforts to address existing challenges.*

## INTRODUCTION

Since the 1970s, Nile tilapia (*Oreochromis niloticus*) farming has been practiced in Indonesia. This aquaculture activity utilizes various farming media, such as earthen ponds, concrete ponds, raceways, and floating nets, along with different management strategies, including extensive, semi-intensive, intensive, monoculture, polyculture, monosex, and mixed systems, in both freshwater and brackish water environments (Altun et al., 2006).

Kutai Kartanegara Regency is one of the seven regencies in East Kalimantan Province designated as a minapolitan area through the Decree of the Minister of Marine Affairs and Fisheries of Indonesia No. 32/MEN/2010. This designation was further reinforced by the Kutai Kartanegara Regent's Decree No. 234/SK-BUP/HK/2011, which established the development location for the minapolitan area in Loa Kulu District as a growth pole for freshwater aquaculture activities.

Ponoragan Village, located in Loa Kulu District, Kutai Kartanegara Regency, has a strategic location with sufficient water resources to support the tilapia farming business. This village is also considered the center of fish farming activities in Loa Kulu District, with significant fisheries potential. Freshwater fisheries in this village produce Nile tilapia (*Oreochromis niloticus*) in ponds (Anshori, 2018). Fish farmers in Ponoragan Village have long been engaged in tilapia farming. They tend to prefer raising Nile tilapia because it is easier to maintain, requires minimal special treatment during the farming process, and is relatively simple to manage from stocking to harvest.

Based on observations and interviews with the Department of Marine Affairs and Fisheries of Kutai Kartanegara Regency and fisheries extension officers, it is suspected that the implementation of the Fisheries Farming Village Program in Ponoragan Village will have economic impacts, including increased household income for fish farmers and greater employment absorption.

## METHODOLOGY

This research was conducted from August 2024 to January 2025. The research location will be in Ponoragan Village, Loa Kulu District, Kutai Kartanegara Regency. The research data is divided into two types: primary data and secondary data.

Primary data consists of key information obtained from interviews with respondents in the field, structured according to the research objectives. Secondary data comes from supporting sources such as data from the Central Bureau of Statistics, the Fisheries Office, Village Monographs, books, theses, and journals (Nashrullah et al., 2023).

The primary data required for this study includes respondent identity, business performance (costs, investment costs, operational costs, production volume, and selling price), and labor absorption. Secondary data needed includes the Monograph of Ponoragan Village and Loa Kulu District, policies related to the Aquaculture Village for Nile Tilapia, and previous research relevant to the study's objectives.

Syafril et al. (2022) stated that primary data is collected through direct observation at the study site, accompanied by in-depth discussions with respondents. The guideline used is a list of questions prepared based on the research objectives. Secondary data is obtained through a literature review of sources related to the research objectives. Secondary data consists of both published and unpublished studies.

### Sampling method

Sugiyono (2016), as cited by Maharani et al. (2023), states that a sample is a portion of the total population and its characteristics. Therefore, the sample taken from the population must be truly representative so that there is no fixed rule or exact formula for determining sample size. The validity of a sample depends on whether its attributes and characteristics are proportional to those of the population.

The research sample consists of Nile tilapia seed cultivators in Ponoragan Village. The sampling method used in this study is Purposive Sampling, which is a type of sampling based on specific criteria predetermined by the researcher. This means that the sample is not selected randomly; instead, the researcher determines the sample based on certain considerations or standards (Justika et al., 2022).

The sample of Nile tilapia seed cultivators was determined based on specific criteria, namely:

1. Members of the aquaculture group who are still actively engaged in fish farming activities.
2. Aquaculture groups that have received government assistance related to the Aquaculture Village Program**.**

There are 60 Nile tilapia seed cultivators who are members of the aquaculture group, 30 of whom participate in the Aquaculture Village Program. Based on this data, the research sample consists of 30 cultivators. This study is supported by key informants, including one Fisheries Extension Officer (PPL) from Kutai Kartanegara Regency and an official from the Department of Marine Affairs & Fisheries of Kutai Kartanegara Regency.

The economic impact of implementing the Aquaculture Village Program in Ponoragan Village is measured using income analysis, analysis of the average income difference before and after program implementation using a paired t-test (Paired T-Test), and labor absorption analysis.

**Income Analysis**

Maylivia et al. (2023) state that income is the difference between the total revenue from the sale of fishery products and the total production costs incurred by fisheries business operators. Income is calculated using the formula from Soekartawi (2003):

$$K=PrT-BT-BTT$$

Explanation*:*

K = Total income from the fisheries business (Rp/month)
PrT = Total revenue from the fisheries business (Rp/month)
BT = Total fixed costs of the fisheries business (Rp/month)
BTT = Total variable costs of the fisheries business (Rp/month)

**Analysis of Income Differences**

This analysis aims to measure the significant difference in the average income of cultivators before and after the implementation of the program. This analysis uses the paired t-test, as stated by Nurgiyantoro et al. (2015) and cited by Abdusysyahid et al. (2021):

$$t = \frac{\sum D}{\frac{\sqrt{N\sum D^2 - (\sum D)^2}}{N-1}}$$

Explanation:

D = Difference between paired data
$\sum D$ = Sum of all differences
$\sum D^2$ = Sum of squared differences
N = Number of sample pairs

**Labor Absorption Analysis**

Labor absorption analysis is conducted based on variables such as the number of workers employed, working hours, and income of cultivators before and after program implementation. This analysis uses the formula for measuring labor absorption from non-family workers within the village, as stated by Yuliana (2017):

$$\text{PTK} = \frac{\sum \text{TK Non} - \text{Family from the Village}}{\sum \text{Workforce}} \times 100\%$$

Explanation:

PTK = Labor absorption rate

TK = Workers

Similarly, the formula for measuring labor absorption from family workers within the village is:

$$\text{PTK} = \frac{\sum \text{TK Family from the Village}}{\sum \text{Workforce}} \times 100\%$$

Explanation:
PTK = Labor absorption rate
TK = Workers

## RESULT AND DISCUSSION

### General overview of Ponoragan Village

Ponoragan Village is one of the villages located in Loa Kulu District, Kutai Kartanegara Regency, covering an area of 449.9 hectares. The village consists of 7 neighborhood units (RT) with a total population of 2,640 people, comprising 1,359 males and 1,281 females, spread across 833 households.

### Nile tilapia aquaculture in Ponoragan Village

Ponoragan Village has suitable soil and climate conditions for aquaculture activities. The cultivation of fish in this village aims to meet market demand for Nile tilapia while also serving as the main source of livelihood for the community. Nile tilapia (*Oreochromis niloticus*) is the most commonly farmed freshwater fish in Ponoragan Village due to several reasons:

1. Nile tilapia has a relatively fast growth rate, with a production cycle of 4–6 months.
2. It has high environmental tolerance, adapting well to water conditions such as temperature, pH, turbidity, COD, and BOD levels.
3. The fish is easy to cultivate and can be fed with a variety of food sources.
4. It has high economic value, both for local consumption and export markets.

The Nile tilapia aquaculture activities in the village involve a series of production processes, including pond preparation, water filling, fish seed stocking, feeding, water quality management, and harvesting.

### Aquaculture Village Program

The Aquaculture Village Program is a policy initiated by the Ministry of Marine Affairs and Fisheries to promote aquaculture production, thereby enhancing food security and supporting economic recovery after the COVID-19 pandemic at both regional and national levels. This program focuses on developing local superior commodities by increasing fish production and productivity, improving the income and welfare of fish farmers, and encouraging local community participation (Ministry of Marine Affairs and Fisheries, 2022).


Figure 1. Series of Nile Tilapia Seed Cultivation Activities (a) Pond preparation, (b) and (c) Water filling from a tributary of the Mahakam River, (d) Seed stocking, (e) Feeding, (f) Harvesting of Nile tilapia juveniles.

The aquaculture village program in Ponoragan Village has been running since 2022. To ensure the success of this program, activities such as training, hatchery development, fish grow-out, and marketing of aquaculture products have been conducted.

Assistance provided to Nile tilapia farmers under this program includes broodstock, biofloc cultivation systems, fish seeds and feed, silk worms, and other hatchery facilities. The fish farmer groups (Pokdakan) that have received support include Pokdakan Mina Kolam Mandiri Jaya, Pokdakan Cahaya Ulam Ponoragan, Pokdakan Pemuda Ponoragan, Pokdakan Gunung Ore, and Pokdakan Bina Kolam.

**Challenges in program implementation**

Despite its benefits, the program faces several challenges: Some fish farmer groups (Pokdakan) have not yet obtained legal status from the Kutai Kartanegara Regency Government. Members of the Pokdakan groups do not yet maintain proper financial records that meet the requirements of the Ministry of Marine Affairs and Fisheries.

**Income Analysis**

The income analysis begins with a **production cost analysis**, which evaluates the total production expenses incurred in Nile tilapia hatchery operations, both before and after receiving assistance from the aquaculture village program.

Production costs are categorized into Fixed Costs and Variable Costs. Before the program, total production costs were IDR 3,530,358, After the program, production costs increased to IDR 5,623,736. This difference in production costs indicates an increase in production activities for Nile tilapia seed cultivation following the program's implementation.

The program provided variable cost assistance to participating fish farmers, including Nile tilapia broodstock, feed, and vitamins. The total value of the assistance was IDR 168,667,000, distributed among 30 fish farmers.

Table 1. Variable Cost Assistance for Nile Tilapia Seed Farmers After Program Implementation

| No. | Description | Total Value (IDR/Production) | Average Per Respondent (IDR/Production) |
|---|---|---|---|
| 1 | Fish Seeds | 152,600,000 | 5,086,667 |
| 2 | Feed | 14,820,000 | 494,000 |
| 3 | Booster Stress Off Vitamin C | 367,500 | 12,250 |
| 4 | Booster Inrofloxs-25 | 498,000 | 16,600 |
| 5 | Effective Microorganisms 4 | 381,500 | 12,717 |
| Total | | 168,667,000 | 5,622,233 |

Income is the difference between revenue and the total production costs incurred during the production process (Iqbal et al., 2023). In farming businesses, income is divided into two types: gross income and net income. Gross income refers to revenue before deducting production costs, while net income is the income after deducting production costs (Ibrahim et al., 2021). The income obtained by fish farming respondents in Ponoragan Village is presented in the table below.

Table 2. Average Income of Fish Farmers Before and After the Aquaculture Village Program

| No. | Variable | Unit | Before | After |
|---|---|---|---|---|
| 1 | Production Volume | Fish/Month | 868,000 | 2,256,000 |
| 2 | Selling Price | IDR/Fish | 200-250 | 200-250 |
| 3 | Fixed Costs | IDR/Month | 5,857,728 | 45,072 |
| 4 | Variable Costs | IDR/Month | 100,053,000 | 168,667,000 |
| 5 | Total Production Costs | IDR/Month | 105,910,728 | 45,072 |
| 6 | Revenue | IDR/Month | 199,960,000 | 517,680,000 |
| 7 | Income | IDR/Month | 94,049,272 | 517,634,928 |

The implementation of the aquaculture village program in Ponoragan Village has had a positive impact on fish farmers, including support for fish seed production facilities such as feed, fish vitamins, and Nile tilapia broodstock worth IDR 168,667,000. This assistance was allocated to variable costs, increasing production output. This benefit allows farmers to use their capital for future production cycles. The increase in production has led to higher revenue and income for fish farmers, with a 500% increase in income after the program's implementation.

**Analysis of Income Differences before and after the Aquaculture Village Program**

A paired t-test was used to analyze whether there was a significant difference in the average income of fish farmers before and after the aquaculture village program for Nile tilapia in Ponoragan Village. The average income after receiving program assistance was IDR 17,254,498 per month, compared to IDR 3,134,976 per month before the assistance. The difference in average income before and after receiving assistance was IDR 14,119,522. Statistically, this difference is significant at a 5% confidence level, indicating that the program has had a meaningful impact on increasing fish farmers' income.

Benefits of the Aquaculture Village Program for Farmers:

1. Investment Support: Farmers received essential aquaculture infrastructure, such as PVC pipes, nets, boots, sorting tanks, and pH measurement tools. Since these investments are costly, the support allowed farmers to reallocate funds to operational expenses or household needs.
2. Operational Support: Assistance included broodstock, feed, vitamins (booster stress off vitamin C, booster inrofloxs-25, and EM4 for agriculture), which helped increase production capacity.
3. Market Expansion: The program increased demand for Nile tilapia fry as farmers could produce high-quality seeds in large quantities, meeting market demands beyond Ponoragan Village.

**Analysis of Labor Absorption in Families**

This study examines labor absorption from both within the family and from non-family members in the village before and after the implementation of the aquaculture village policy. Generally, in Ponoragan Village, priority is given to obtaining labor from within the family rather than from non-family members. However, aquaculture farmers may also employ external labor to support their business operations. Farmers typically implement a daily wage system during the cultivation process.

Before the establishment of the aquaculture village, the percentage of labor absorption from within the family was 0.01228 percent. After the implementation of the policy, labor absorption increased slightly to 0.01283 percent, indicating a minor change following the policy. Family labor typically consists of household members who do not yet have a fixed income, such as fathers, mothers, children, and siblings, who are utilized by farmers to assist in production activities.

**Analysis of Non-Family Labor Absorption**

Before the implementation of the aquaculture village policy, the percentage of non-family labor absorption was 0.01283 percent. After the program was implemented, this percentage increased to 0.01897 percent. This rise indicates additional labor absorption, both from within and outside the family, driven by increased production, higher revenue, and the goodwill of aquaculture farmers in employing local community members.

**Challenges in Implementing the Aquaculture Village Program**

1. Limited Availability of High-Quality Nile Tilapia Broodstock
   Farmers must purchase certified broodstock, and the breeding methods they employ must also be certified to ensure high-quality fish seed production.
2. Lack of Coordination Between Local Government and Farmers
   There is insufficient coordination, particularly in monitoring and evaluation. A possible solution is conducting outreach programs to improve farmers' understanding and involvement in implementing the aquaculture village program.
3. Limited Number of Fisheries Extension Officers
   The shortage of extension officers impacts program implementation from planning to execution and monitoring. A step-by-step monitoring approach should be applied to ensure program success.

**Challenges in Fish Seed Production**

1. Extreme Weather Conditions
   Harsh weather can cause crop failure in fish farming.
2. River Water Intrusion
   The intrusion of river water into ponds increases water volume, causing fish to escape. A possible solution is to build embankments along the riverbanks to prevent water from entering the ponds.
3. Use of Pesticides in Fish Ponds
   The use of pesticides in aquaculture is prohibited by several Indonesian laws, including:
   - Law No. 31 of 2004 on Fisheries
   - Law No. 32 of 2009 on Environmental Protection and Management
   - Law No. 74 of 2001 on Hazardous and Toxic Substances Management
   - Ministerial Decree No. 28 of 2004 on Good Aquaculture Practices (CBIB)
   - Law No. 22 of 2019 on Sustainable Agricultural Systems

However, pesticide use remains a dilemma. If pesticides are not used, predatory fish may eat the newly hatched Nile tilapia fry. A more effective solution is needed to address this issue.

## CONCLUSION

1. The implementation of Ministerial Regulation No. 16 of 2022 regarding the Nile Tilapia Aquaculture Village in Ponoragan Village has had a positive impact on household income, increasing by 500 percent.
2. Regarding labor absorption: Family labor absorption before implementation was 0.01228 percent and after implementation 0.01172 percent. Non-family labor absorption before implementation was 0.01283 percent and after implementation 0.01897 percent.
3. The aquaculture village program has resulted in significant income differences before and after its implementation.
4. The main challenges faced by Nile tilapia farmers include: extreme weather causing crop failure, river water intrusion into ponds, increasing water volume and causing fish to escape, continued use of pesticides to control pests and predatory fish, requiring a more sustainable solution.

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