Production Analysis of Nile Tilapia (*Oreochromis niloticus*) Cultivation in Floating Net Cages in Loa Kulu District: A Case Study

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ABSTRACT

This study aimed to analyze the financial feasibility of Nile tilapia ***Oreochromis niloticus*** *aquaculture conducted using floating net cages in Loa Kulu District. The research employed a case study approach, with data collected through direct observation, interviews, and participation in ongoing aquaculture activities at the study site. The collected data included information related to production aspects and the financial conditions of Nile tilapia farming operations in the field. The financial analysis of the "Sumber Rezeki" Nile tilapia (Oreochromis niloticus) farming enterprise in Sepakat Village demonstrated profitability and feasibility. The business generated an annual net profit of* ***IDR 13.48 million****, with positive investment indicators:* ***NPV = IDR 73.99 million****,* ***IRR = 89%****,* ***Net B/C = 3.55****, and a* ***Payback Period of 1.41 years****. Both production and sales exceeded break-even points, confirming the enterprise's viability and sustainable operation.*

INTRODUCTION

Kutai Kartanegara Regency, which covers an area of 27,263.10 km², is geographically located between 115°26′ and 117°36′ East Longitude and between 1°28′ North Latitude and 1°08′ South Latitude. Following regional administrative expansion, Kutai Kartanegara Regency is currently divided into 18 districts, namely Samboja, Muara Jawa, Sanga-Sanga, Loa Janan, Loa Kulu, Muara Muntai, Muara Wis, Kota Bangun, Tenggarong, Sebulu, Tenggarong Seberang, Anggana, Muara Badak, Marangkayu, Muara Kaman, Kenohan, Kembang Janggut, and Tabang. One of these districts is Loa Kulu District, which has an area of 1,405.7 km² and a population of 56,492 inhabitants (Central Bureau of Statistics of Loa Kulu District, 2024).

Kutai Kartanegara Regency possesses substantial potential in the natural resource sector. The abundance of natural resources has been utilized by local communities for various economic activities, including fisheries. In 2020, aquaculture production in Kutai Kartanegara Regency reached 125,428.65 tons. This production consisted of 838.22 tons from marine aquaculture, 51,350.14 tons from brackish-water pond culture, 1,857.36 tons from freshwater pond culture, 70,520.50 tons from cage culture, 836.23 tons from floating net cage culture, and 6.10 tons from rice-field aquaculture.

Nile tilapia *Oreochromis niloticus* is one of the major freshwater fish commodities originating from the Nile River and belongs to the family Cichlidae (Boyd et al., 2004). This species is characterized by a laterally compressed body shape, rough and broad ctenoid scales, and a relatively small head size (Arifin, 2016). Nile tilapia exhibits a wide tolerance to variations in temperature, pH, salinity, and dissolved oxygen,

making it highly suitable for aquaculture. Optimal water quality conditions for Nile tilapia culture include a water temperature of 23–30°C, pH ranging from 6.5 to 8.5, dissolved oxygen levels above 5 mg/L, ammonia concentrations below 0.02 mg/L, and water transparency exceeding 3 meters for grow-out culture in floating net cage systems (SNI, 2009). Additional advantages of Nile tilapia include its ability to spawn throughout the year, rapid growth when fed low-protein diets, and high resistance to disease (Anggraeni et al., 2020). The grow-out period required for Nile tilapia to reach market size generally takes approximately four months (Islami, 2013). In 2021, the number of floating net cages in Sepakat Village was recorded at 870 units; however, these data have not yet been updated by the village authorities.

METHODOLOGY

This research was planned to be conducted from August 2023 to May 2025. The research stages began with the preparation of the research proposal and continued through to the completion of the undergraduate thesis. The study was carried out in Sepakat Village. The basic method employed in this study was a case study approach. A case study is a form of research conducted by examining a particular case within a limited object of study (Raco et al., 2010).

The data used in this study consisted of both primary and secondary data. Primary data served as the main source of information and were obtained through direct interviews with the head of the "Sumber Rezeki" Nile tilapia farming group in Sepakat Village, Loa Kulu District. Interviews were conducted using a structured questionnaire developed based on the objectives of the study. Secondary data functioned as supporting information obtained from intermediary sources, including the Central Bureau of Statistics, the Fisheries Service Office, village monographs, monographs of the "Sumber Rezeki" Nile tilapia farming group in Sepakat Village, books, undergraduate theses, and previous scientific journals.

The primary data required in this study included respondent identity, sources of capital, and research variables such as investment costs, production costs, production output, and selling prices. Meanwhile, the secondary data included information obtained from institutions and agencies related to the study, relevant previous research findings, monographic data of Sepakat Village and Nile tilapia farmers in Loa Kulu District, annual variables such as production, selling prices, and revenue, reports from the Department of Marine Affairs and Fisheries, and other supporting references.

Sampling Method

Respondent selection in this study was conducted using a case study approach on the production analysis of Nile tilapia *Oreochromis niloticus* aquaculture in floating net cages in Loa Kulu District. Data collection was carried out through direct observation, interviews, and participation in ongoing aquaculture activities at the research site in order to obtain data, information, and explanations related to the research subjects in the field. This study employed a survey method, with interviews serving as the primary data collection technique. The collected primary data included descriptions of on-farm activities related to production performance and business performance.

Financial Aspect Analysis

Cost Analysis

According to Sobana (2018), costs refer to all expenditures incurred by a business enterprise. These costs include fixed costs, variable costs, taxes, and depreciation of investment assets. Total cost is calculated using the following formula:

$$\boldsymbol{TC = TFC + TVC}$$

Where:
TC *= Total Cost (IDR/cycle)*

TFC *= Total Fixed Cost (IDR/cycle)*
TVC *= Total Variable Cost (IDR/cycle)*

Total Revenue (TR)

According to Sobana (2018), revenue is obtained from the total sales of products generated within a specific period. Total revenue is calculated as follows:

$$\boldsymbol{TR = P \times Q}$$

Where:
TR *= Total Revenue (IDR/cycle)*
P *= Product Selling Price (IDR/fish)*
Q *= Quantity of Product Produced (fish)*

Profit Analysis

According to Nurdin (2010), profit is defined as the difference between total revenue and total production costs (fixed and variable costs). Profit is calculated using the following equation:

$$\boldsymbol{\pi = TR - TC}$$

Where:
$\boldsymbol{\pi}$ *= Profit (IDR/cycle)*
TR *= Total Revenue (IDR/cycle)*
TC *= Total Cost (IDR/cycle)*

Revenue–Cost Ratio (RCR)

To determine whether a business operation is profitable and financially feasible (Effendi & Oktariza, 2006), the Revenue–Cost Ratio (RCR) is calculated using the following formula:

$$\boldsymbol{RCR = TR/TC}$$

Where:
RCR (Revenue–Cost Ratio) *= Ratio between total revenue and total cost*
TR (Total Revenue) *= Total Revenue (IDR/cycle)*
TC (Total Cost) *= Total Cost (IDR/cycle)*

Criteria:

RCR > 1: the aquaculture business is profitable and financially feasible.
RCR < 1: the aquaculture business is not profitable and is financially unfeasible.
RCR = 1: the aquaculture business is operating at the break-even point.

Net Present Value (NPV)

Net Present Value (NPV), or net benefit, represents the present value of the income stream generated by an investment. NPV is calculated using the following formula:

$$\sum_{t=0}^{n} \frac{(Bt - Ct)}{(1+i)^{i}}$$

Where:
Bt *= Benefit in year* t
Ct *= Cost in year* t
n *= Business/project lifespan*
i *= Interest rate (discount rate, %)*
t *= Year of business operation*

Net Benefit–Cost Ratio (Net B/C)

The Net Benefit–Cost Ratio is obtained by dividing the present value of benefit flows by the present value of cost flows. The Net B/C ratio indicates the additional benefit generated for every one rupiah invested. A project is considered feasible if the Net B/C value is greater than one. Mathematically, the Net B/C ratio can be expressed as follows:

$$Net\frac{B}{c} = \frac{\sum_{t=0}^{n}\frac{(Bt-Ct)}{(1+i)^{i}}(Bt-Ct)<0}{\sum_{t=0}^{n}\frac{(Bt-Ct)}{(1+i)^{i}}(Bt-Ct)<0}$$

Where:
Bt *= Revenue (benefit) generated by investment in year* t
Ct *= Annual cost resulting from investment in year* t
i *= Interest rate (%)*
t *= Project lifespan (*t *= 1, 2, 3, ...,* n*)*
1/(1+i)^t *= Discount factor (DF) in year* t

Criteria:

Net B/C > 1: the business is financially feasible to implement.
Net B/C < 1: the business is not financially feasible to implement.

Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is the average annual internal profit rate expressed as a percentage. If the IRR value is greater than the applicable discount rate, the project is considered financially feasible to implement. Conversely, if the IRR value is lower than the prevailing interest rate, the project is considered not feasible to continue. Mathematically, IRR can be formulated as follows:

$$IRR = i' + (\frac{NPV^{-}}{NPV^{+} - NPV^{-}})X(i^{n} - i')$$

Where:
i′ *= Interest rate producing a positive NPV*
i″ *= Interest rate producing a negative NPV*
NPV^{+} *= NPV at interest rate* i′
NPV^{-} *= NPV at interest rate* i″

Criteria:

IRR > i: the business is financially feasible to continue.
IRR < i: the business is not financially feasible and should be discontinued.

Payback Period (PP)

The Payback Period (PP) refers to the period of time required to recover the total invested capital, calculated from the beginning of the project until the cumulative net cash flow equals the total investment value. Mathematically, the Payback Period is expressed as follows:

$$\boldsymbol{PP = \frac{I}{Ab}}$$

Where:
PP *= Length of time (years/periods) required to recover the investment capital*
I *= Total investment capital*
Ab *= Net annual/periodic profit or average annual net income*

Break-Even Point (BEP)

According to Pengemanan (2016), the Break-Even Point (BEP) is a method used to determine the production volume at which a business neither gains profit nor incurs losses. According to Wahyuni, Yulinda, and Bathara (2020), the Break-Even Point can be formulated as follows:

Production Break-Even Point

The calculation of the production BEP in units of products sold is expressed as follows:

$$\boldsymbol{BEP_{(Production)} = \frac{TFC}{(P - AVC)}}$$

Where:
TFC (Total Fixed Cost) *= Total fixed cost (IDR/cycle)*
AVC (Average Variable Cost) *= Average variable cost*
P (Price) *= Product selling price (IDR)*

Criteria:

If **BEP Production < actual production**, the business is profitable.
If **BEP Production = actual production**, the business is at the break-even point.
If **BEP Production > actual production**, the business is unprofitable or operating at a loss.

Sales Break-Even Point

The Sales BEP represents the level of sales revenue at which operating revenue exactly covers operating costs, indicating the relationship between production level and operational expenses. It is calculated as follows:

$$\boldsymbol{BEP_{(Seles)} = TFC[1 - \left(\frac{TVC}{(S)}\right)]}$$

Where:
TFC (Total Fixed Cost) *= Total fixed cost (IDR/cycle)*
TVC (Total Variable Cost) *= Total variable cost (IDR/cycle)*
S (Sales) *= Total sales revenue (IDR/cycle)*

Criteria:

If **BEP Sales < actual sales**, the business is profitable.

If **BEP Sales = actual sales**, the business is at the break-even point.
If **BEP Sales > actual sales**, the business is unprofitable or operating at a loss.

RESULT AND DISCUSSION

Investment Costs

Investment costs are expenditures incurred prior to the commencement of business operations for the "Sumber Rezeki" Nile tilapia farming enterprise in Sepakat Village. The detailed investment costs incurred by the Nile tilapia farming business are presented in Table 1.

Table 1. Investment Costs of the "Sumber Rezeki" Nile Tilapia Farming Enterprise in Sepakat Village, Loa Kulu District, Kutai Kartanegara Regency

No.	Description	Unit	Unit Price (IDR)	Total Cost (IDR)
A	Cage Construction			
1	Ulin wood beam, 5 cm × 5 cm × 4 m	8	25,000	200,000
2	Ulin wood beam, 8 cm × 8 cm × 4 m	6	75,000	450,000
3	Siring board, width = 10 cm, length = 2 m, thickness = 1 cm (bundle)	8	25,000	200,000
4	3.5-inch bolts	13	20,000	260,000
5	3-inch ulin nails for rafters/beams (5 cm × 5 cm) (kg)	2	35,000	70,000
6	1-inch ulin nails for siring boards (kg)	4	30,000	120,000
7	Blue plastic drums (units)	15	130,000	1,950,000
8	Ulin boards for cage connecting bridge (width = 20 cm, length = 4 m, thickness = 2.5 cm)	3	65,000	195,000
9	Polyethylene nylon rope (36 mm) for tying drums (kg)	3	70,000	210,000
	Total per cage unit			3,655,000
	Total for 6 cage units			21,930,000
B	Equipment			
10	Rope for cage construction fastening (5 kg)	3	90,000	270,000
11	Feed bucket (unit)	1	20,000	20,000
12	Oppo mobile phone	1	2,000,000	2,000,000
13	Netting/fish net	1	500,000	500,000
14	Shade net (paranet)	1	520,000	520,000
15	Trolley	1	100,000	100,000
16	Scoop net	1	80,000	80,000
17	Weighing scale	1	400,000	400,000
18	Sorting container	2	80,000	160,000
19	Gloves	1	22,000	22,000
20	Motorcycle	1	3,000,000	3,000,000
21	Scissors	1	10,000	10,000
22	Dipper	2	10,000	20,000

No.	Description	Unit	Unit Price (IDR)	Total Cost (IDR)
	Total Equipment Cost			7,102,000
	Total Investment Cost			29,032,000

The investment costs included the construction of floating net cages and supporting equipment such as ulin wood beams, plastic drums, nylon ropes, nets, weighing scales, and transportation equipment. The total investment cost incurred for the procurement of all equipment and facilities amounted to IDR 29,032,000, with an estimated useful life ranging from 1 to 10 years.

Operational Costs

Operational costs are expenses incurred during production and operational activities of the "Sumber Rezeki" Nile tilapia farming enterprise in Loa Kulu District. These operational costs consisted of fixed costs and variable costs. The detailed operational costs are presented in Tables 2 and 3.

Table 2. Fixed Operational Costs of the "Sumber Rezeki" Nile Tilapia Farming Enterprise in Loa Kulu District, Kutai Kartanegara Regency

No.	Fixed Cost Description	Quantity (Unit)	Unit Price (IDR)	Cost per Production Cycle (IDR)	Cost per Year (IDR)
1	Electricity	1	250,000	1,000,000	3,000,000
2	Mobile phone credit	1	100,000	100,000	300,000
3	Cage maintenance	1	225,000	225,000	675,000
4	Fuel (gasoline)	5	13,000	65,000	195,000
5	Depreciation cost			4,507,250	13,521,750
	Subtotal A			5,897,250	17,691,750

The fixed operational costs included electricity, mobile phone credit, cage maintenance, fuel expenses, and depreciation costs. The total fixed operational cost amounted to IDR 17,691,750 per year.

Table 3. Variable Operational Costs of the "Sumber Rezeki" Nile Tilapia Farming Enterprise in Loa Kulu District, Kutai Kartanegara Regency

No.	Variable Cost Description	Quantity/Year (kg/unit)	Unit Price (IDR)	Total Annual Cost (IDR)
1	New Hope 833 feed	5,400	13,000	70,200,000
2	Tilapia fingerlings	30,000	200	6,000,000
3	Packaging plastic	300	2,500	750,000
4	Rubber bands	3	8,000	24,000
	Subtotal B			76,974,000
	Total Subtotal A + B			94,665,750

The variable operational costs included fish feed, Nile tilapia seed, plastic packaging, and rubber bands. The total variable operational cost amounted to IDR 76,974,000 per year. Based on Tables 2 and 3, the total annual operational cost incurred by the "Sumber Rezeki" Nile tilapia farming enterprise in Loa Kulu District, Kutai Kartanegara Regency amounted to IDR 94,665,750 per year.

Revenue

The "Sumber Rezeki" Nile tilapia farming enterprise in Sepakat Village conducted production activities three times annually. In practice, each floating net cage was harvested twice per month; however, the production cycle for each cage required approximately four months before the next production cycle could begin. Detailed revenue data for the enterprise are presented in Table 4.

Table 4. Revenue of the "Sumber Rezeki" Nile Tilapia Farming Enterprise in Loa Kulu District, Kutai Kartanegara Regency

No.	Harvest Period	Production per Cycle (kg)	Annual Production (kg/year)	Price (IDR/kg)	Revenue (IDR/year)
1	Cage 1	150	450	35,000	15,750,000
2	Cage 2	190	570	35,000	19,950,000
3	Cage 3	180	540	35,000	18,900,000
4	Cage 4	150	450	35,000	15,750,000
5	Cage 5	160	480	35,000	16,800,000
6	Cage 6	200	600	35,000	21,000,000
	Total	1,030	3,090		108,150,000

The total production obtained from six floating net cages reached 3,090 kg per year, with a selling price of IDR 35,000 per kilogram. The total annual revenue generated by the enterprise amounted to IDR 108,150,000.

The mortality rate observed during the Nile tilapia *Oreochromis niloticus* seed production process was approximately 10%. This finding is consistent with the study conducted by Islami (2013), which reported that Nile tilapia hatchery activities at the Fish Seed Center (BBI) Tenggarang Bondowoso experienced a mortality rate of up to 10%.

Profit and Loss Analysis

Profit represents the net income received by the manager of the "Sumber Rezeki" Nile tilapia farming enterprise, calculated as the difference between total revenue and total operational costs during one year of production activities. Detailed profit data are presented in Table 5.

Table 5. Profit of the "Sumber Rezeki" Nile Tilapia Farming Enterprise in Loa Kulu District, Kutai Kartanegara Regency

No.	Description	Amount (IDR/year)
1	Total Revenue	108,150,000
2	Operational Costs	94,665,750
	Net Profit	13,484,250

The total annual revenue generated by the fish farming business amounted to IDR 108,150,000, which exceeded the total operational cost of IDR 94,665,750. According to Gupito et al. (2014), a business can be considered profitable when total revenue exceeds total operational costs. The profit analysis showed that the "Sumber Rezeki" Nile tilapia farming enterprise generated a net profit of IDR 13,484,250 per year. These findings indicate that the Nile tilapia farming operation was economically profitable and financially viable.

CONCLUSION

The "Sumber Rezeki" Nile tilapia farming enterprise in Loa Kulu District incurred a total production cost of IDR 94,665,750 per year. The total annual revenue obtained from the business amounted to IDR 108,150,000. Since the total production cost was lower than the total revenue, the enterprise generated a net profit of IDR 13,484,250 per year.

The Nile tilapia Oreochromis niloticus farming enterprise operated by "Sumber Rezeki" in Sepakat Village was financially feasible based on the investment criteria applied in this study. The financial analysis showed a Net Present Value (NPV) of IDR 73,993,148, indicating that NPV > 0 and therefore the business was feasible to operate. The Internal Rate of Return (IRR) was 89%, which exceeded the Opportunity Cost of Capital (OCC), indicating that the business was financially viable. The Net Benefit–Cost Ratio (Net B/C) was 3.55, demonstrating that Net B/C > 1 and confirming the feasibility of the business. Furthermore, the Payback Period (PP) was 1.41 years, which was shorter than the economic life of the enterprise, indicating that the investment could be recovered within a feasible timeframe. The Production Break-Even Point (BEP) was 829.486 kg per year, which was lower than the actual annual production level, indicating that the business generated profit. In addition, the Sales Break-Even Point (BEP) was IDR 6,166,525 per year, confirming that the enterprise operated profitably.

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