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Economic performance and financial feasibility of pearl lobster (*P. ornatus*) grow-out aquaculture in South Sulawesi, Indonesia

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ABSTRACT

Aquaculture has quickly grown, with increasing interest in high-value products that contribute to the economic and social development of coastal communities. One example is the pearl lobster (*Panulirus ornatus*), which is in high demand and commands a high price. While production and research have improved, there is still little information on whether commercial grow-out systems are financially viable in Indonesia. This study examines the economic performance and investment potential of pearl lobster farming in South Sulawesi, Indonesia. Researchers gathered primary data from 94 farmers in three main production areas using a stratified sampling method. They measured economic performance by looking at profitability and analyzed investment feasibility using Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit-Cost Ratio (Net B/C), Payback Period (PP), and sensitivity analysis. The results show that pearl lobster farming yields a net profit of USD 1,584 per production cycle, indicating strong operations. Financial indicators also show that investing in this sector is attractive, with an NPV of USD 5,623, an IRR of 367%, a Net B/C of 13.25, and a PP of 0.35 years. Sensitivity analysis shows that the business remains financially sound in all tested scenarios. Even though investment results are most affected by changes in annual revenue, the project still produces positive returns when revenue drops, costs rise, or survival rates fall. This shows that the business is financially resilient. Besides confirming that pearl lobster farming is profitable, this study fills a gap by combining profitability assessment, discounted cash flow analysis, and investment risk evaluation into a single framework. The findings offer real-world evidence to help guide investment decisions and policy for tropical lobster aquaculture. In summary, the results suggest that pearl lobster grow-out farming is a strong, resilient business and deserves serious consideration for future development.

Keywords: Pearl lobster aquaculture, Financial feasibility, Investment appraisal, Sensitivity analysis, Sustainable aquaculture

Introduction

Global fisheries production is currently showing a significant shift away from the dominance of capture fisheries towards aquaculture. Aquaculture and capture fisheries are vital sources of fish protein and income for a significant portion of the global population (FAO, 2022). However, in recent decades, capture fisheries yields have declined, primarily as a result of diminishing wild fish stocks in natural aquatic environments. In 2022, total global aquaculture production reached 130.9 million tonnes, surpassing wild-caught fish production, which stood at just 92.3 million tonnes (FAO, 2024). Aquaculture is seen as a solution to meet the growing demand for fish, driven by ongoing advancements in the sector and declining fish production from capture fisheries (Nugroho et al., 2022).

In 2024, Indonesia's fisheries production totaled 23.57 million tonnes, with aquaculture outpacing capture fisheries (KKP, 2025). As aquaculture expands, businesses must focus not only on increasing production but also on sustainability and effective resource management to ensure a thriving, responsible industry. South Sulawesi Province has seen significant growth in its fisheries sector, particularly in aquaculture, with a total production of 4.116.723 tons in 2023. One standout commodity is lobster. According to the Ministry of Marine Affairs and Fisheries (KKP, 2021), the total sustainable potential for lobster resources is 330.000 tons. Lobsters are a commercially valuable species with limited availability, making them a promising candidate for aquaculture (Haj, 2023). The pearl lobster (*P. ornatus*) is favored for its rapid growth and high market value, attracting farmers' attention (Susanti et al., 2017).

Lobster farming in South Sulawesi commonly utilizes two systems: floating net cages (KJA) and fixed net cages (KJD). These systems differ in their operational processes, such as feeding and harvesting times, as well as the level of investment required (Aïzonou et al., 2021). The total investment for the KJA system is significantly higher at US$4,867.40, compared to the KJD system, which requires only US$330.59 (Haj, 2022). Reliance on low-quality fish feed, accounting for up to 70 percent of production costs, heightens the vulnerability of fish farmers in negotiations with feed suppliers. Furthermore, this reliance raises significant concerns about the long-term sustainability of aquaculture enterprises (Junaidi et al., 2020).

The lobster fisheries in South Sulawesi have significant sustainable potential, and the economic value of lobsters, whether sourced from wild catches or aquaculture, can be quantified. This value serves as an important source of income for coastal communities. The rising global demand for lobsters is partly because of changing consumption patterns, with consumers increasingly shifting from red meat to white meat (Straume et al., 2020). Unfortunately, efforts to meet increasing demand have intensified pressure on lobster stocks, resulting in the harvesting of juvenile lobsters. In response, aquaculture development and advancements in hatchery technology have been implemented to decrease dependence on wild-caught juvenile lobsters (Salin & Arome Ataguba, 2018).

Over the past decade, research on the aquaculture of the pearl lobster (*P. ornatus*) has grown significantly, driven by its high economic value and rising international market demand. Previous studies have mainly focused on seed availability, biological performance, larval development, rearing technology, and sustainable management. Priyambodo et al. (2020) demonstrated that Indonesia produces over 100 million lobster larvae annually, positioning the country to support one of the world's largest lobster farming industries. Similarly, a study by Radhakrishnan et al. (2019) has emphasized the strategic importance of wild seedstock resources for the development of tropical lobster aquaculture. However, these studies have largely concentrated on resource availability and production potential rather than on the economic viability of lobster farming enterprises.

Numerous studies on crustacean aquaculture have highlighted the importance of economic viability in the adoption and expansion of technologies. While biological performance indicators such as growth rate, survival rate, and feed conversion ratio are significant (Vazirzadeh, 2024). They do not necessarily reflect the financial profitability of an aquaculture venture. In many developing countries, aquaculture projects often fail not only because of technical limitations but also a lack of understanding of investment requirements, operational costs, market risks, and potential financial returns (de Franca et al., 2024). As a result, economic assessment is increasingly regarded as a crucial element of sustainable aquaculture planning.

Lobster aquaculture has experienced significant expansion and demonstrates considerable market potential. Nevertheless, significant economic and operational challenges persist, especially concerning the performance of various aquaculture systems. The higher capital costs of floating net cages (KJA) compared to fixed net cages (KJD) may limit profitability and financial viability for small-scale farmers (Saha et al., 2022).

Furthermore, dependence on wild-caught juveniles, fluctuations in market prices, feed costs, and environmental risks can threaten long-term sustainability (Zulbainarni et al., 2024). This study examines the economic potential and financial feasibility of pearl lobster (*P. ornatus*) grow-out aquaculture in South Sulawesi.

Materials and Methods

Study Area

The study area took place in three regencies in South Sulawesi Province, Indonesia: Pangkep, Takalar, and Jeneponto. These areas were chosen because they are the main centers for spiny lobster farming in the province, with 110 in Pangkep, 225 in Takalar, and 137 in Jeneponto. Data were collected in Balang Lompo Island (Pangkep), Laikang Bay (Takalar), and Bontorannu Urban Village (Jeneponto) (Fig. 1). These sites were chosen on purpose to reflect different parts of the lobster production system in South Sulawesi, such as seed collection areas, coastal nurseries, and commercial grow-out sites. This range of locations gives a broad view of the regional lobster farming value chain and allows for the study of farming practices in different production and environmental settings. All the study sites have tropical coastal ecosystems with coral reefs and seagrass beds, which are important habitats for *Panulirus* species. The sites also have favorable ocean conditions, such as strong water flow, stable salinity, and high dissolved oxygen, which are known to support lobster growth, survival, and farming success. Choosing these sites provides a solid basis for examining the technical, environmental, and social aspects of lobster farming in South Sulawesi.

Data Collection

We collected data for this study through face-to-face interviews held from January to May 2026. We used stratified sampling, which divides the target population into similar subgroups based on shared traits to improve accuracy and ensure each group is represented. In our research, we grouped farmers at each site by aquaculture production system, since differences in farming methods, management, and production were expected to affect socioeconomic and production results. From each group, we selected about 20% of the farmers, following the approach suggested by Raifman et al. (2022). This method ensured that each aquaculture system was represented proportionally to its size in the population and helped reduce sampling bias. Our final sample included 22 from Balang Lompo Island, 45 farmers from Laikang Bay, and 27 from Bontorannu Urban Village, for a total of 94 respondents. This approach improved the representativeness of our sample and made our findings more reliable and applicable across different aquaculture systems.

Statistical Analysis

Profitability analysis

A comprehensive analysis of the economic potential of lobster farming is essential, with particular emphasis on profitability assessment. Profitability analysis quantitatively measures the financial performance of an aquaculture enterprise by comparing revenue from production activities to total costs incurred during the production cycle. This assessment is vital for determining the economic feasibility and long-term sustainability of lobster farming, as it allows producers and policymakers to assess whether the enterprise generates adequate returns to justify investment and operational expenditures. Furthermore, profit analysis provides a foundation for comparing the economic performance of various production systems, technologies, or management practices, thereby facilitating evidence-based decision-making to enhance farm efficiency and competitiveness. The general formula for calculating profit is provided in the following equation (Magni, 2019):

$$\pi = TR\text{-}TC \quad (1)$$

Where π denotes profit, TR represents total revenue, and TC refers to total cost. Profit analysis constitutes a fundamental metric for assessing the economic performance of farming enterprises by quantifying the difference between revenues generated from production and costs incurred throughout the production cycle (Otumawu-Apreku & McWhinnie, 2020). In lobster farming (*Panulirus* spp.), this analysis is particularly significant given the industry's substantial capital and operational expenditures, including costs for seed, feed, labor, and cage maintenance. Additionally, the sector faces significant production risks, including fluctuations in survival rates, disease outbreaks, environmental variability, and market price volatility. Therefore, profit analysis is a critical tool for evaluating the financial viability and sustainability of sea lobster farming operations and for informing investment and management decisions.

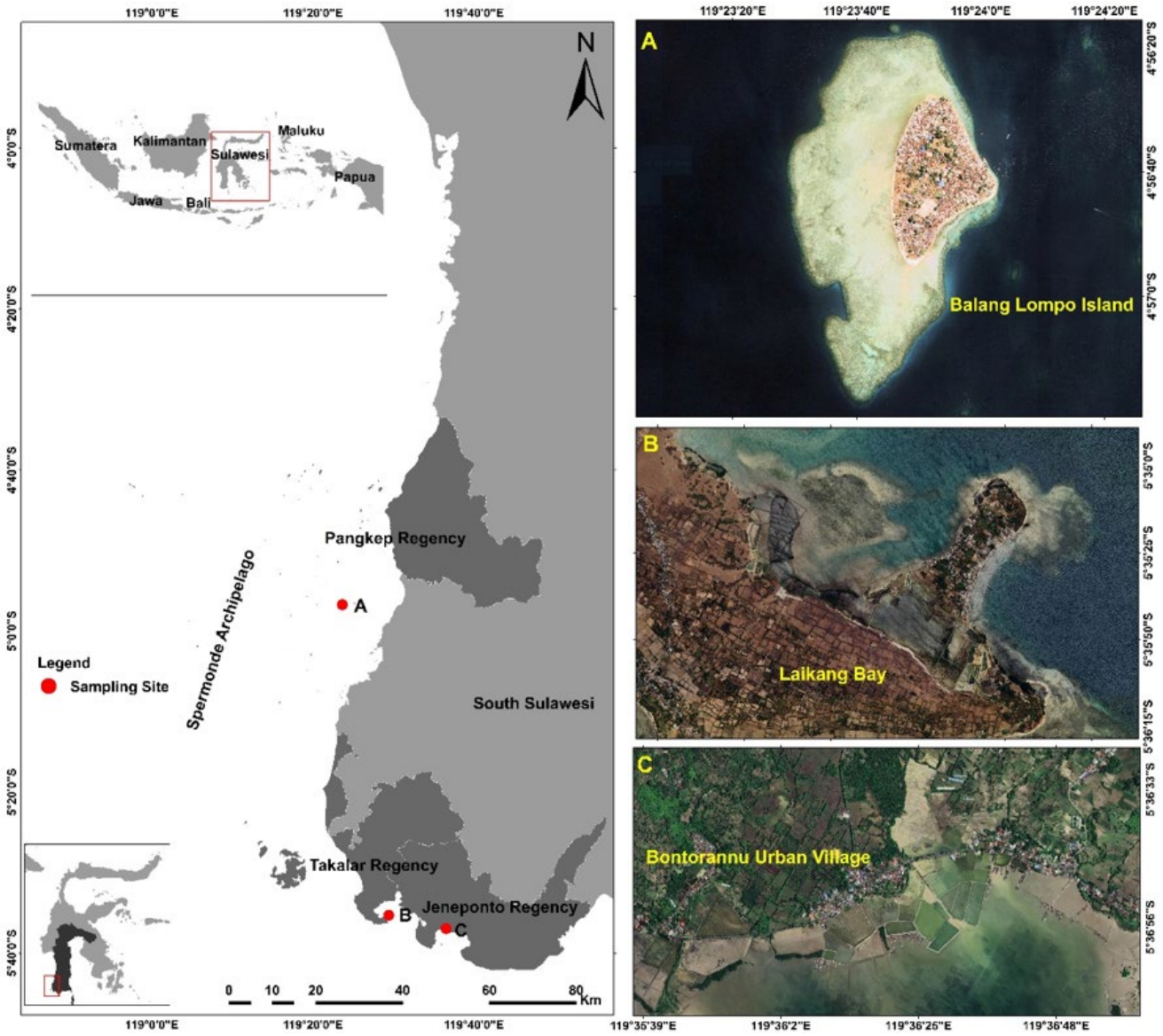

Fig. 1. Map of the study area: A (Balang Lompo Island), B (Laikang Bay), and C (Bontorannu Urban Village)

Financial feasibility analysis

Financial feasibility analysis is a quantitative method for evaluating the economic viability and long-term sustainability of investments or business ventures by assessing expected financial performance over the project life cycle. This approach offers an objective framework for determining whether a project can generate returns sufficient to justify the capital invested, while considering the time value of money, operational uncertainty, and investment risk. In aquaculture and fisheries, financial feasibility analysis is a critical tool for investment decision-making, as production outcomes are strongly influenced by biological performance, feed costs, survival rates, and market price fluctuations. Recent studies indicate that combining financial indicators with risk and sensitivity analyses yields more reliable investment assessments and enhances strategic planning for sustainable aquaculture development (Lan et al, 2022).

Financial feasibility is typically assessed using several investment criteria, such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP). Each indicator evaluates a distinct aspect of investment performance and should be interpreted in conjunction with the others. NPV calculates the net economic value generated by an investment by discounting future cash flows to their present value. IRR

identifies the discount rate at which the NPV of a project is zero, reflecting the anticipated rate of return. PP determines the period required to recover the initial investment. Using these indicators together provides a more thorough assessment of investment attractiveness and financial sustainability than relying on a single metric (Diatin et al., 2021).

Furthermore, financial feasibility analysis functions not only as an investment appraisal method but also as a strategic planning tool for forecasting future cash flows, evaluating production scenarios, and assessing business resilience under changing economic conditions. Recent aquaculture research has increasingly incorporated sensitivity analysis and risk assessment alongside conventional financial indicators to address uncertainties in production costs, survival rates, and product prices, thereby strengthening the robustness of investment decision-making (Lobanov et al., 2025). In addition, financial feasibility analysis provides a basis for forecasting a business unit's production plan for future years (Ariadi et al., 2019). The general formula for calculating financial feasibility is presented in the equation below:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} - I_0 \quad (2)$$

$$IRR = 0 = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - I_0 \quad (3)$$

$$Net\ B/C = \frac{\sum PV\ Benefit}{\sum PVCost} \quad (4)$$

$$PP = \frac{Initial\ investment}{Annual\ net\ cash\ flow} \quad (5)$$

Where CF_t = cash flow at period t, r = discount rate, t = time period, n = total number of periods, PV = present value.

$$SV = \frac{\left(\frac{O_1 - O_0}{O_0} \times 100\%\right)}{\left(\frac{I_1 - I_0}{I_0} \times 100\%\right)} \quad (6)$$

Where SV = sensitivity value, O_0 = the first output value, O_1 = the output value after change, I0 = the first input value, I1 = the input value after change.

Results and Discussion

Demographic Characteristics of the Cage Farmers

Table 1. Demographic characteristics of the fixed net cage (KJD) farmers in South Sulawesi, Indonesia

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	95	100
Education Level	Primary	79	83.16
	Secondary	16	16.84
Primary Occupation	Lobster farmer	3	3.16
	Fisherman	92	96.84

Table 1 summarizes the demographic characteristics of the respondents. The findings show that pearl lobster grow-out in South Sulawesi is primarily undertaken by male small-scale fishers with limited formal education and a strong reliance on capture fisheries. These socio-economic characteristics are essential for contextualizing the financial feasibility results presented in later sections, as investment decisions, production management, and risk perception are shaped by farmers' educational backgrounds and livelihood structures (Huda et al., 2021).

Characteristics of Pearl Lobster Grow-Out Aquaculture

Grow-out farming of pearl lobster (*Panulirus ornatus*) in South Sulawesi primarily utilizes a fixed net cage (KJD) system located in sheltered coastal waters with stable environmental conditions. Juvenile lobsters are typically sourced from local collectors and reared until they attain marketable size. This production system features moderate stocking densities, daily feeding with fresh trash fish and baby crabs, and a culture period of several months, which varies according to the initial size of juveniles, environmental factors, and market demand. More details can be seen in Table 2.

Table 2. Production performance of pearl lobster grow-out aquaculture

Variable	Unit	Value
Cage size	m × m × m	12
Stocking density	lobster cage^{-1}	75
Initial lobster weight	g	350
Harvest weight	g	700
Culture period	month	7
Survival rate	%	85
Feed consumption	kg cycle^{-1}	980
Total production	kg cycle^{-1}	65
Selling price	USD kg^{-1}	39,26

Table 2 shows the production characteristics of the pearl lobster (*Panulirus ornatus*) grow-out system in South Sulawesi. Lobsters were reared in fixed net cages with a volume of 12 m^3 at a stocking density of 75 individuals per cage. Juveniles with an initial body weight of 350 g achieved an average harvest weight of 700 g after 7 months of culture, demonstrating a doubling of harvest weight during the culture period.

In this study, the culture period was shorter than the 10 to 12 months typically reported for commercial pearl lobster farming in South Sulawesi, where lobsters typically take 10 to 12 months to reach market size. This shorter production cycle may mean greater efficiency, possibly because larger juveniles were used at stocking, the environment was favorable, or farm management improved. A shorter culture period can also yield economic benefits by enabling more production cycles per year and reducing overall operating costs.

The survival rate in this study was 85%, which is higher than the average 80% observed in floating net cage systems in South Sulawesi, but slightly lower than the 90% reported in fixed-net cage systems under similar conditions. These differences probably result from factors such as the number of lobsters stocked, cage design, water flow, and handling practices. Earlier studies have shown that reducing stress, improving care, and better feeding can help lobsters survive during grow-out. The survival rate in this study indicates that the culture method was efficient and could be used for commercial production (Kropielnicka-Kruket et al., 2022).

Feed consumption reached 980 kg per production cycle, resulting in a harvest of 65 kg. Although feed conversion efficiency was not directly assessed because feed conversion ratio (FCR) data were unavailable, feed continues to represent the primary operational expense in tropical lobster aquaculture. Previous studies have demonstrated that reliance on trash fish increases production costs, degrades water quality, and increases disease risk (Astuti et al., 2023). In contrast, recent advances in formulated feeds have demonstrated considerable potential to improve feed efficiency and mitigate environmental impacts. Consequently, optimizing feed management remains one of the most effective ways to enhance farm profitability and sustainability (Nankervis & Jones, 2022).

The average selling price of USD 39,26 per kilogram shows that pearl lobster (*P. ornatus*) has a high market value in Asian seafood markets. This price is consistent with earlier studies that list pearl lobster as one of Indonesia's most valuable cultured crustaceans (Haj, 2023). Because revenue depends on both the amount harvested and the market price, changes in the selling price have a strong effect on financial measures such as net present value (NPV), internal rate of return (IRR), net benefit-cost ratio (Net B/C), and payback period. Financial studies from South Sulawesi show that lobster farming can remain profitable, even with high investment costs, as long as production and market prices remain steady (Haj, 2022).

Cost Structure of Pearl Lobster Grow-out Aquaculture

A comprehensive understanding of the cost structure in pearl lobster (*Panulirus ornatus*) grow-out operations is crucial for evaluating the economic performance and long-term sustainability of aquaculture enterprises. Analyzing the allocation of production expenses among investment, fixed, and variable costs helps identify key factors influencing profitability and operational efficiency. Further explanation can be found in Table 3.

Table 3. Cost component of pearl lobster grow-out aquaculture

Cost Component	Value (USD)	Percentage (%)
Investment Cost		
Cage construction	349,07	81.53
Aquaculture equipment	79,06	18.47
Fixed Cost		
Cage maintenance	27,84	100
Variable Cost		
Seed	487,14	52.30
Feed	444,27	47.70

Table 3 presents the investment, fixed, and variable cost components associated with pearl lobster (*Panulirus ornatus*) grow-out farming in South Sulawesi. Investment costs were predominantly driven by cage construction, which accounted for USD 349,07 (81.53%) of the total, while aquaculture equipment accounted for only USD 79,06 (18.47%). This distribution indicates that establishing fixed cage infrastructure requires a substantial initial capital outlay and underscores the importance of durable facilities for maintaining production stability in marine environments. Although investment costs are incurred only at the beginning of the production cycle and are depreciated over several years, they remain a significant barrier to entry for prospective lobster farmers, especially small-scale producers, because of the high capital requirements. Similar findings have been reported in tropical spiny lobster aquaculture, where floating net cage infrastructure represents the largest capital investment and necessitates materials that can withstand waves, currents, and extended production cycles.

Fixed costs in this study were limited to cage maintenance, totaling USD 27,84. Although this amount is minor compared to investment and operational costs, routine maintenance is essential for preserving cage integrity, minimizing structural damage, and preventing stock losses from biofouling, predator intrusion, or extreme weather events. Effective maintenance also enhances survival rates and production efficiency by ensuring adequate water exchange and maintaining environmental quality within the culture system. Recent research emphasizes that regular maintenance of fixed net cages is fundamental for sustainable lobster farming, as deteriorated infrastructure can negatively affect biological performance and increase long-term operational costs.

Variable costs accounted for the largest recurring expenditure during the production cycle, with seed procurement totaling USD 487,14 (52.30%) and feed costs totaling USD 444,27 (47.70%). The slightly higher allocation to seed procurement indicates that the profitability of pearl lobster farming is highly dependent on the availability and price of juvenile lobsters. In Indonesia, commercial production relies primarily on wild-caught puerile and juveniles, leading to fluctuating seed prices influenced by seasonal recruitment patterns and fisheries regulations (Kawirian et al., 2023). Consequently, farmers face significant uncertainty regarding production costs before the start of the grow-out cycle. This finding aligns with recent reviews, which indicate that reliance on wild seedstock remains a primary economic constraint on the expansion and competitiveness of tropical spiny lobster aquaculture in Southeast Asia (Smith et al., 2017).

Feed was the second-largest operational cost, accounting for 47.70% of total variable expenses. Although this proportion was slightly lower than seed procurement, feed remains the primary cost component that farmers can directly influence through improved feeding practices and feed efficiency. Most pearl lobster farms in Indonesia continue to use fresh trash fish because of its availability and the lobsters' high acceptance of it. However, this practice is associated with variable prices, inconsistent nutritional quality, reduced feed conversion efficiency, and increased risk of water quality deterioration from feed waste. As a result, optimizing feed management and adopting nutritionally balanced formulated diets have become strategic priorities for reducing operational costs and improving growth performance and profitability.

Adopting formulated feeds may advance aquaculture technology. Recent research on *Panulirus ornatus* has increasingly emphasized nutrient utilization and feed formulation, indicating a shift toward species-specific nutrition (Hammel et al., 2024). However, discontinuing fresh feed immediately in South Sulawesi is not recommended. A gradual transition to feeding strategies that incorporate nutritional quality, feeding response, size-based rations, and quantifiable feed efficiency is advisable.

Improved feed efficiency offers two primary benefits: it reduces variable costs and decreases the volume of organic waste discharged into the environment (Hai & Speelman, 2020). Feed technology thus exemplifies how economic efficiency can align with environmental sustainability. Feed efficiency represents a significant gap in current research and development efforts. Without feed conversion ratio measurements, financial analyses account for feed costs but do not reflect how efficiently feed is converted into lobster biomass. Future research should directly assess feed conversion ratio, protein retention, feed wastage, and nutrient discharge. Adding these metrics would strengthen the link between economic viability and environmental sustainability.

Economic Potential of Pearl Lobster Grow-Out Aquaculture

Economic analysis demonstrated that pearl lobster grow-out aquaculture in South Sulawesi yields a net profit of USD 1,584 per production cycle. These findings indicate that lobster farming possesses considerable economic potential and could provide a significant source of income for coastal communities (Table 4).

Table 4. Economic performance of pearl lobster grow-out aquaculture

Indicator	Value (USD)
Revenue	2.550
Total cost	966
Net profit	1,584

Table 4 presents the financial performance of the lobster aquaculture business, including revenue, total production costs, and net profit. The enterprise achieved total revenue of USD 2,550 and incurred total production costs of USD 966, resulting in a net profit of USD 1,584. Retaining approximately 62.1% of total revenue as profit after accounting for all production costs indicates a high level of operational efficiency.

The relatively low production costs compared to total revenue suggest that the enterprise maintains an efficient cost structure. In aquaculture, profitability depends primarily on controlling variable costs, such as feed, seed, labor, and operational maintenance, while sustaining high production performance and product quality (Haj, 2022). Effective cost management is widely recognized as a principal driver of financial sustainability in aquaculture, as production costs typically account for the largest share of total expenditure. Recent

studies indicate that efficient resource allocation significantly improves profit margins and reduces financial risks, particularly for small-scale aquaculture systems (Asche et al., 2016).

The observed positive profit indicates that lobster farming significantly contributes to household income and local economic development. Recent studies on tropical lobster aquaculture have yielded consistent findings, indicating that lobster is among the highest-value crustacean commodities in Southeast Asia as a result of robust export demand and premium market prices (Jones & Priyambodo, 2026). Consistent with previous studies, the present findings confirm that lobster farming in Indonesia yields positive economic returns and provides a viable alternative livelihood for coastal fishers.

Financial Feasibility Analysis

A financial feasibility assessment is crucial for determining whether an aquaculture investment can generate sustainable economic returns. Beyond measuring profitability, financial feasibility analysis examines the relationships among investment costs, operating expenses, production performance, and revenue generation within a time-value-of-money framework (Samat et al., 2024). This evaluation is particularly important for spiny lobster aquaculture, which involves substantial initial capital requirements, prolonged grow-out periods, and uncertainties in both biological and market variables that can significantly influence investment outcomes. Consequently, multiple discounted cash flow indicators are employed to provide a comprehensive review of project viability. In this study, financial feasibility is evaluated using Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit-Cost Ratio (Net B/C), Payback Period (PP), and sensitivity analysis, which collectively offer complementary perspectives on profitability, investment efficiency, and capital recovery. Financial parameters and indicators can be seen in Tables 5 and 6.

Table 5. Financial parameters used in the analysis

Parameter	Value
Initial Investment	USD 431
Annual Revenue	USD 2,550
Total Annual Cost	USD 966
Annual Net Benefit	USD 1,584
Discount Rate	12%
Project Life	5 Years

Table 5 demonstrates that pearl lobster (*Panulirus ornatus*) grow-out farming in South Sulawesi generates substantial positive cash flows throughout the project duration. The initial investment required is USD 431, while the annual net benefit reaches USD 1,584. Consequently, the business yields more than three times the initial capital each year. The annual net cash inflow significantly exceeds the amount necessary to initiate the production system, indicating strong profitability potential. Over a five-year period, applying a 12% discount rate, these cash flows are projected to yield a high Net Present Value (NPV), suggesting that the total discounted benefits exceed the initial investment.

Table 6. Financial feasibility indicators of lobster grow-out aquaculture

Indicator	Value	Decision Criteria	Status
NPV	USD 5,280	> 0	Feasible
IRR	367%	> Discount rate	Feasible
Net B/C	13.25	> 1	Feasible
Payback Period	0.35 years	Shorter than project life	Feasible

Table 6 indicates that pearl lobster (*Panulirus ornatus*) grow-out farming in South Sulawesi is profitable and economically viable. The enterprise achieved a Net Present Value (NPV) of USD 5,280, an Internal Rate of Return (IRR) of 367%, a Net Benefit–Cost Ratio (Net B/C) of 13.25, and a Payback Period of 0.35 years. These financial indicators exceed standard investment benchmarks, suggesting strong economic returns over a five-year period.

Net present value (NPV) of USD 5,623 demonstrates that discounted future cash inflows significantly exceed the initial investment of USD 431. The net present value (NPV) results from three primary factors. First, the initial capital requirement is low because of the use of simple floating net cages and basic equipment. Second, annual net benefits reached USD 1,584, which is approximately 3.7 times the initial investment, resulting in positive cash flow from the first production cycle. Third, the elevated export price of pearl lobster (*P. ornatus*) enhances annual revenue even at moderate production levels. Comparable trends of low investment and high value have been documented in other aquaculture enterprises, where consistent cash flow and minimal capital requirements contribute to improved NPV.

The IRR of 367% greatly exceeds the 12% discount rate, indicating a highly attractive investment. This elevated IRR reflects rapid annual profit generation relative to the initial capital outlay. In investment analysis, a high IRR may coincide with significant operational risks, particularly when uncertainties exist regarding survival rates, market prices, seed availability, and production volumes (Ronyastra, 2025). Unlike many aquaculture ventures that require significant upfront investment before returns are realized, pearl lobster

farming requires less capital while still yielding substantial returns for both domestic and export markets. As a result, the project's returns far exceed the cost of capital, providing a significant margin of safety against fluctuations in costs or market prices. The fact that the IRR is above 300% indicates that the project is resilient and profitable under current analytical assumptions.

The Net B/C ratio of 13.25 demonstrates strong economic efficiency, with each USD 1 invested yielding USD 13.25 in discounted benefits over the project's life. This value is well above the minimum standard of Net B/C > 1, indicating an effective balance between costs and revenue. Although seed and feed represent the largest expenses, the high selling price of pearl lobster offsets these costs, resulting in a high benefit-to-cost ratio. These findings indicate that efficient production and strong market demand significantly enhance investment performance in lobster farming. The payback period of 0.35 years (approximately 4.2 months) means the initial investment is recovered within the first year. This rapid recovery reduces investment risk, as capital is recouped before exposure to long-term market changes, disease, or cost fluctuations. A short payback period also improves cash flow, enabling producers to reinvest in farm expansion or upgrades. Consequently, pearl lobster farming is an attractive option for both small-scale farmers and private investors seeking rapid returns.

Compared to other aquaculture products, pearl lobster farming demonstrates superior financial performance. For instance, catfish farming in Indonesia, using water-exchange and aquaponic systems, achieved IRRs of approximately 302–303% and BCRs of 12.52–12.57 (Daitin et al., 2021). Although these figures are high, they remain lower than the IRR (367%) and Net B/C (13.25) observed in pearl lobster farming. Vannamei shrimp farming in Indonesia typically reports IRRs below 100% and Net B/C values around 2.0, indicating lower investment efficiency despite high production volumes (Makalingga et al., 2019). Furthermore, Divu et al. (2024) identified IRR values between 25% and 40% for integrated crab-shrimp farming systems in the Mekong Delta, Vietnam. Collectively, these results show that this study offers a strong investment opportunity compared to others in a competitive market.

Sensitivity Analysis

Following the assessment of basic financial feasibility, a sensitivity analysis was conducted to assess the investment's stability under varying economic conditions. This analysis examines how fluctuations in key variables, such as annual revenue, production costs, and survival rate, influence Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit-Cost Ratio (Net B/C), and Payback Period (PP). Evaluating the response of these financial indicators to adverse changes in assumptions demonstrates the project's resilience and identifies the principal risks that may impact its long-term financial viability. The results of the sensitivity analysis of pearl lobster grow-out aquaculture were shown in Tabel 7, Table 8, and Table 9.

Table 7. Sensitivity to changes in survival rates

Survival Rate	Annual Net Benefit (USD)	NPV (USD)	Net B/C
100%	1,863	6,286	15.58
95%	1,770	5,952	14.80
85% (Baseline)	1,584	5,280	13.25
75%	1,397	4,604	11.69
65%	1,211	3,934	10.12
55%	1,025	3,264	8.56

Table 8. Sensitivity to changes in revenue

Scenario	Revenue	Net Benefit	NPV
+30%	3,315	2,349	8,037
+20%	3,060	2,094	7,119
+10%	2,805	1,839	6,199
Baseline	2,550	1,584	5,280
-10%	2,295	1,329	4,360
-20%	2,040	1,074	3,441
-30%	1,785	819	2,521

Table 9. Sensitivity to changes in operating cost

Scenario	Operating Cost	Net Benefit	NPV
-30%	676	1,874	6,325
-20%	773	1,777	5,975
-10%	869	1,681	5,629
Baseline	966	1,584	5,280
+10%	1,063	1,487	4,931
+20%	1,159	1,391	4,585
+30%	1,256	1,294	4,235

A sensitivity analysis was performed to assess the robustness of the lobster farming investment in response to variations in biological and economic parameters. The analysis focused on three primary variables: survival rate, annual revenue, and operating cost. The baseline scenario yielded a net present value (NPV) of approximately USD 5,280, demonstrating the investment's financial feasibility over a five-year project period.

Annual revenue exerted the greatest influence on financial performance among the parameters evaluated. A 30% decrease in revenue reduced the NPV by approximately 52%, from USD 5,280 to USD 2,521. Despite this reduction, the NPV remained positive, indicating continued financial feasibility. In contrast, a 30% increase in revenue raised the NPV to USD 8,037, an increase of approximately 52% compared to the baseline. These findings indicate that business profitability is predominantly determined by production output and market prices, rather than by production costs. This pattern aligns with bioeconomic theory in aquaculture, which posits that cash inflows are directly affected by harvest volume and selling prices, while production costs tend to change more slowly (Garlock et al., 2025).

Variations in operating costs had a comparatively minor effect. A 30% increase in production costs reduced the NPV to USD 4,235, while a 30% decrease in operating costs increased the NPV to USD 6,325. These results suggest that profitability is more sensitive to changes in revenue than to fluctuations in production costs (Divu et al., 2024). The analysis of the survival rate further demonstrated the investment's biological resilience. Reducing the survival rate from 85% to 55% lowered the NPV to USD 3,264; however, the investment remained economically feasible, as the NPV stayed positive and the Net Benefit-Cost (B/C) ratio remained well above one.

Conclusion

Based on the findings of this study, it can be concluded that pearl lobster farming represents a highly lucrative aquaculture venture, yielding a net profit of USD 1,584 per production cycle while maintaining an efficient cost structure. Financial feasibility indicators consistently surpassed traditional investment benchmarks, with a Net Present Value (NPV) of USD 5,623, an Internal Rate of Return (IRR) of 367%, a Net Benefit-Cost Ratio (Net B/C) of 13.25, and a Payback Period (PP) of merely 0.35 years. These results affirm that pearl lobster grow-out farming is financially appealing, capable of generating substantial economic returns, and can recoup its initial investment in a remarkably brief timeframe. Furthermore, the enterprise holds significant potential for enhancing household incomes and bolstering the economic resilience of coastal communities in South Sulawesi.

The sensitivity analysis revealed that the investment remained economically viable across all simulated scenarios. In particular, Annual revenue was found to be the main factor influencing investment performance. Even when revenue dropped by 30%, the net present value (NPV) stayed positive. Annual revenue was found to be the main factor influencing investment performance. Even when revenue dropped by 30%, the net present value (NPV) stayed positive. Similarly, variations in operating costs and survival rates impacted financial performance but did not undermine the overall feasibility of the investment. These findings underscore the relatively high financial resilience of pearl lobster farming while highlighting that production output, market prices, and biological performance are the primary factors governing long-term profitability.

Based on scientific perspective, this study fills an important gap in the literature on tropical spiny lobster aquaculture by incorporating profitability analysis, discounted cash flow investment appraisal, and sensitivity analysis within a unified financial evaluation framework. Previous research has predominantly concentrated on biological performance, seed availability, culture technology, or resource management. In contrast, empirical evidence regarding the economic viability of commercial pearl lobster grow-out systems has been relatively scarce. Thus, this research represents one of the most comprehensive financial assessments of pearl lobster (*P. ornatus*) grow-out aquaculture in Indonesia, providing empirical evidence that reinforces the economic foundation for investment decision-making in tropical lobster aquaculture.

Compliance with Ethical Standards

Conflict of interest: The author(s) declare no actual, potential, or perceived conflict of interest for this article.

Ethics committee approval: The authors declare that this study does not involve experiments with human or animal subjects, and therefore, ethics committee approval is not required.

Data availability: The data will be made available upon request from the author.

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