Proceedings of the 10th International Conference on Fisheries and Aquaculture, Vol. 10, Issue 1, 2023, pp. 21-34

ISSN 2386-1282 online
DOI: https://doi.org/10.17501/23861282.2023.10103

DEVELOPMENT OF FARM-SCALE SALINE TILAPIA HATCHERY TO ADAPT TO THE IMPACT OF GLOBAL WARMING: A TECHNO-ECONOMIC ANALYSIS

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Abstract: Tilapia (Orechromis sp) is a freshwater fish species that is widely cultivated because of its high survival ability, easy breeding, and high market demand. However, obtaining land for cultivation in freshwater areas is increasingly difficult because it competes with industrial and residential needs. On the other hand, more brackish water area is available due to the weakening of shrimp prices and rising sea levels caused by global warming. A team of The Agency for the Assessment and Application of Technology from 2008 to 2014, through a selective breeding process, produced saline-tolerant Indonesian Tilapia (officially named "Nila Salina"), which can adapt to high salinity. This variety is superior to other tilapia varieties, but it has yet to be widely cultivated because no hatcheries produce these tilapia seeds. This study aims to explain a feasibility study on the construction of a Nila Salina hatchery in Indramayu Regency, West Java, with a pond area of 3 hectares owned by a local farmer. The study began with a field survey, technical design, primary and secondary data collection, and analysis. Based on the analysis results, it is shown that a Nila Salina hatchery, starting with six packages of broodstock (1800 females and 600 males), can produce 6,040,000 seeds per year. Financial analysis shows that the economic parameters are pretty good, namely the NPV of IDR 2,414,811,000 and IRR of 26.93, indicating that the plan to develop a Nila Salina hatchery in Indramayu is feasible to implement.

Keywords: hatchery, Nila Salina, feasibility, global warming

Introduction

The biggest challenges faced by humanity today are population growth, limited natural resources, and climate change (Mugwanya et al., 2022). The increase in human population puts pressure on limited natural resources such as land and freshwater, thereby threatening global food security (Ray and Ray, 2011). Even though there has been significant growth in food production over the last century, there are still around 720 to 811 million people in the world who faced hunger in 2020 (FAO, 2021). On the other hand, climate change, occurring globally with its various adverse effects, is the biggest threat to the continuity of global food security (Fears, 2020).

The fisheries sector, especially aquaculture, has been the fastest-growing over the last few decades and has significantly contributed to world animal protein production (FAO, 2022). Aquaculture production accounts for almost 50% of fish produced for consumption, and estimates suggest a fivefold increase in production will be needed in the next two decades to meet society's protein demand (FAO, 2014). This share is expected to reach 52% in 2025, which is equivalent to production

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of 102 million tonnes. This indicates that the aquaculture sector will be the primary driver of world fish supplies (FAO, 2021).

Tilapia is an important aquaculture species because it is cultivated in more than 135 countries in the world (Khanjani et al., 2022). This fish is characterized by large body size, fast growth, easy breeding, delicious meat taste, and relatively cheap production costs (Arumugam et al., 2023). This fish is called aquatic chicken, which can be developed like the poultry industry (El-Sayed & Fitzsimmons, 2023). As tilapia production and consumption grow globally, it will likely become the foundation product for all farmed fish, just as chicken is the base for the poultry industry (Liu et al., 2011). Tilapia production at the global level has kept increasing by around 10 percent per year since 2001 and is expected to reach 128 million tonnes in 2030 (Subasinghe, 2017; FAO 2018 in Mahboub et al., 2022).

Although aquaculture production continues to increase, climate change threatens maintaining this sector's production and sustainability. These threats include increasing temperatures, increasing ocean acidity, the emergence of disease and dangerous algae, rising sea levels, changes in sea surface salinity, and dangerous climate events (Maulu et al., 2021). For Indonesia, an archipelago country where 75% of its territory is the sea, rising sea levels and salinity are phenomena faced by fish farmers near the coast who generally cultivate shrimp, milkfish, and other brackish water fish species.

The impact of climate change is thought to have influenced the number of brackish water ponds abandoned by fish farmers in Indonesia, thus affecting fisheries production. The Ministry of Maritime Affairs and Fisheries reports that shrimp ponds in Indonesia in 2021 cover an area of 562,000 hectares, and the majority (93%) are traditional ponds. Among these traditional ponds, around 56%, or an area of 292,656 hectares, are ponds that are not utilized (idle) or have changed function (Rahman, 2021). For this reason, efforts are needed to revive the enthusiasm of the farmers to continue their business.

One of the efforts is to introduce Tilapia (*Oreochromis sp.*) for cultivation in brackish water ponds. Even though it is a freshwater species, this fish has a high tolerance for osmotic pressure and alkalinity (Arumugam et al., 2023). To realize this effort the Agency for the Assessment and Application of Technology (BPPT), which is transformed into National Research and Innovation Agency (BRIN), initiated a program to develop a superior tilapia fish that can develop and grow in brackish waters and seawater by utilizing the euryhaline character of tilapia fish. Diallel crossing was carried out on five varieties of Tilapia from the species *Oreochromis sp*. in Indonesia, namely 1. BEST, 2. Nirwana, 3. Sukabumi (Sultana), 4. Red NIFI, and 5. Red Tilapia. (Aliah, 2017). The best hybrid was obtained from the crosses and performance tests: a cross between the female Red NIFI variety and the male Sultana variety. This superior hybrid was named Nila Salina (saline-tolerant Indonesian Tilapia). It was officially released by the Minister of Maritime Affairs and Fisheries in March 2014 based on the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 22/KEPMEN-KP/2014 concerning the Release of "Nila Salina" (Kementerian Kelautan dan Perikanan, 2014).

The development activities of the "Nila Salina" by the engineering team were carried out for five years (2008-2013) at the Outdoor Aquaculture Laboratory at the Agro-Industrial and Bio-Medical Technology Development Laboratory (LAPTIAB) at PUSPIPTEK Serpong. Meanwhile, field activities were carried out at the Brackish Water and Marine Aquaculture Development Center (BPBAPL) and the Karawang Aquaculture Production Business Service Center (BLUPPB).

Meanwhile, trial activities were carried out in Wanantara Village, Sindang - Indramayu District, Balongan - Indramayu District, Pekalongan, BBI Rappoa - Bantaeng, South Sulawesi, and BBI Kote, Singkep District, Lingga - Riau Islands. From the results of field trials, "Nila Salina" showed superiority compared to other varieties in terms of growth, FCR, and survival (Aliah, 2017).

The problems faced in exploiting the advantages of "Nila Salina" are the unavailability of hatchery units that care for broodstock and carry out the hatching of this type of fish. This is because BPPT needs more facilities, and the collaboration with the Centers that was previously carried out is not continuing. This results in "Nila Salina" seeds not being available on the market despite their advantages. According to information from fish farmers, several hatcheries produce tilapia fish seeds that can adapt to salinity. However, their performance does not satisfy them, mainly because of the high mortality rate and slow growth.

The hatchery and rearing of "Nila Salina" in brackish water ponds in Indramayu Regency - West Java is proposed to provide seeds for fish farmers so that they can develop the business of rearing this fish in many abandoned brackish water ponds, to increase fish production as a source of animal protein for the community and export, as well as increasing the income and welfare of fish farmers thereby reducing poverty rates. Start-up companies carry out the hatchery business, while fish farmers can do the fish-rearing business in Indramayu or other areas.

This article aims to provide a clearer picture of the technical and economic aspects of the "Nila Salina" hatchery in earthen ponds on the north coast of Java, namely in Babadan Village, Indramayu Regency, West Java. This research will provide valuable insights for interested government agencies, local governments, and the private sector interested in investing in this field.

The production parameters for the technical and economic analysis of the "Nila Salina" fish hatchery in Indramayu were based on the experience of "Nila Salina" seed production by the Engineering Team of the Agency for the Assessment and Application of Technology in Karawang Regency during the period 2008 - 2013. These parameters are listed in the attachment to the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 22/KEPMEN-KP/2014 concerning the Release of "Nila Salina". Several technical parameters are the age of adult female and male parents, fecundity, degree of fertilization, degree of hatching, survival of the nursery phase, and length of seed rearing.

Information about hatchery techniques, especially regarding the facilities and stages of hatching, was obtained from the Indonesian National Standard (SNI) book on Black Tilapia Hatchery issued by the National Standards Agency (Badan Standardisasi Nasional, 1999). This book provides information about standard sizes for broodstock ponds, spawning ponds, and tilapia nursery ponds. Likewise, information about the parameters of temperature, pH, dissolved O_2, and water transparency, including broodstock stocking density, ratio of male to female broodstock, seed stocking density, feed dosage, and other parameters.

Data and information on the technical parameters of tilapia hatcheries were also obtained from literature and scientific writings on tilapia hatcheries carried out in various locations and countries.

These parameters are used in economic analysis by applying the assumption that *Oreochromis sp* has similar biological and physical properties and characteristics in various locations.

A field survey to collect technical and economic data in the Indramayu Regency was conducted in June 2023. During the field survey, the team also conducted a Focus Group Discussion, which fishermen and fish farmer leaders attended in Indramayu to gather information about problems and prospects for developing salina tilapia hatcheries. The team also conducted a survey of the pond's location that will be used for the construction of the tilapia fish hatchery, including collecting various physical parameters in the field. Data collection is also conducted after the field survey through correspondence with contact persons and potential investors in the location.

The economic performance of the "Nila Salina" hatchery unit was evaluated using the Cost Benefit Analysis method, abbreviated as CBA. This is a systematic approach to calculating and comparing the benefits and costs of a project, program, or investment. We can predict whether the benefits obtained are more significant than the costs incurred using CBA. CBA has been widely applied in the aquaculture sector as an appropriate tool for implementing rational and systematic decision-making (Valderrama et al., 2016).

The indicators considered in the analysis are Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-cost Ratio (B/C Ratio), Payback Period, Break Even Point (BEP, and Sensitivity Analysis. According to Gittinger (1982), NPV is the present worth of the incremental net benefit or incremental cash flow stream. The IRR is the discount rate that makes the net present worth of the incremental net benefit stream or cash flow equal to zero. Meanwhile, the B/C Ratio is the ratio obtained when the present worth of the benefit stream is divided by the present worth of the cost stream. Another parameter called the payback period is the length of time from the project's beginning until the incremental production stream's net value reaches the capital investment's total amount. Another critical parameter is called the break-even point (BEP), which, according to Tsorakidis et al. (2011), is the point where total income from sales is equal to total expenses (both fixed and variable).

In this paper, a sensitivity analysis is also conducted to test what happens to the earning capacity of the project if events differ from guesses made about them in planning. According to Gittinger (1982), a sensitivity analysis is conducted to test what happens to earning capacity in four principal areas, i.e., price, cost overrun, yield, and delay in implementation. However, the analysis in this paper excludes the last mentioned area. The testing is carried out on the possibility of selling prices and yield decreasing by 5% and 10% and the possibility of costs increasing by 5% and 10% on the NPV and IRR indicators.

Results

After going through various discussions and considerations in selecting the location as well as the opinions of potential investors, the location chosen for the Nila Salina fish hatchery is 3 hectares of 9 hectares of land ex intensive shrimp farming in Babadan Village, Sindang District, Indramayu Regency. The location has a water source from irrigation canals and can be reached using 4-wheeled vehicles via asphalt roads and pavement. It also has state-owned electricity network facilities. From the results of searching Google Maps photos, the land configuration can be seen in Figure 1.

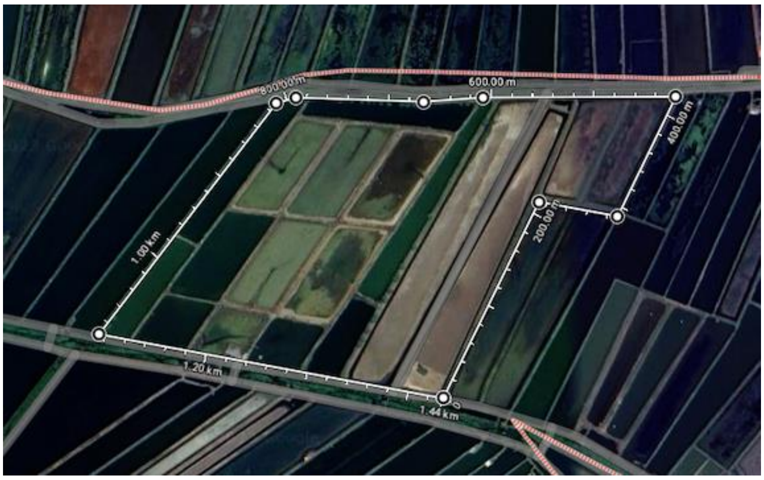

Figure 1. Satellite photo of the pond's location in Babadan Village, Sindang District, Indramayu Regency, which will be used for hatching salina tilapia fish (Source: Goole Map, processed).

The production capacity of the Indramayu hatchery is determined based on the number of broodstock that will be used, namely six broodstock packages (1 package equals 400 broodstock, consisting of 300 female broodstock and 100 male broodstock) so that the total broodstock is 2400 (1800 females and 600 males). By the provisions of Indonesian National Standard (SNI) Number 6141:2009, the ratio between female and male parents in spawning is 3 to 1 (Badan Standar Nasional, 1999). Furthermore, the number of seeds produced is calculated by considering the characteristics of Nila Salina fish as stated in the Attachment to Decree of the Minister of Maritime Affairs and Fisheries Number 22/KEPMEN-KP/2014. The attachment describes the fecundity of 1,206 eggs, fertilization rate of 67.62%, hatching rate of 79.88%, and survival rate at nursery phase was 88.53%. By paying attention to these figures during the whole process (from spawning to seed harvesting), each female broodstock produces 577 seeds; therefore, 1,800 females produce 1,038,062 seeds per cycle. If there are 5.8 production cycles in a year, then about 6.040.158 nila salina fish seeds will be produced yearly.

The results of the calculations above are then used as a basis for estimating the need for infrastructure and facilities for the hatchery to be built. The infrastructure and facilities for the hatchery are in the form of 3 holding ponds of female broodstock (BS) measuring 600 m^2 each (total of 1,800 m^2), and one male holding pond measuring 600 m^2 each. This requirement is calculated based on one head per square meter stocking density. Apart from that, six units of spawning ponds, each measuring 500 m^2 or a total of 3,000 m^2 are needed (stocking density: 1 broodstock m^{-2}), two broodstock resting ponds, each measuring 400 m2 (stocking density: 1 broodstock per m2), and four larval holding tanks measuring 2 m x 4 m x 0.75 m made of plastered masonry, with a stocking density of 3,000 individuals m^{-2}. For the nursery, 26 units of stage I and stage II ponds are needed, each measuring 400 m^2. The stocking density for stage I is 100 individuals m^{-2}, and stage II is 50 individuals m^{-2}. The stocking density is calculated using the SNI Standard for Black Tilapia Fish Hatchery (Badan Standar Nasional, 1999).

Apart from the pond plot, a surrounding channel, water intake, and outlet channels, a wastewater treatment pond, and a reservoir pond covering an area of 500 m^2 are also prepared. Bearing in mind that the land used is former shrimp pond land with a reasonably large plot size (minimum 2800 m^2), the construction of plots for the hatchery is carried out by adding earth embankments or making partitions from waring (net) to obtain the desired pond size.

This hatchery facility will use as little input as possible from outside water sources to avoid water pollution from outside the environment. This hatchery complex will also have housing buildings for workers, feed storage warehouses, workshops, and laboratories. Apart from physical buildings, tools and machines are also provided in the form of water pumps, generators, aerators, PLN electricity, as well as other production equipment such as PVC pipes, water hoses, warings (nets), scoops, buckets, and plastic drums. Details of the required infrastructure, facilities, equipment, and seed grading tools, along with estimated investment costs, can be seen in Table 1.

Table 1. Details of infrastructure, equipment, and investment costs for Nila Salina hatchery units in Indramayu Regency.

Item	Dimension	Unit	Quantity	Cost Per Unit (x1000 IDR)	Total Cost (x1000 IDR)	Useful Life (Years)
Land	**3**	**Ha**	**10**	**10.000**	**300.000**	**10**
Infrastructure					**927.000**	
- Male BS Holding pond	600	m^2	1	35	21.000	10
- Female BS Holding Pond	600	m^2	3	35	63.000	10
Spawning Pond	500	m^2	6	35	105.000	10
Resting Pond	400	m^2	2	35	28.000	10

Larval Holding Tank	8	m^2	4	100	3.200	10
Nursery Pond I	400	m^2	13	35	182.000	10
Nursery Pond 2	400	m^2	13	35	182.000	10
Fingerling Holding Tank	20	m^2	4	35	2.800	10
Reservoir Pond	500	m^2	1	35	17.500	10
Warehouse & Lab	200	m^2	1	500	100.000	10
Worker House	100	m^2	1	1.000	100.000	10
Guard House	30	m^2	4	500	60.000	10
PVC Pipes	6 inch	Unit	100	625	62.500	10
Equipment					**125.300**	
- Floating Net	15 m^2	Unit	30	350	10.500	5
- Electric Generator	50 KVA	Unit	1	80.000	80.000	10
- Electric Installation	1	Unit	1	2.000	2.000	10
- Air Condition	2 PK	Unit	1	4.000	4.000	10
- Centrifugal pump	1 HP	Unit	2	10.000	10.000	10
- Blower	1 HP	Unit	2	2.000	2.000	10
- Thermometer		Unit	1	500	500	5
- Digital scales	100 kg	Unit	1	1.000	1.000	10
- Oxygen tube		Unit	1	2.000	2.000	10
- Refrigerator	2 doors	Unit	1	4.000	4.000	10
- Refractometer		Unit	2	300	3000	5
- Plastic drum	100 litre	Unit	10	2.000	2.000	5
- Bucket/ Basin	20 litre	Unit	20	4.000	4.000	5
- Water hose	1 inc	Unit	30	500	500	5
- Smooth scoop	2 mm	Unit	10	500	500	2
- Large scoop	10 mm	Unit	10	500	500	2
- Fish Grading tool	-	Unit	2	500	500	5
- Fields shoes	-	Unit	5	500	500	5
- Raincoat	-	Unit	5	500	500	5
Total Investment					1.352.300	

The total investment is estimated at IDR 1,352.300,000 (approximately USD 88,000 at 2023 exchange rates). Infrastructure development accounts for 68.5 percent of total investment costs, equipment costs account for around 9.3 percent, and the remainder is for land rental. Although all construction costs are included, all hatchery facilities are assumed to be built on a plot of land rented from the owner for IDR 1,000,000 per hectare per year. In this table, the useful life of each item is also listed for calculating depreciation costs.

Hatchery operations consist of a series of activities starting with the procurement of potential broodstock by purchasing from the government's Center for Freshwater Aquaculture in the city of Sukabumi. The quantity of broodstock is 2,400 individuals, consisting of 1,800 female tilapia of the Red NIFI variety and 600 male tilapia of the Sultana variety. However, to anticipate mortality (around 15%), the number purchased is 2,120 female and 710 male broodstocks. These two groups of fish will first be kept separately for 2 to 3 months at a density of 1 fish m^{-2} in the rearing pond. Maintenance is carried out until the parents reach a size of 200 – 300 grams and are ready to spawn. During the rearing period, prospective broodstock are fed 3% of the fish biomass weight per day and given three times a day. During broodstock maintenance, monitoring is carried out on the health of the broodstock and water quality parameters in the pond, as well as replacing the water as necessary (Aliah, 2017).

After the prospective broodstocks have been reared and reach a size ready to spawn, weighing 150 grams to 200 grams or 18 cm to 20 cm long, they are selected for the following spawning process conducted in the spawning pond. The composition is 300 female parents and 100 male parents per pond (ratio 3: 1). Each spawning batch consists of two ponds carried out simultaneously, or as many as 200 male parents and 600 female parents in each batch. The next batch is carried out with an interval of one month. The spawning process between males and females will take one month (30 days) at water salinity below 10 ppt. One week after merging, the fish seeds will be incubated by the parent and then appear on the water's surface at the pond's edge, ready to be collected using a scoop net; put them in a bucket, and then place them in temporary holding tanks. At the end of the spawning cycle, the pond will be drained so that the remaining water remains in the "foil," the remaining brood and fry will be collected and ready to be transferred to the brood recovery pond and temporary larval holding tank.

The broodstock that has spawned is rested for 30 days in the broodstock recovery pond by separating the males and females. Whenever the spawning ponds are empty, they are then dried until the bottom of the pond cracks, put 1 ton ha^{-1} of quicklime, 1-2 tons ha^{-1} of manure, and filled with water to grow plankton for 30 days, and ready to be used for spawning the next batch Click or tap here to enter text.(Alam Tani, 2014).

Nila Salina seeds collected from spawning ponds are placed in temporary holding tanks with a density of 3,000 seeds m^{-2} and equipped with aerators and water changes for several days. The seeds in this tub are given fine food, disease prevention, counting, and size selection. The type of feed used at this stage is fine feed of 1-3 grams per 100 heads.

The next stage is stocking the seeds in the Phase I nursery pond at a density of 100 individuals m^{-2} and rearing them for 15 days until they measure 3-5 cm. Phase II nursery is carried out in the same size pond for 30 days with a stocking density of 50 fish m^{-2} until the seeds reach the size of 8-12 cm and are ready for sale. The salinity in the nursery pond is kept at around 10 – 20 ppt, so the seeds experience adaptation and do not develop gonads (Aliah, 2017). During stages I and II, the seeds are given pellet feed of 3% of the fish biomass weight.

Through this process, the seed production can be carried out continuously. Every period (cycle) of spawning will be carried out in 3 batches or a total of 6 ponds or 2400 broodstock (1800 females and 600 males) where each batch will start with a difference of 1 month. Thus, every month, it can be harvested and sold seeds. Table 2 summarizes the working capital requirements for implementing seeding activities for one year (12 months), according to the scale and description of activities.

Table 2. Details of working capital per year for Indramayu Nila Salina hatchery

Item	**Unit**	**Quantity**	**Cost/unit (IDR)**	**Total Cost (x1000 IDR)**
Variable Cost				1.175.813
- Male parent stock	Individuals	600	12.500	7.500
- Female parent stock	individuals	1800	12.500	22.500
- Parent stock feed	Kg	9.169	30.000	275.076
- Seed feed	Kg	43.489	12.500	652.337
- Fertilizer & medicine	Pack	12	5.000.000	60.000
- Fuel & lubricant	Pack	12	4.000.000	48.000
- Electricity	Month	12	2.000.000	24.000
- Daily labor	Person-day	720	120.000	86.000
Fixed Cost				260.830
- Daily logistic	Month	12	3000.000	36.000
- Permanent labor	Person-month	36	3.000.000	108.000
- Depreciation				116.830
Total Production Cost				1.327.920

Working capital expenditure, or the cost of producing tilapia seeds measuring 5 to 7 cm for one year, is estimated at IDR 1,327,920,000 (≈USD 86,413). The highest cost item is the purchase of feed, which accounts for 64.55 percent of the total cost. Fixed costs (including depreciation costs) represent 18.16 percent of total costs.

Table 3 presents a cash flow budget analysis for a 3-hectare hatchery. With a selling price of IDR 300 (≈USD 0.02) per individual seed, the annual cash inflow is IDR 1,812 million. Significant investments

Table 3. Cash flow for ten years of the Nila Salina Hatchery Business. Capacity 5.45 million seeds per year in Indramayu Regency.

Item	Year										
	0	1	2	3	4	5	6	7	8	9	10
Seed Quantity	0	3,838,085	6,040,158	6,040,158	6,040,158	6,040,158	6,040,158	6,040,158	6,040,158	6,040,158	6,040,158
Price of Seeds	0	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30
Inflows	0	1,151,426	1,812,047	1,812,047	1,812,047	1,812,047	1,812,047	1,812,047	1,812,047	1,812,047	1,812,047
Outflows	1,352,300	1,019,598	1,315,444	1,346,827	1,315,444	1,366,127	1,315,444	1,346,827	1,315,444	1,346,827	1,315,344
Investment	1.352.300	-	100		100	19,300	100		100		
Prod. Costs	0	1,018,164	1,268,813	1,304,188	1,268,813	1,304,188	1,268,813	1,304,188	1,268,813	1,304,188	1,268,813
- Broodstock	0	35,375	-	35,375	-	35,375	-	35,375	-	35,375	-
- Feed & Vit.	0	734,589	972,413	972,413	972,413	972,413	972,413	972,413	972,413	972,413	972,413
- Personnel	0	148,200	194,400	194,400	194,400	194,400	194,400	194,400	194,400	194,400	194,400
- Electricity	0	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000
- Other	0	28,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
- Taxes	0	1,433	46,530	42,639	46,530	42,639	46,530	42,639	46,530	42,639	46,530
Cash Flows	(1,352,300)	131,828	496,704	465,220	496,704	465,220	496,704	465,220	496,704	465,220	496,704
NPV		2,414,811									
IRR		26,93									

are assumed to occur in Year 0 of the project, with smaller reinvestments occurring in Year 5 to replace worn items (see Table 2). Cash outflows consist of investment and production costs as well as taxes on income (which take into account depreciation costs for tax purposes). Tax regime for small and medium enterprises as determined by the Ministry of Finance. In the first year, expenditure for working capital is less because fish spawning activities begin in the fifth month. After all, the previous months are used for preparing and maturing prospective broodstock until they are ready to be spawned.

The cost-benefit analysis produces a relatively good estimate of the production costs of Nila Salina fingerlings at the Indramayu Hatchery. Based on an estimated annual production of 6.04 million seeds measuring 5 – 7 cm, with a selling price of IDR 300 (≈USD 0.0195), this project is financially feasible with an NPV of IDR 2,414,811,000 and an IRR of 26,93 (Table 3). The NPV figure indicates a large amount of present worth of the incremental net benefit, while the IRR figure is far above the bank loan interest rate, so it meets financial feasibility. The analysis also indicates that the B/C Ratio of this project is 1,39, indicating a favourable ratio between benefit and cost. Meanwhile, the payback period of this project is five years, meaning that the net value of the incremental production stream reaches the total amount of the capital investment in 5 years. Another indicator is the break-even point (BEP), which indicates the point where total income from either unit (quantity) or revenue (sales) is equal to total expenses (both fixed and variable). The analysis resulted in a BEP at 1,290,593 units of seed or a total revenue (sales) of IDR 1,166,188,000.

Discussion

The financial feasibility of a tilapia hatchery business is primarily determined by its technical performance. A critical factor is the ability of each parent to produce seeds. Various research results or publications show variations in the average number of seeds each parent tilapia fish produces. The seed production range for each *Oreochromis niloticus* parent was reported to be 800 – 1000 (Aryandini & Rosi, 2018), 500 – 1000 (Alam Tani, 2014), 75-1000 (Arumugam et al., 2023), 500-750 (Badan Standar Nasional, 1999), and 243 - 847 seeds (Peña-Mendoza et al., 2005). In the financial analysis of the Indramayu hatchery, a figure of 577 seeds per broodstock was used. This figure is an actual one, as indicated in the attachment to the Decree of the Minister of Marine Affairs and Fisheries about the release of "Nila Salina"). Financial feasibility can be increased if each parent's ability to produce seeds is improved. One way is to increase the survival rate at each seeding stage, for example, by increasing the fecundity level by providing quality feed to the parent stock. Providing quality feed to the parents and supported by a healthy aquatic environment can also increase the egg hatching rate. Furthermore, the mortality rate at the larval rearing stage through to nursery stage two can be reduced by maintaining environmental quality, especially related to sufficient oxygen content and preventing the emergence of disease and predation.

Another factor that determines business profitability is the selling price of the seeds. Information from local fish farmers shows that the price of tilapia seeds originating from Karawang or Jepara is IDR 250 per fish. Meanwhile, the price of tilapia seeds from Sukabumi (DeJeefish, 2023) Red Tilapia measuring 4-7 cm is IDR 350, and black Tilapia measuring 4 -7 cm is IDR 250. Based on these references, the figures used in financial analysis calculations is IDR 300 for each "Nila Salina" seed. The price level set for Salina Tilapia seeds is entirely rational considering that the quality of these seeds is better than similar seeds, namely their ability to live and grow in waters with high salinity, even up to 35 ppt. If the selling price can be increased even higher, the profit level will be higher too.

The results of the financial sensitivity analysis show that an increase in investment costs of 5% and 10% has a significant effect on IRR. If the cost increases by 5%, the IRR will reduce from 26,93 to 25,49, while the cost increase by 10% will reduce the IRR to 24,16. A factor that requires special attention is the increase in the price of feed since feed costs account for the most considerable portion of variable costs; therefore, breakthroughs need to be sought to find alternative feed technologies that can increase efficiency. Regarding the selling price, the sensitivity analysis indicates that a 5% decrease in selling price reduces the IRR value to 20,53%, and a 10% decrease in selling price results in the IRR being 13,52%. However, by setting the seed price figure at a moderate level in this financial calculation and considering that the salina tilapia seeds that will be produced have their advantages, consumers will not mind this price.

As explained in the introductory chapter, the development of salina tilapia hatchery units is expected to support adaptation efforts to the impacts of climate change. Nila Salina hatchery in Indramayu is targeted to supply 6.04 million seeds per year. It is expected to encourage the recovery of idle ponds on the north coast of Java. If it is calculated that each hectare of pond requires 50,000 -100,000 seeds, then this hatchery can supply 60 ha to 120 hectares of ponds per growing season. Compared with the area of idle ponds due to climate change in Indonesia of 292,656 hectares, hundreds or even thousands of Nila Salina hatchery units are still needed in Indonesia.

Conclusion

Developing a "Nila Salina" hatchery unit in Indramayu is technically and economically feasible. Technical feasibility is demonstrated by the land and water environment that meets the requirements for developing salina tilapia fish hatcheries. Economic feasibility is demonstrated by a reasonably good level of business profitability as indicated by financial parameters. Apart from that, the marketing prospects are also quite good because the Indramayu area and the north coast of Java Island generally have pond areas that are not utilized (idle) for developing salina tilapia cultivation.

The development of the "Nila Salina" hatchery unit is one of the efforts that can be made to adapt to the impact of climate change on coastal ecosystems, especially brackish water shrimp pond areas. The increasing number of idle ponds caused by climate change can be overcome by increasing the cultivation of tilapia fish tolerant of high salinity and whose seeds are supplied by hatchery units in areas near the coast. The success of the hatchery in Indramayu can be used as a role model for developing similar hatcheries in other areas so that the impact of climate change on pond production can be overcome.

Author contributions

IC and RSA conceptualized the paper; all authors participated in at least some parts of the surveys, data collection, and analysis, which were for physical and technical parameters (IC, DY) and biological parameters (RSA, DY), financial analysis (IC, KMD), technical and biological analysis (RSA, WS, NM). IC wrote the manuscript, and all authors evaluated the manuscript.

Declaration of Interest Statement

The authors declare that they have no conflict of interest.

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