Fisheries Journal, 15 (5), 2583-2594 (2025)
http://doi.org/10.29303/jp.v15i5.1764

CASE STUDY: VANNAMEI SHRIMP *(Litopenaeus vannamei)* GROW-OUT FARMING AT ANTONIUS HDPE POND, MUARA JAMBU VILLAGE, LINGGO SARI BAGANTI SUB-DISTRICT, PESISIR SELATAN REGENCY

Studi Kasus: Usaha Pembesaran Udang Vaname (*Litopenaeus vannamei*) di Tambak Hdpe Antonius Desa Muara Jambu, Kecamatan Linggo Sari Baganti, Kabupaten Pesisir Selatan

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(Received August 6nd 2025; Accepted October 25th 2025)

ABSTRACT

HDPE ponds are a type of aquaculture pond (such as for shrimp or fish) in which the base is lined with an HDPE (High Density Polyethylene) geomembrane, a kind of plastic that is highly durable and resistant to chemicals, UV rays, and mechanical damage. HDPE ponds are also more environmentally friendly compared to conventional earthen ponds because they reduce the risk of soil and surrounding water contamination from aquaculture waste. This study aims to examine the effectiveness of the HDPE pond system in the grow-out culture of whiteleg shrimp (*Litopenaeus vannamei*) in Pesisir Selatan Regency, West Sumatra. This research employed a descriptive, quantitative case study approach spanning three cultural cycles. The observed parameters included shrimp growth, survival rate (SR), feed conversion ratio (FCR), water quality, and business feasibility analysis. The best results were obtained in the third cycle, with an SR of 95%, FCR of 1.4, and production of 3,500 kg. The HDPE pond system proved to increase production efficiency and support sustainable aquaculture. The best culture performance occurred in the third cycle because rainfall was very low during this period and environmental conditions were well controlled.

Keywords: vannamei shrimp, HDPE pond, aquaculture farming, survival rate, FCR

ABSTRAK

Tambak HDPE adalah jenis tambak budidaya perikanan (seperti udang atau ikan) yang bagian dasarnya dilapisi dengan geomembran HDPE (High Density Polyethylene)**,** yaitu sejenis plastik berkekuatan tinggi dan tahan terhadap bahan kimia, sinar UV, serta kerusakan mekanis. tambak HDPE juga lebih ramah lingkungan dibandingkan dengan tambak tanah konvensional karena mengurangi resiko pencemaran tanah dan perairan sekitarnya akibat limbah budidaya Penelitian ini bertujuan untuk mengkaji efektivitas sistem tambak HDPE dalam usaha pembesaran udang vaname (*Litopenaeus vannamei*) di Kabupaten Pesisir Selatan, Sumatera Barat. Penelitian ini menggunakan pendekatan studi kasus deskriptif kuantitatif selama tiga siklus budidaya. Parameter yang diamati meliputi pertumbuhan udang, tingkat kelangsungan hidup (SR), efisiensi pakan (FCR), kualitas air, dan analisis kelayakan usaha. Hasil terbaik diperoleh pada siklus ketiga dengan SR sebesar 95%, FCR 1,4, dan produksi sebesar 3.500 kg. Sistem tambak HDPE terbukti meningkatkan efisiensi produksi dan keberlanjutan budidaya. Budidaya yang baik adalah berada di siklus 3 karena pada saat ini curah hujan sangat rendah dan kondisi lingkungan terkontrol.

Kata Kunci: udang vaname, tambak HDPE, budidaya akuakultur, kelangsungan hidup, FCR

INTRODUCTION

Litopenaeus vannamei, or whiteleg shrimp, is a key commodity in Indonesian aquaculture. This shrimp species boasts several advantages, such as a rapid growth rate, high survival rate, and good adaptability to various pond environmental conditions (Suwoyo *et al.,* 2018). With increasing demand in both local and global markets, whiteleg shrimp has become a high-value fishery product (Ministry of Maritime Affairs and Fisheries, 2020). HDPE-based ponds are considered more environmentally friendly than conventional clay ponds because they minimize the potential for pollution to the soil and surrounding waters from aquaculture waste (Putra, 2021). With better water quality and a more efficient management system, HDPE ponds support the implementation of high-tech whiteleg shrimp cultivation with stocking densities that can exceed 200 individuals per square meter, directly impacting production yields (Santoso & Widiyanti, 2022).

The sustainability of whiteleg shrimp cultivation in HDPE pond systems is strongly influenced by proper water quality management. Several important parameters, such as temperature, pH, dissolved oxygen (DO), and ammonia levels, must remain within ideal ranges to prevent shrimp growth (Subekti & Raharjo, 2018). The use of HDPE systems facilitates water quality control because there is no direct contact with the soil, thus minimizing parameter fluctuations due to external factors (Yulianto, 2020). With the increasing demand for whiteleg shrimp and the various challenges in their cultivation, studies related to whiteleg shrimp rearing methods in HDPE ponds have become increasingly relevant. The purpose of this research is to evaluate production techniques that can increase cultivation efficiency, reduce the risk of disease, and support the sustainability of the pond environment (Iskandar, 2022).

Given the increasing demand for whiteleg shrimp and the challenges in their cultivation, research on whiteleg shrimp rearing production techniques in HDPE ponds is crucial for continued development. This research aims to analyze various production techniques that can increase cultivation efficiency, reduce the risk of disease, and enhance the sustainability of the pond environment (Iskandar, 2022).

This study aims to examine in depth the efforts to enlarge whiteleg shrimp (Litopenaeus vannamei) using the High-Density Polyethylene (HDPE) pond system carried out in Antonius Pond, Muara Jambu Village, Linggo Sari Baganti District, Pesisir Selatan Regency.

RESEARCH METHODS

This research was conducted using a case study method with a quantitative descriptive approach, a research approach used to systematically describe a phenomenon, fact, or event using numerical data. The research location was in Antonius's pond, Muara Jambu Village, Linggo Sari Baganti District, Pesisir Selatan Regency, West Sumatra. Data were collected through field observations, direct interviews with the pond manager, and documentation during three cultivation cycles (March–May 2025). Observed parameters included water quality (temperature, pH, DO, salinity, brightness), shrimp growth, survival rate (SR), feed conversion ratio (FCR), and business analysis (production costs, income, and profit). Data were analyzed descriptively to describe the condition and performance of the cultivation during the research period.

1. Temperature

Temperature is a key factor to consider in whiteleg shrimp cultivation because it affects various vital processes such as physiology, metabolism, appetite, and growth. Boyd (1990) states that the ideal temperature range for supporting whiteleg shrimp growth is 28–32°C, within which enzyme activity and the shrimp's immune system can function optimally.

2. pH

pH plays a crucial role in whiteleg shrimp cultivation because it affects the chemical balance of the water, its health, and its survival rate. The optimal pH range for whiteleg shrimp growth is 7.5–8.5, which supports proper physiological processes (Boyd, 1990). If the pH is too low (acidic), it can cause respiratory problems and reduce the shrimp's appetite, while a pH that is too high (alkaline) can trigger ammonia poisoning.

3. DO

Dissolved oxygen (DO) is a key water quality parameter that plays a crucial role in the success of whiteleg shrimp cultivation, as it is essential for respiration and metabolism. The appropriate DO range to support whiteleg shrimp growth is 4–7 mg/L, at which point the oxygen content in the water is sufficient for physiological activity and maintains the balance of the pond ecosystem. If DO levels decrease, shrimp experience stress, reduced appetite, slower growth, and can even lead to death.

4. Salinity

Salinity is a crucial factor in whiteleg shrimp cultivation because it impacts osmoregulation, growth, and survival. Whiteleg shrimp are euryhaline organisms capable of adapting to a wide range of salinity levels, but the optimal range for growth is 15–25 ppt. If salinity is below the standard, the osmoregulation system will work harder, triggering stress and slowing growth. While salinity levels exceeding the optimal limit can reduce metabolic efficiency and even increase the risk of mortality.

5. Brightness

Water clarity is an indicator of water quality, reflecting how deeply sunlight can penetrate the pond water column. Factors that influence clarity include the presence of suspended particles, the number of phytoplankton, and water color. In whiteleg shrimp cultivation, a good clarity range is 30–40 cm, as under these conditions, sufficient light penetrates to support phytoplankton photosynthesis without causing an excessive population explosion. If clarity is too low, photosynthesis will be disrupted, resulting in a decreased oxygen supply. While clarity that is too high indicates low plankton density, which can disrupt the ecosystem's balance.

6. Average Shrimp Growth

Is the average weight of shrimp per tail, the unit used is grams. With the formula:

$$\mathbf{ABW\ (Grams\ per\ tail)} = \frac{\mathbf{Shrimp\ Weight\ (gr)}}{\mathbf{number\ of\ shrimp\ (ekor)}}$$

Information:
ABW : average weight of shrimp per tail
Total weight of shrimp (gf) : total weight of shrimp

Number of shrimp (tails) : the number of shrimp weighed

7. Survival Rate (SR)

It is the survival rate expressed as a percentage (%). With the formula:

$$\textbf{Survival rate} = \frac{\textbf{number of live shrimp (tails)}}{\textbf{number of spread (tails)}} \textbf{ X 100\%}$$

8. Income

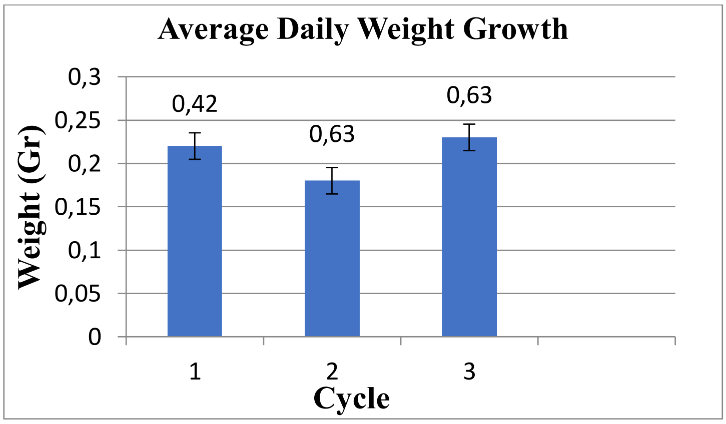
Revenue analysis is useful for determining business profits by analyzing the business's input and output. Revenue can be calculated using the following formula:

$$\text{Income} = \text{TR} - \text{TC}$$

Information:
TR : Total revenue
TC : Total cost

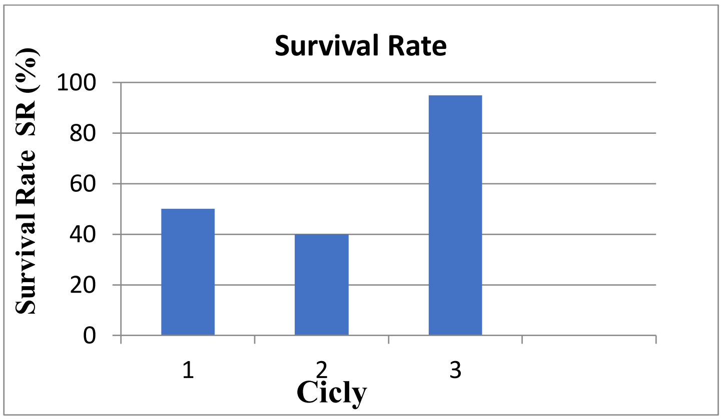
RESULT

1. Average Daily Weight Growth



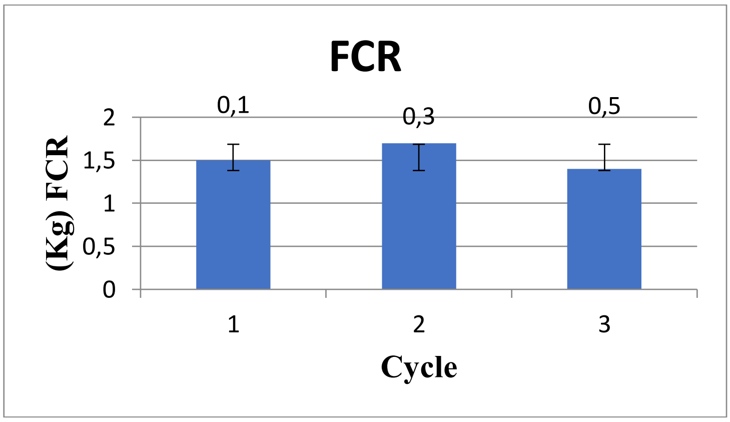
In the third cycle, the average daily growth of shrimp was recorded at 0.23 ± 0.63 grams per individual. While this average figure is considered good, the high standard deviation indicates a significant difference in growth between individuals. This is likely due to uneven feed distribution, competition among shrimp for food, or unstable environmental conditions such as fluctuations in water quality. In the second cycle, the average daily shrimp growth reached 0.18 ± 0.63 grams per individual. The high standard deviation indicates a significant difference in growth between shrimp. This imbalance can be influenced by suboptimal feed distribution, differences in competitive ability between individuals, environmental changes such as temperature and dissolved oxygen levels, and potential environmental stressors that have not been effectively addressed. Figure 3 shows that the average daily shrimp growth in the first cycle reached 0.22 ± 0.42 grams per individual. The t-test results yielded a value of -18.13, indicating a significant difference between individuals, although this average value is still generally considered good.

2. *Survival Rate* (SR)



In the third cycle, the shrimp survival rate reached 95%, indicating that the majority of shrimp survived until the end of the rearing period. This percentage is considered very high and is an indicator of the success of the implementation of effective cultivation management, such as low rainfall intensity, proper feeding, optimal water quality management, and the application of appropriate stocking density. The Survival Rate (SR) in the first cycle was recorded at 50%, meaning that only half of the total stocked fry were able to survive until the end of the rearing period. This low survival rate is likely caused by several factors, such as fluctuating water quality conditions, stocking densities that exceed optimal capacity, disease attacks, and environmental pressures that cause stress to the shrimp. The Survival Rate (SR) in the second cycle was recorded at 40%, indicating that only a small portion of the shrimp managed to survive until the end of the rearing period.

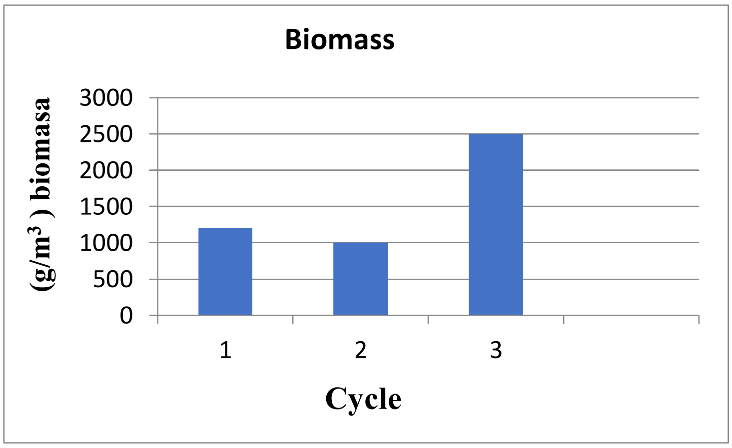
3. *Food Convertion Ratio* (FCR)



In the third cycle, the Feed Conversion Ratio (FCR) was recorded at 1.4, with a t-test result of -1.059. This value indicates that feed utilization efficiency is quite good, as only 1.4 kg of feed is needed to produce 1 kg of shrimp biomass. This efficiency reflects optimal feeding management, possibly also influenced by the quality of the feed used. In the second cycle, the Feed Conversion Ratio (FCR) was recorded at 1.7, with a t-test result of 1.091. This figure indicates that the efficiency of feed conversion for shrimp biomass growth is less than optimal, as 1.7 kg of feed is needed to produce 1 kg of shrimp weight. This condition is likely caused by a decrease in shrimp appetite, inadequate feed quality, or inaccuracies in feed management. As shown in the figure above, the Feed Conversion Ratio (FCR) value in the first cycle was

1.4, with a t-test result of 1.07. This value shows that the efficiency of feed use in supporting shrimp biomass growth is relatively good and is still within a reasonable range for vaname shrimp cultivation, although it has not yet fully reached the maximum efficiency level.

4. *Biomass*



In the third cycle, biomass production reached 3.5 tons, indicating excellent shrimp cultivation productivity. This achievement reflects the success of overall shrimp cultivation management, likely supported by several factors such as high survival rates, optimal average shrimp weight growth, high feed efficiency, and stable environmental conditions throughout the cultivation process. Biomass production in the second cycle reached 2 tons, indicating relatively high shrimp production throughout the cultivation period. This reflects the success of overall shrimp cultivation management. This achievement was likely driven by factors such as good survival rates, optimal individual growth, and efficient feed conversion, which supported production performance. In the first cycle, total biomass production was 2.1 tons, indicating high shrimp yields and reflecting successful shrimp cultivation management during that period. This success was likely influenced by various factors, such as adequate survival rates, good individual growth, efficient feeding, and stable environmental conditions throughout the cultivation process.

5. Water Quality

Table 1. Water Quality

Cycle	Temperature	DO	pH	Salinity	Brightness
1.	30̊C	6,1	7,5	23	18
2.	30˚C	6	7,8	24	20
3.	30̊C	6,3	7,9	25	23

During three cultivation cycles, water quality parameters were recorded within a temperature range of 30°C, pH between 7.5 and 7.9, dissolved oxygen (DO) levels of 6–6.3 mg/L, salinity of 23–25 ppt, and a brightness level of 18–23 cm. All of these values are within optimal limits to support the growth and survival of whiteleg shrimp. This condition reflects the successful implementation of the HDPE pond system in maintaining a stable cultivation environment. These findings align with those of Suwoyo and Pratama (2019) who stated that the ideal temperature for whiteleg shrimp is between 28–32°C, pH 7.5–8.5, DO above 5 mg/L, optimal salinity between 15–30 ppt, and good brightness in the range of 20–40 ºC.

6. Business Analysis

Whiteleg shrimp cultivation at Antonius Pond is progressing very well. Production volume and value are presented in Table 2.

Table 2. Whiteleg shrimp production volume and value

Cycle	Production volume (Kg)	Production value(Rp)
Cycle 1	2.100	126.000.000
Cycle 2	2.000	120.000.000
Cycle 3	3.500	280.000.000
Total	7.600	526.000.000

Referring to production data from three cultivation cycles, the highest production level was achieved in the third cycle, with a total harvest of 3,500 kg and a production value of Rp280,000,000. This increase reflects the successful implementation of more effective cultivation management, including improvements in feeding strategies, better water quality management, and more optimal disease control. Conversely, production decreased in the second cycle, from 2,100 kg in the first cycle to 2,000 kg, accompanied by a decrease in production value from Rp126,000,000 to Rp120,000,000. This decrease was most likely caused by environmental disturbances or shrimp health issues. Overall, the accumulated production during the three cycles reached 7,600 kg with an economic value of IDR 526,000,000, which shows that vaname shrimp cultivation in HDPE ponds has good economic prospects if managed properly. This is in accordance with research by Widanarni et al. (2018), which states that the implementation of proper water and feed quality management plays an important role in increasing the productivity and efficiency of vaname shrimp cultivation businesses.

Table 3. Results of Vaname Shrimp Cultivation Business Analysis

Cycle	Land area (M)	Fixed costs (Rp)	Operating costs (Rp)	Income	Efficiency
1.	1.300	89.400.000	15.000.000	126.000.000	1,4
2.	1.300	98.4000.000	15.000.000	120.000.000	1.2
3.	1.300	127.4000.000	15.000.000	280.000.000	4,1

Based on the business efficiency analysis across three cycles of whiteleg shrimp cultivation, the third cycle demonstrated the highest efficiency level, with a R/C ratio of 4.1. With total expenses of Rp142,400,000, consisting of Rp127,400,000 in fixed costs and Rp15,000,000 in operational costs, revenue of Rp280,000,000 was generated. This means that every Rp1 of expenses generated Rp4.10 in revenue, indicating that this cultivation business was highly profitable in that cycle.

In the first cycle, the efficiency score was recorded at 1.4, indicating that the business was profitable, although not yet optimal. Total costs incurred in this cycle reached Rp104,400,000, with revenue of Rp126,000,000. Meanwhile, in the second cycle, efficiency declined, with an R/C ratio of 1.2, indicating a very small profit margin. The variation in efficiency values in each cycle indicates that financial success in cultivation is greatly influenced by the implementation of appropriate management, including the selection of quality fry, regulation of feed provision, management of water quality, and efficiency in controlling fixed costs.

DISCUSSION

1. Average Daily Weight Growth

In the third cycle, the average daily growth of shrimp was recorded at 0.23 ± 0.63 grams per individual. While this average figure is considered good, the high standard deviation indicates a significant difference in growth between individuals. This is likely due to uneven feed distribution, competition among shrimp for food, or unstable environmental conditions such as fluctuations in water quality. In the second cycle, the average daily shrimp growth reached 0.18 ± 0.63 grams per individual. A high standard deviation indicates a significant difference in growth between shrimp (Ishad *et al.,* 2020). This imbalance may be influenced by suboptimal feed distribution, differences in competitive ability between individuals, changes in environmental parameters such as temperature and dissolved oxygen levels, and potential environmental stressors that have not been effectively addressed. The average daily shrimp growth in the first cycle reached 0.22 ± 0.42 grams per shrimp. The t-test results yielded a value of -18.13, indicating a significant difference between individuals, although the average value is still generally considered good. This aligns with Effendi, (2003)'s opinion that uneven growth in shrimp farming can be caused by internal factors such as the dominance of certain individuals in competing for food, as well as external factors such as fluctuations in water quality that affect metabolism and appetite.

2. *Survival Rate* (SR)

In the third cycle, the shrimp survival rate reached 95%, indicating that the majority of shrimp survived to the end of the rearing period. This percentage is very high and is an indicator of the success of effective cultivation management, such as low rainfall intensity, proper feeding, optimal water quality management, and appropriate stocking densities. The *survival rate* (SR) in the first cycle was recorded at 50%, meaning only half of the total stocked fry survived to the end of the rearing period. This low survival rate was likely caused by several factors, such as fluctuating water quality conditions, stocking densities exceeding optimal capacity, disease infestation, and environmental stressors that caused stress to the shrimp.

The *survival rate* in the second cycle was recorded at 40%, indicating that only a small proportion of shrimp survived to the end of the rearing period. This low rate was likely caused by high levels of stress, disease infection, significant water quality decline, inappropriate stocking densities, and suboptimal feed and environmental management. This is consistent with research by Purnama *et al.,* (2020) stated that the survival rate of vaname shrimp is greatly influenced by the stability of water quality, stocking density, and the effectiveness of maintenance and biosecurity management

3. *Food Convertion Ratio* (FCR)

In the third cycle, the Feed Conversion Ratio (FCR) was recorded at 1.4, with a t-test result of -1.059. This value indicates that feed utilization efficiency is quite good, as only 1.4 kg of feed is needed to produce 1 kg of shrimp biomass. This efficiency reflects optimal feeding management, possibly also influenced by the quality of the feed used. In the second cycle, the Feed Conversion Ratio (FCR) was recorded at 1.7, with a t-test result of 1.091. This figure indicates that the efficiency of feed conversion for shrimp biomass growth is less than optimal, as 1.7 kg of feed is needed to produce 1 kg of shrimp weight. This condition is likely caused by a decrease in shrimp appetite, inadequate feed quality, or inaccuracies in feed management. As shown in the figure above, the Feed Conversion Ratio (FCR) value in the first cycle was 1.4, with a t-test result of 1.07. This value indicates that the efficiency of feed use in supporting shrimp biomass growth is relatively good and is still within a reasonable range for whiteleg shrimp cultivation, although it has not yet fully reached the maximum efficiency level. This finding is in line with the opinion of Ali *et al.,* (2019) and Nur *et al.,* (2020) who stated that the ideal FCR value for whiteleg shrimp cultivation ranges from 1.2 to 1.6, and can be influenced by the type of feed, frequency of feeding, application techniques, and environmental conditions of the waters.

4. Biomass

In the third cycle, biomass production reached 3.5 tons, indicating excellent shrimp cultivation productivity. This achievement reflects the success of overall shrimp cultivation management, likely supported by several factors, including high survival rates, optimal average shrimp weight growth, high feed efficiency, and stable environmental conditions throughout the cultivation process. Biomass production in the second cycle reached 2 tons, indicating relatively high shrimp production throughout the cultivation period. This reflects the success of overall shrimp cultivation management. This achievement was likely driven by factors such as a relatively good survival rate, optimal individual growth, and feed conversion efficiency, which supported production performance (Iswanto *et al.,* 2022).

In the first cycle, the total biomass production was 2.1 tons, indicating a high shrimp yield and reflecting the success of shrimp cultivation management during that period. This success was likely influenced by various factors, including adequate survival rates, good individual growth, efficient feeding, and stable environmental conditions throughout the cultivation process. This is consistent with research by Santoso *et al.,* (2020) stated that the biomass productivity of vaname shrimp is influenced by survival, growth, feed conversion efficiency, and the stability of the pond environmental quality.

5. Water Quality

During three cultivation cycles, water quality parameters were recorded within a temperature range of 30°C, pH between 7.5 and 7.9, dissolved oxygen (DO) levels of 6–6.3 mg/L, salinity of 23–25 ppt, and a transparency level of 18–23 cm. All of these values are within optimal limits to support the growth and survival of whiteleg shrimp. This condition reflects the successful implementation of the HDPE pond system in maintaining a stable cultivation environment. These findings align with those of Suwoyo & Pratama (2019) who stated that the ideal temperature for whiteleg shrimp is between 28–32°C, pH 7.5–8.5, DO above 5 mg/L, optimal salinity between 15–30 ppt, and good transparency in the range of 20–40 cm.

6. Business Analysis

Referring to production data during three cultivation cycles, the highest production level was achieved in the third cycle with a total harvest of 3,500 kg and a production value of Rp280,000,000. This increase reflects the successful implementation of more effective cultivation management, including improvements in feeding strategies, better water quality management, and more optimal disease control. Conversely, production decreased in the second cycle, from 2,100 kg in the first cycle to 2,000 kg, accompanied by a decrease in production value from Rp126,000,000 to Rp120,000,000. This decrease was most likely caused by environmental disturbances or shrimp health problems. Overall, the accumulated production during the three cycles reached 7,600 kg with an economic value of Rp526,000,000, indicating that vaname shrimp cultivation in HDPE ponds has good economic prospects if managed properly. This is in accordance with research by Widanarni *et al.,* (2018) and Pratama *et al.,* (2022) stated that proper water quality and feed management play a crucial role in increasing the productivity and efficiency of whiteleg shrimp farming.

Based on an analysis of business efficiency across three whiteleg shrimp farming cycles, the third cycle demonstrated the highest efficiency level, with a R/C ratio of 4.1. With total expenses of IDR 142,400,000, consisting of IDR 127,400,000 in fixed costs and IDR 15,000,000 in operational costs, revenue of IDR 280,000,000 was generated. This means that every IDR 1 of expenses generated IDR 4.10 in revenue, indicating that this farming business was highly profitable in that cycle. In the first cycle, the efficiency value was recorded at 1.4, indicating that the business was profitable, although not yet optimal. Total costs incurred in this cycle reached IDR 104,400,000, with revenue of IDR 126,000,000. Meanwhile, in the second cycle, efficiency decreased, with an R/C ratio of 1.2, indicating a very small profit margin. The variation in efficiency values across cycles indicates that financial success in cultivation is significantly influenced by the implementation of appropriate management, including the selection of quality fry, feeding arrangements, water quality management, and efficiency in controlling fixed costs. This aligns with research by Kordi Tanu, (2021) and Nurdin et al. (2021), which states that the efficiency of vannamei shrimp cultivation is significantly influenced by the appropriate management of costs and production inputs, which can significantly increase productivity and profits.

CONCLUSION

Vannamei shrimp cultivation in Antonius' HDPE ponds achieved the best results in the third cycle, as indicated by a survival rate (SR) of 95%, a feed conversion ratio (FCR) of 1.4, and a total production of 3,500 kg. This success was attributed to good water quality management, selection of superior fry, and efficient feed utilization. The use of the HDPE pond system has proven to support sustainability and increase profitability in intensive vannamei shrimp cultivation.

ACKNOWLEDGEMENT

The author would like to thank Nahdlatul Ulama University of West Sumatra, the supervisor Ms. Endryeni, S.Pi., M.Sc, and the examiners Ms. Sriyenica Roza, S.Pi., M.Si and Mr. Irwandi, S.Pi., M.M., and Ms. Lisa Mayasari, S.Pi., M.Si. Thanks are also extended to Mr. Antonius and Mr. Anton for their cooperation in carrying out this research.

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