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Performance Evaluation of Vannamei Shrimp (*Litopenaeus vannamei*) Culture in Round Ponds (Millennial Shrimp Farm) under Applied Management Practices at BPBAP Ujung Batee

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ABSTRACT

This study evaluated the growth and production performance of vannamei shrimp (*Litopenaeus vannamei*) cultured in round ponds using the Millennial Shrimp Farm (MSF) system under applied management practices at BPBAP Ujung Batee up to 60 days of culture (DOC 60). Performance parameters included average body weight (ABW), average daily growth (ADG), survival rate (SR), feed conversion ratio (FCR), biomass, and water quality, analyzed descriptively and presented as mean ± standard deviation. At DOC 60, shrimp reached an ABW of 5.25 ± 2.86 $g \cdot ind^{-1}$ and an ADG of 0.21 ± 0.06 $g \cdot ind^{-1} \cdot day^{-1}$, with survival rates ranging from 84 to 89% and an FCR of approximately 1.4. Ammonia concentration ranged from 0.02 to 1.65 $mg \cdot L^{-1}$ and showed a strong negative relationship with survival rate ($r = -0.94$). These results indicate that shrimp performance during the mid-culture phase was maintained within acceptable ranges, with ammonia control being a key factor influencing survival.

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1. INTRODUCTION

Vannamei shrimp (L. *vannamei*) aquaculture in Indonesia is currently very popular and has promising market prospects, as vannamei shrimp is one of the leading fisheries commodities in both national and international markets. In 2019, a total of 207 thousand tons of shrimp were exported to the global market with an export value of US$ 1.7 billion. Furthermore, BPS (2021) recorded an increase in shrimp exports in 2020 to 239 thousand tons with an export value of US$ 2 billion, placing Indonesia as the 5th largest shrimp-exporting country after Ecuador, India, Vietnam, and Argentina BPS (2021) in (Yulisti & Mulyawan 2021).

One of the reasons for the increased production of vannamei shrimp (L. *vannamei*) is the biological advantages of the species, including its nocturnal feeding behavior (Pratiwi, 2008), its ability to tolerate wide salinity ranges (euryhaline) (Widiani & Ambarwati, 2018), relatively fast growth rates, and high adaptability to environmental changes such as temperature and salinity fluctuations (Manan, 2014). In addition, vannamei shrimp can be cultured at high stocking densities and possess strong resistance against diseases (Muhsin et al., 2020; Tahe & Suwoyo, 2011; Lutfiana et al., 2019). Due to these advantages, along with continual production increases, vannamei shrimp is currently one of the most important aquaculture commodities in Indonesia.

However, the development of the vannamei shrimp farming industry remains constrained by several limiting factors, including the availability of water resources, limited land area, and environmental pollution (Amir et al., 2018). Therefore, technological innovations are required to ensure the sustainability of shrimp culture, especially through the use of limited land such as residential yards by utilizing round ponds without compromising production outcomes. This grow-out method is known as Millennial Shrimp Farm (MSF), which is considered suitable for millennial farmers due to its practicality. Unlike conventional ponds, MSF uses circular pond structures, requires minimal land, and can be dismantled and adjusted according to available space. Vannamei shrimp culture in round ponds has recently developed in Indonesia, including in Aceh Province. Round ponds are recommended for vannamei culture due to their cost efficiency, high survival rate, and improved shrimp quality (Irsyam et al., 2019).

To achieve target production in round-pond vannamei farming, proper management is required. Management is a process consisting of planning, organizing, actuating, and controlling to achieve predetermined objectives through the utilization of human resources and other production factors. Management plays an important role in organizing production activities to achieve predetermined targets (Koso et al., 2018). However, vannamei shrimp farming practices frequently lack optimal management, which results in decreased production performance.

Based on the aforementioned issues, this study focused on "Grow-out Management of Vannamei Shrimp (L. vannamei) in Round Ponds (Millennial Shrimp Farm) at the Brackish Water Aquaculture Center (BPBAP) Ujung Batee, Aceh Besar, Nanggroe Aceh Darussalam." This study aimed to evaluate the growth and production performance of vannamei shrimp (*Litopenaeus vannamei*) cultured in round ponds at BPBAP Ujung Batee under applied management procedures up to DOC 60.

2. RESEARCH METHODOLOGY

The tools used in this study included measuring cylinders, anco nets, Secchi disk, refractometer, pH pen, DO meter, digital scale, platform scale, water level gauge, and colorimeter. The materials used consisted of PL-10 shrimp postlarvae, feed, probiotics, molasses, yeast, wheat flour, dolomite lime, chlorine, and sodium bicarbonate. Data collection was carried out through observation by participating directly in field activities, conducting measurements and monitoring throughout the culture process, and interviewing field supervisors.

The study was conducted for 90 days by applying the POAC (Planning, Organizing, Actuating, and Controlling) management approach to vannamei shrimp grow-out activities in round ponds. The planning stage included determining production targets and scheduling

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production activities. The organizing stage involved assigning labor responsibilities for pre-production, production, and post-production activities. The actuating stage included pond and media preparation, postlarvae stocking, and feed management. The controlling stage included water quality management, pest and disease control, growth monitoring, and harvesting. Performance evaluation of the vannamei shrimp grow-out was conducted by observing technical parameters, including:

Average Body Weight (ABW)

According to Bahri et al. (2020), the formula for calculating the Average Body Weight (ABW) of shrimp is:

$$ABW = \frac{Total\ Sample\ Mass\ (g)}{Number\ of\ Shrimp\ Samples\ (ind)}$$

Average Daily Growth (ADG)

Average Daily Growth (ADG) represents the average daily weight gain of shrimp over a specific period and can be used to determine growth rate (Bahri et al., 2020). ADG was calculated based on changes in average body weight over the culture period.ADG can be calculated using the following formula:

$$ADG = \frac{ABW\ II\ (g) - ABW\ I\ (g)}{Sampling\ Interval}$$

Feed Convertion Ratio (FCR)

According to Pratama (2017), the feed convertion ratio is calculated as follows:

$$FCR = \frac{Cumulative\ Feed\ Amount}{Shrimp\ Biomass}$$

Survival Rate (SR)

According to Haliman and Adiwijaya (2005) in Fuady et al. (2013), SR can be calculated using the following formula:

$$SR\ (\%) = \frac{Number\ of\ Shrimp\ at\ the\ End\ of\ Rearing}{Shrimp\ Stocking\ Population}$$

Data analysis was conducted using descriptive analysis to describe the research results based on observed data. Correlation analysis was performed to examine the relationship between ammonia concentration and survival rate during the culture period.

3. RESULTS AND DISCUSSION

Vannamei shrimp grow-out activities were carried out based on the production targets set by the institution, including stocking density, biomass, FCR, ADG, SR, and cultivation period. BPBAP Ujung Batee operated 4 round ponds and conducted grow-out activities for three production cycles per year. The production targets are presented in Table 1.

Table 1 Production Targets

No.	Description	Target
1	Day of Culture (days)	120
2	Density (ind/m³)	275
3	SR (%)	80
4	FCR	1.5
5	ADG (g/ind/days)	0.2

Source : BPBAP Ujung Batee

To ensure that production targets were achieved, cultivation activities were carried out according to the predetermined schedule. Production schedules were arranged by the field coordinator, while technical schedules were prepared by the grow-out technicians. The production schedule is shown in Table 2.

Table 2. Production Activity Schedule

No.	Activity	Target
1	Pond Preparation	7 days
2	Media Preparation	14 days
3	Stocking	1 days
4	Grow-out	120 days
5	Harvesting	1 days
Total Duration		143 days

Production planning is an initial stage in the production process aimed at achieving desired outputs. Dakhi (2016) described planning as setting goals and determining strategies to achieve them. Planning is considered a primary management function encompassing all managerial efforts.

A structured organization was applied to support the implementation of grow-out activities to divide tasks and ensure smooth operations. According to Basyirah & Wardi (2020), organizing is a process of designing, grouping, arranging, and distributing tasks so that organizational goals can be achieved efficiently.

Organizing also involves forming cooperative relationships among individuals to create a unified system directed toward common objectives (Mohi et al., 2020). Human resources play an important role in determining the success of aquaculture operations, and skilled personnel are necessary to manage farming activities. The organizational structure is presented in Figure 1.

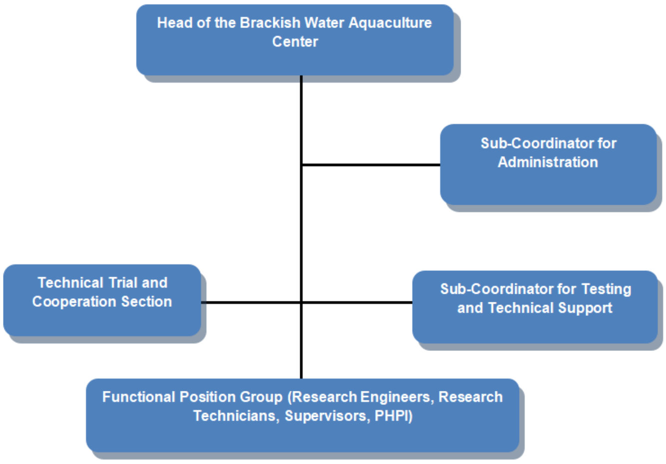

Figure 1. Organizational Structure (source: BPBAP Ujung Batee)

Round ponds utilized wiremesh steel structures with a diameter of 10 meters and were covered with 0.5 mm High-Density Polyethylene (HDPE). The pond bottom was sloped toward the central drain to facilitate waste removal and harvesting, consistent with Hajar (2020), who noted that sloped pond bottoms improve water discharge efficiency and shrimp collection during harvest. The layout of the grow-out area is presented in Figure 2.

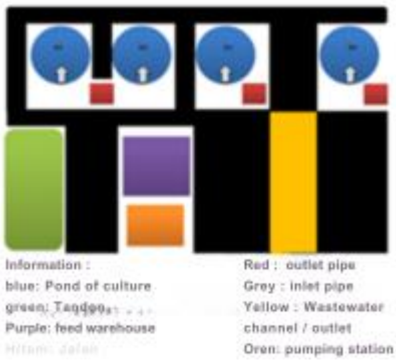

Figure 2. Layout of MSF Pond Area

The grow-out facility consisted of 4 ponds with a total land area of 1000 m^2. Each pond measured 10 m in diameter and 1.4 m in height, resulting in a surface area of 78.5 m^2 and a water volume of 110 m^3. The initial water level during early culture was set at 120 cm, producing a water volume of 94 m^3.

Cleaning of the culture pond was carried out through brushing and sun-drying for approximately 1 week after final harvest to remove organic residues and minimize pathogenic contamination. The cleaning process used sponge/brushes and detergents, followed by freshwater rinsing and sun-drying for 1–2 days. Equipment such as paddlewheels, aerotubes, nets, water level gauges, and inlet filters were also sanitized. This step aimed to prevent disease carryover to the next cycle (Safitrah et al., 2020; Rahayu, 2010).

Paddlewheels and aerotubes were installed to provide aeration and prevent water stratification. A 1 HP paddlewheel was sufficient to support oxygen supply, drive sludge toward the central drain, and assist in water treatment (Untara et al., 2018; Hermawan et al., 2020; Makmur et al., 2018). Aerotubes (7 points per pond) were installed around the pond perimeter for uniform oxygen distribution (Tampangallo et al., 2014).

Media preparation included water filling, sterilization, and liming. Seawater was filtered and pumped into the ponds until reaching a height of 120 cm, while filtering was applied to prevent the entry of pathogen carriers (Yuni et al., 2019). Sterilization was conducted using 60% chlorine at a dosage of 10 $g \cdot m^{-3}$, aerated for 2 hours using paddlewheels, and allowed to settle for 24 hours (Novitasari et al., 2016; Sinaga et al., 2020). Dolomite ($CaMg(CO_3)_2$) was applied at a dosage of 20 $g \cdot m^{-3}$ to increase pH, supply nutrients for plankton, and improve water quality (Akmal et al., 2020).

Stocking was conducted using PL-10 postlarvae. At this stage, shrimp already possess complete organ development, expanded tail morphology, are virus-free, transparent in body coloration, have intact digestive tracts, and swim actively against the current (SNI 01-7252-2006). Postlarvae were sourced from CP Prima Bireuen, transported for approximately 220 km with a travel duration of ±5 hours. Visual inspection was conducted using two sample bags to assess physical quality and determine total counts. High-quality postlarvae are essential for cultivation success, as superior PL leads to optimal production outputs (Suseno et al., 2021). After stocking, shrimp were provided 100 g of powdered feed per pond to reduce cannibalism. Stocking details are presented in Table 3.

Tabel 3. Post Larva Stocking Data

No	**Date**	**Pond**	**Volume (m^3)**	**Stocking (ind)**	**Density (ind/m^3)**
1	04-04-2021	K1	94	25.987	276
2	04-04-2021	K2	94	26.050	277
3	04-04-2021	K3	94	25.889	275
4	04-04-2021	K4	94	25.951	276

Stocking was conducted through acclimatization of temperature and salinity. Temperature acclimatization was performed by floating shrimp bags for ±30 minutes, while salinity acclimatization was performed gradually by splashing pond water into the bag until shrimp exited voluntarily. This procedure aligns with Ghufron et al. (2018) and Kusyairi et al. (2019), who stated that acclimatization should be performed through immersion and gradual salinity adjustment to minimize stress.

During culture, shrimp were provided two feed types: natural feed and artificial feed. Natural feed in the form of phytoplankton was supplied from early stocking until harvest and played an important role in fulfilling nutritional needs during early development, supporting survival, growth, and metamorphosis (Rukmana et al., 2017). Phytoplankton also stabilized water quality through oxygen production, nutrient absorption, and prevention of direct sunlight penetration to the pond bottom (Sudinno et al., 2015), thereby reducing stress and mortality (Zaqiyah, 2017). Dominant phytoplankton included *Nannochloropsis sp.*, although during grow-out its role shifted more toward water quality support rather than primary nutrition.

Artificial feed served as the main feed source in crumble and pellet forms. Nutritional composition met vannamei requirements, consisting of 20–35% protein, 4–18% lipid, and 3.12–4.96% fiber (Akmal et al., 2020). Feeding was performed using blind feeding and demand feeding. Blind feeding was applied during the early phase (1–30 days) based on stocking density and harvest target, using crumble feed without direct sampling control. Ariadi (2020) stated that blind feeding is applied during the initial 25–30 days of culture.
After 30 days, demand feeding was applied using Feeding Rate (FR) based on sampling, culture age, and ABW. FR values were calculated from biomass (Hartini, 2019) and declined as shrimp aged. Feeding frequency was four times daily (07:00; 11:00; 16:00; 21:00 WIB), aligning with recommended frequencies of 4–6 times per day for optimal results (Suri et al., 2018; Zainuddin, 2014).

Water exchange began at DOC 30 at an exchange rate of 15–20% of total volume to maintain water stability and remove feed residues and dead plankton contributing to ammonia accumulation. In this culture cycle, ammonia levels in pond K2 increased to 1.65 $mg \cdot L^{-1}$, prompting a 50% water exchange and probiotic application. Subyakto et al. (2009) noted that accumulated feed waste and fecal residues increase with shrimp age and may reduce growth performance.

Probiotics and molasses were applied to enhance water quality by degrading metabolic waste (Fuady & Supardjo, 2013). Probiotics containing *Lactobacillus sp.* and *Bacillus sp.* were applied every 4 days (5 $mL \cdot m^{-3}$). Molasses (5 $mL \cdot m^{-3}$) was applied weekly as a carbon source for bacterial growth (Sartika et al., 2012). Dolomite lime and sodium bicarbonate were also applied weekly (20 $g \cdot m^{-3}$) to stabilize pH and supply minerals. Liming contributes to pH stability and supports moulting (Romadhona, 2016; Angke et al., 2016).

Growth monitoring was conducted through sampling by submerging an anco net at a fixed point in each pond starting at DOC 30. Shrimp collected during sampling were counted to determine ABW, ADG, biomass, and population. Sampling was conducted every 10 days to monitor growth, feeding activity, and health. This aligns with Aisyah et al. (2017), who stated that initial sampling is typically conducted when shrimp reach 30 days of age. Measurement results were compared with standard growth curves to assess performance.

Pest and disease control was conducted through biosecurity measures and media sterilization prior to stocking using chlorine. Sterilization aimed to reduce carrier organisms and prevent contamination (Katili et al., 2017). Biosecurity practices included the use of inlet filters (Widiani & Ambarwati, 2018). However, the absence of fencing resulted in shrimp jumping out of ponds, which reduced stocking population and survival.

Partial harvest was conducted at DOC >60 to control biomass, prevent exceedance of carrying capacity, reduce spatial and feeding competition, and enhance growth of remaining shrimp (Wafi et al., 2020). Partial harvest also maintained optimal oxygen availability (Septiningsih, 2015), minimized financial risks due to crop failure, and supported operational cost recovery. Final harvest was performed at ±120 days according to production targets.

Water quality monitoring included daily parameters (salinity, pH, DO, temperature, and transparency) and weekly parameters (alkalinity and ammonia). Salinity ranged from 28–32 $g \cdot L^{-1}$ and remained within the tolerance range of vannamei shrimp, which are euryhaline species (Febriani et al., 2018; Arsad et al., 2017; Purnamasari et al., 2017). The pH values of 7.9–8.5 were within the optimal range (Zulfahmi et al., 2018; SNI 01-7246-2006). DO levels of 4.31–5.67 $mg \cdot L^{-1}$ were considered optimal (Makmur et al., 2018; SNI 01-7246-2006). Temperatures of 27.3–31.1°C were close to the ideal range of 28–30°C (Santanumurti et al., 2019; SNI 01-7246-2006). Transparency levels of 25–40 cm were still within operational ranges (Awanis, 2017), although slightly below SNI standards due to reduced phytoplankton populations (Renitasari & Musa, 2020). Alkalinity values of 100–200 $mg \cdot L^{-1}$ remained within a range supportive of growth (Ariadi et al., 2020).

Ammonia concentration during the culture period ranged from 0.02 to 1.65 $mg \cdot L^{-1}$, with values exceeding the recommended SNI standard and potentially originating from shrimp excretion and the accumulation of organic matter (Sahrijanna & Sahabuddin, 2014). Correlation analysis showed a strong negative relationship between ammonia concentration and survival rate ($r = -0.94$), indicating a tendency of reduced survival at higher ammonia levels. Mitigation efforts were conducted through water exchange, as ammonia concentrations above certain thresholds are reported to be harmful to shrimp (Syah et al., 2017). Evaluation of production performance was conducted throughout the culture period to compare achieved results with the production targets.

Average Body Weight (ABW)

Sampling results showed an increase in ABW as DOC increased. The mean ABW of vannamei shrimp at DOC 60 across four ponds was 5.25 ± 2.86 g/ind (Table 4).

Table 4. ABW Growth

No	Pond	ADG (g/ind)
1	K1	5.22 ± 2.74
2	K2	5.34 ± 2.91
3	K3	5.50 ± 3.05
4	K4	4.95 ± 2.74

Average Daily Growth (ADG)

The mean ADG reached 0.21 ± 0.06 g/ind/day, indicating relatively uniform growth performance among ponds (Table 5). Variation in ADG among sampling periods was influenced by shrimp health and feeding activity. A decrease in ADG during the fourth sampling occurred in all ponds, with the most substantial reduction in K2 due to suboptimal environmental conditions and health status. Fuady et al. (2013) stated that water quality management strongly affects shrimp growth rate.

Table 5. ADG Growth

No	Pond	ADG (g/ind)
1	K1	0.21 ± 0.02
2	K2	0.22 ± 0.07
3	K3	0.22 ± 0.10
4	K4	0.21 ± 0.05

Survival Rate (SR)

SR was monitored until DOC 60 (Figure 6). SR values in K1–K4 exceeded the round pond target (80%) and exceeded the commonly reported minimum survival threshold (>70%) for vannamei culture (Helda, 2018). The highest SR was recorded in K1 and K4 (89%), while the lowest was recorded in K2 (84%). Reduced SR in K2 was influenced by suboptimal water quality, including elevated ammonia and decreased growth performance. Pratama (2017) noted that survival is affected by biotic and abiotic factors, including water quality that supports shrimp physiological processes.

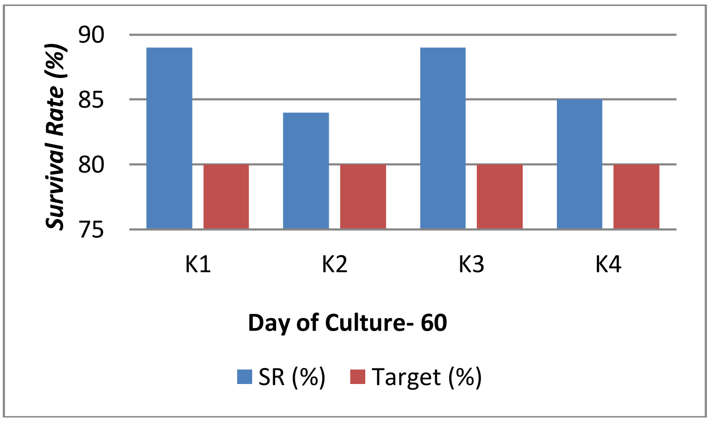

Figure 6. SR Curve

Feed Convertion Ratio (FCR)

FCR values in K1–K4 at DOC 60 were approximately 1.4 (Figure 7), were lower than the production target value (1.5). These values were within efficient feed conversion ranges for vannamei culture (≤1.5) (Lailiyah et al., 2018; Hendriana, 2020).

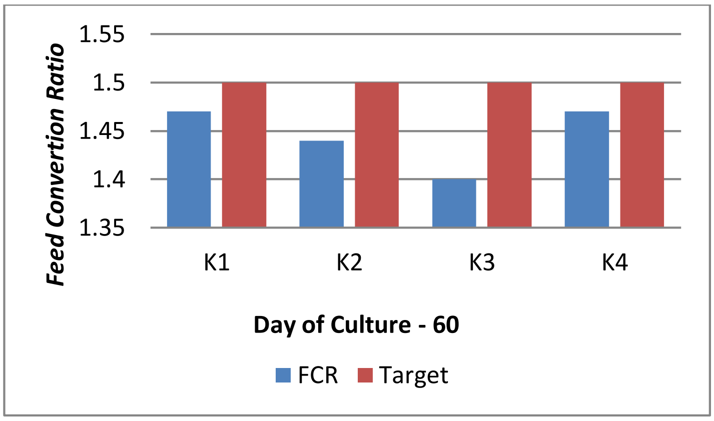

Figure 7. FCR Curve

4. CONCLUSIONS

The evaluation of vannamei shrimp culture in round ponds using the MSF system up to DOC 60 showed that shrimp growth and survival were maintained within acceptable technical ranges under the applied management practices. Differences in survival among ponds were closely related to variations in water quality conditions. Ammonia concentration played an important role in influencing shrimp survival, emphasizing the need for careful monitoring and timely management actions during the mid-culture phase. This study provides baseline performance information for vannamei shrimp culture in round pond systems and may support further evaluation under extended culture periods.

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