Fisheries Journal, 16 (1), 430-444 (2026)
http://doi.org/10.29303/jp.v14i3.2143

PRODUCTIVITY OF WHITELEG SHRIMP (*Litopenaeus vannamei*) CULTIVATION BASED ON WATER QUALITY, GROWTH, FEED EFFICIENCY, AND BUSINESS ANALYSIS FACTORS

Produktivitas Budidaya Udang Vaname (*Litopenaeus vannamei*) Berdasarkan Faktor Kualitas Air, Pertumbuhan, Efisiensi Pakan, dan Analisa Usaha

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(Received March 3rd 2026; Accepted March 6th 2026)

ABSTRACT

The productivity of whiteleg shrimp (Litopenaeus vannamei) cultivation is influenced by technical and non-technical factors. Technical factors include water quality, growth and survival, and feed efficiency. Non-technical factors, such as business analysis and feasibility, are related to cultivation productivity. The study was conducted in Pandeglang, Banten, Indonesia, for three months. Six ponds were observed, each with an area of 2.500 m^2, 2.000 m^2 and 1.500 m^2, with a stocking density of 125 shrimp/m^2. The results showed that water quality was mostly within the optimal range, except for parameters such as brightness, nitrite, ammonium, ammonia, phosphate, Total Organic Matter (TOM), and magnesium. The growth values of Average Body Weight (ABW) and Average Daily Growth (ADG) were very good, with a low mortality rate or high SR, and optimal feed efficiency throughout the pond. The results of the business analysis show a positive value on the productivity of L. vannamei. In general, productivity factors such as water quality, growth and survival, feed efficiency and business analysis are related to biomass production with R^2 values, namely: 0.9942 (pond 1), 0.9922 (pond 2), 0.9956 (pond 3), 0.9598 (pond 4), 0.9903 (pond 5) and 0.9844 (pond 6).

Keywords: Business Analysis, Feed Efficiency, Litopenaeus vannamei, Water Quality

ABSTRAK

Produktivitas budidaya udang vaname (*Litopenaeus vannamei*) dipengaruhi oleh faktor teknis dan non teknis. Faktor teknis seperti kualitas air, pertumbuhan dan kelangsungan hidup, serta efisiensi pakan. Sedangkan faktor non teknis seperti analisa usaha dan kelayakan usaha berkaitan dengan produktivitas budidaya. Penelitian dilaksanakan di Pandeglang, Banten, Indonesia selama tiga bulan. Tambak yang diamati sebanyak 6 petak dengan luasan 2500 m^2, 2000 m^2 dan 1500 m^2 dengan padat tebar 125 ekor/m^2. Hasil penelitian diperoleh bahwa kualitas air sebagian besar berada dalam kisaran optimal kevuali parameter kecerahan, nitrit, ammonium, ammonia, fosfat, Total Organic Matter (TOM) dan magnesium. Nilai pertumbuhan ABW dan ADG sangat baik dengan tingkat mortalitas rendah atau SR tinggi serta efisiesni pakan optimal pada keseluruhan kolam. Hasil analisis usaha menunjukan nilai yang positif terhadap produktivitas *L. vannamei.* Secara umum, faktor produktivitas seperti kualitas air, pertumbuhan dan kelangsungan hidup, efisiensi pakan dan analisa usaha berhubungan dengan produksi biomassa dengan nilai R^2, yakni: 0.9942 (tambak 1), 0.9922 (tambak 2), 0.9956 (tambak 3), 0.9598 (tambak 4), 0.9903 (tambak 5) dan 0.9844 (tambak 6).

Kata Kunci: Analisa usaha, Efisiensi Pakan, Kualitas air, *Litopenaeus vannamei*

INTRODUCTION

Whiteleg shrimp (Litopenaeus vannamei) productivity is influenced by various technical and non-technical factors. Technical factors include water quality, growth and survival rate, and feed efficiency. The main non-technical factors include business analysis and feasibility. Various factors in L. vannamei cultivation are directly related to shrimp performance. The performance of L. vannamei is influenced by physical, chemical, and biological factors in the water. These factors can be observed based on the values of cultivation water parameters such as temperature, Dissolved Oxygen (DO), power of Hydrogen (pH), salinity, nitrate, nitrite, phosphate, Total Organic Matter (TOM), alkalinity, and the presence of aquatic microorganisms (Mahmudi et al., 2018; Akbarurrasyid et al., 2023) . The concentration of cultivation water parameters indicates the level of water quality in L. vannamei production activities. Cultivation water quality is a factor that experiences dynamic fluctuations based on time/temporally, technology, and cultivation treatments and activities. Fluctuations in cultivation water quality impact the level of osmoregulation, nutrient absorption, and shrimp growth, resulting in decreased shrimp performance and production. L. vannamei can grow optimally in environmental conditions that meet requirements, thus increasing production (Ariadi et al., 2023) .

L. vannamei grows optimally in stable aquatic environments. Indicators of aquatic environmental stability can be observed through the conditions of various relevant water quality parameters. Unstable aquatic conditions impact the interaction patterns between various aquatic parameters and affect living creatures in the aquatic environment, this occurs in complex conditions and impacts the sustainability of the use of aquatic environments for L. vannamei cultivation activities. Water quality plays an important role in shrimp cultivation activities, such as: differences in salinity that affect water quality, growth performance, and shrimp physiology (Khanjani et al., 2020) , the presence of microalgae in shrimp cultivation ponds is related to water quality, shrimp development and harvest yields (Huang et al., 2022; Palupi *et al.,* 2022) and the combination of various water quality parameters on L. vannamei growth (Pebriani et al., 2025) . The complexity of aquatic environmental conditions in supporting L. vannamei cultivation performance requires in-depth study because it is directly related to the analysis and feasibility of cultivation efforts.

Shrimp farming business can be maximized by increasing revenue and reducing production costs. Acceptance is related to shrimp growth and survival factors. The maximum growth and survival rate of shrimp impacts price and revenue increases. According to Fujaya et al., (2021), the growth of L. vannamei shrimp influences the selling price, R/C ratio , and *payback period* . Meanwhile, the largest production cost in shrimp farming comes from feed components. According to Fahrudin *et al*., (2023), feed is the largest component in L. vannamei cultivation activities, accounting for approximately 70–80% of production costs. Excessive feed use impacts increased production costs, resulting in low revenue levels. Furthermore, excessive and underutilized feed is directly related to potential problems in the pond environment that impact productivity levels. According to Rahi et al., (2025), excessive feed causes problems with increasing waste in the cultivation media which affects the success of cultivation activities. Based on this, research was conducted related to the productivity of L. vannamei cultivation based on factors such as water quality, growth, feed efficiency, and business analysis. This research was conducted to determine the value of water quality, growth, feed efficiency and business analysis as well as the relationship of related factors to L. vannamei productivity.

RESEARCH METHODS

Research Location

The research was conducted in ponds in the Ujung Kulon area, Pandeglang, Banten during the L. vannamei cultivation cycle. The research data collected includes productivity data such as water quality (physical, chemical and biological), growth (Average Body Weight and Average Daily Growth) and survival rate, feed efficiency and business analysis in 6 (six) L. vannamei cultivation ponds. Cultivation of L. vannamei was carried out for 93 days in 6 ponds measuring 2.500 m^2/pond (2 ponds), 2.000 m^2/pond (2 ponds) and 1.500 m^2/pond (2 ponds) with a stocking density of 125 individuals/m^2 for all ponds.

Research Procedures

Water Quality Monitoring

The observed water quality parameters are important and supporting parameters in the activities and performance indicators of L. vannamei cultivation. Observations of water quality parameters (Table. 1) were carried out *in situ* and ex situ. The results of water quality observations were analyzed in accordance with established water quality standards (Ma et al., 2013). The observed parameters are the main parameters that support the growth and survival *of* L. vannamei.

Table 1. Water Quality Observations

No	Parameters	Technique	Method	Period	Opt.Value		Reference
					Min	Max	
1	Brightness (cm)	In situ	Secchi disk	Daily	25	30	(Ariadi et al., 2023)
2	Temperature (˚C)	In situ	Multiprobe	Daily	25	30	(Ariadi et al., 2023)
3	Dissolved Oxygen (mg·L^{-1})	In Situ	Multiprobe	Daily	4	7.5	(Akbarurrasyid et al., 2023)
4	power of Hydrogen	In situ	Multiprobe	Daily	7.5	8.5	(Ariadi et al., 2023)
5	Salinity (‰)	In situ	Refractometer	Daily	15	35	(Ariadi et al., 2023)
6	Nitrite (mg·L^{-1})	Ex situ	Spectrophotometry	Weekly	0	0.1	(Ariadi et al., 2023)
7	Nitrate (mg·L^{-1})	Ex situ	Spectrophotometry	Weekly	0	3	(Akbarurrasyid et al., 2023)
8	Ammonium (mg·L^{-1})	Ex situ	Spectrophotometry	Weekly	0	0.1	(Kementerian Kelautan dan Perikanan, 2016)
9	Ammonia (mg·L^{-1})	Ex situ	Spectrophotometry	Weekly	0	<0.1	(Kementerian Kelautan dan Perikanan, 2016)
10	Phosphate (mg·L^{-1})	Ex situ	Spectrophotometry	Weekly	0	0.1	(Ariadi et al., 2023)
11	Alkalinity (mg·L^{-1})	Ex situ	Titration	Weekly	120	180	(Akbarurrasyid et al., 2023)

No	Parameters	Technique	Method	Period	Opt.Value		Reference
					Min	Max	
12	Total Organic Matter (mg·L^{-1})	Ex situ	Titration	Weekly	37	87	(Akbarurrasyid et al., 2023)
13	Calcium (mg·L^{-1})	Ex situ	Spectrophotometry	Weekly	134	773	(Jaganmohan et al., 2018)
14	Magnesium (mg·L^{-1})	Ex situ	Spectrophotometry	Weekly	50	590	(Iffat et al., 2018)
15	Total Vibrio Count (CFU·mL^{-1})	Ex situ	Plate count methode	Weekly	1000	10.000	(Kementerian Kelautan dan Perikanan, 2016)
16	Plankton (ind·mL^{-1})	Ex situ	Haemocytometer	Weekly	45	1745	(Akbarurrasyid et al., 2023)

Growth and Survival Rate Observation

Shrimp performance was observed based on growth rate and survival rate throughout the cultivation cycle. L. vannamei performance was reviewed based on growth parameters such as ABW, ADG, and SR (Al-Subiai et al., 2025; Rakhmanda et al., 2021) . Performance observations are an important variable in productivity analysis to determine the level of relationship with other factors in L. vannamei cultivation activities.

Average Body Weight

Average Body Weight (ABW) is the shrimp growth rate based on the average shrimp weight obtained from the growth sampling process. According to Pramudia et al., (2023), ABW can be calculated using the following formula:

$$ABW\ (grams/tail) = \frac{Shrimp\ Sampling\ Weight\ (grams)}{Number\ of\ Shrimp\ Sampling\ (tails)}$$

Average Daily Growth

Average Daily Growth (ADG) is the growth rate of shrimp based on the average daily weight gain of shrimp over a specific period. According to Pramudia et al., (2023) , ADG can be calculated using the following formula:

$$ADG\ (gram/day) = \frac{ABW\ Current\ (grams/tail) - MBW\ Before\ (grams/tail)}{Sampling\ Time\ Interval\ (days)}$$

Survivale Rate

Survival Rate (SR) is the percentage of shrimp surviving at the end of a cultivation activity. The SR value is obtained by calculating the initial stocking rate and the number surviving at the end of cultivation. According to Pramudia *et al.* (2023), SR can be calculated using the following formula:

$$SR\ (\%) = \frac{Final\ Number\ of\ Live\ Shrimp\ (tails)}{Initial\ Number\ of\ Shrimp\ (tails)}$$

Feeding Efficiency

Feeding efficiency is a factor used to determine the level of effectiveness of the feed given on the growth *of* L. vannamei. Feeding efficiency is reviewed based on the Feed Utilization Efficiency (FUE) and Feed Conversion Ratio (FCR) values.

Feed Utilization Efficiency

Feed Utilization Efficiency (FUE) is the level of feed utilization during *the* L. vannamei cultivation period. According to Tacon *et al*., (2013) the FUE value can be calculated using the following formula:

$$FUE\ (\%) = \frac{Final\ Shrimp\ Biomass\ (kg) - Initial\ Shrimp\ Biomass\ (kg)}{Cumulative\ Feed\ (kg)}$$

Feed Convertion Ratio

The Feed Convertion Ratio (FCR) is the ratio that indicates the amount of feed given to produce 1 kg of shrimp weight. According to Tacon *et al.*, (2013), the FCR value can be calculated using the following formula:

$$FCR = \frac{Cumulative\ Feed\ (kg)}{Shrimp\ Biomass\ (kg)}$$

L. vannamei Cultivation Business

L. vannamei cultivation business was analyzed based on investment costs, depreciation costs, production costs (variable and fixed operational costs), total revenue, profit, *Break Even Point* (BEP), Revenue Cost Ratio (R/C Ratio), Benefit Cost Ratio (B/C Ratio), and Payback Period (PP).

Investment Costs

Investment costs are the accumulated costs incurred based on the investment components incurred when starting a business. According to Akbarurrasyid et al. (2024), investment cost components include: maintenance ponds, facilities and infrastructure, and aeration systems. Investment components experience annual depreciation based on their economic life and usage; this is referred to as depreciation costs.

Production Cost

Production costs are the costs incurred in carrying out cultivation operations. Production costs are divided into two parts: variable operating costs and fixed operating costs. According to (Ulumiah et al., 2020), total production costs can be calculated using the following formula:

$$Production\ Cost\ (IDR) = Fixed\ Cost\ (IDR) + Variabel\ Cost\ (IDR)$$

Total Revenue

Total revenue is the rupiah value received based on the shrimp sales value multiplied by the harvested shrimp volume. Shrimp harvesting can be carried out partially or completely. According to Ulumiah et al., (2020), total revenue can be calculated using the following formula:

$$Total\ Revenue\ (IDR) = Shrimp\ Price\ per\ kg\ (IDR) x\ Harvested\ Shrimp\ Volume\ (kg)$$

Profit

Profit is the difference between total shrimp sales revenue and total expenses incurred during shrimp farming. According to Wafi et al. (2021), profit can be calculated using the following formula:

$$Total\ Profit\ (IDR) = Total\ Revenue\ (IDR) - Fixed\ Cost\ (IDR)$$

Break Event Point

Break Even Point (BEP) is a business feasibility analysis that aims to provide information regarding the break-even point for a shrimp farming business. BEP can be traced based on price and production volume. According to Mauladani et al. (2020), BEP can be determined using the following formula:

$$BEP\ Price = \frac{Total\ Business\ Costs\ (Rp.)}{Total\ production\ (Kg)}$$

$$BEP\ Volume = \frac{Total\ Business\ Coats\ (IDR)}{Shrimp\ Selling\ Price\ (IDR)}$$

Revenue Cost Ratio

The Revenue-Cost Ratio (R/C Ratio) is a comparative analysis of revenue and costs incurred during shrimp farming production activities. According to Wafi et al., (2021), the R/C Ratio can be determined using the following formula:

$$R/C\ Ratio = \frac{Ammount\ of\ Acceptance\ (IDR)}{Total\ Expenditure\ (IDR)}$$

Benefit Cost Ratio

The Benefit Cost Ratio (B/C Ratio) is an analysis used to determine the level of business feasibility based on the comparison of profits earned with total costs incurred in business activities. According to Mauladani et al., (2020), the B/C Ratio can be determined using the following formula:

$$B/C\ Ratio\ = \frac{Total\ Profit\ (IDR)}{Total\ Business\ Cost\ (IDR)}$$

Payback Period

Payback Period (PP) is an analysis of the return on an investment over a specific time period using present value. According to Mauladani *et al.* (2020), PP can be determined using the following formula:

$$PP = \frac{Investment\ Cost\ (IDR)}{Profit\ (IDR)}\ x\ 1\ year$$

Data analysis

L. vannamei cultivation productivity data is divided into three categories: cultivation productivity factors and the relationships between these factors. Productivity factors were analyzed using descriptive quantitative methods related to water quality, growth and survival, feed efficiency, and business analysis. According to Anton et al., (2022) growth parameters such as ABW and ADG, as well as survival, were analyzed descriptively quantitatively. Meanwhile, the analysis of the relationship between cultivation productivity factors was carried out using regression analysis. Regression is used to analyze the factors that influence productivity in L. vannamei shrimp cultivation as a whole (Zam et al., 2024) .

RESULT

Water Quality for L. vannamei Cultivation

Water quality acts as a cultivation medium that is susceptible to various environmental factors and cultivation inputs. Observations of water quality factors in L. vannamei cultivation can be seen in Table 2.

Table 2. Water quality for L. vannamei cultivation

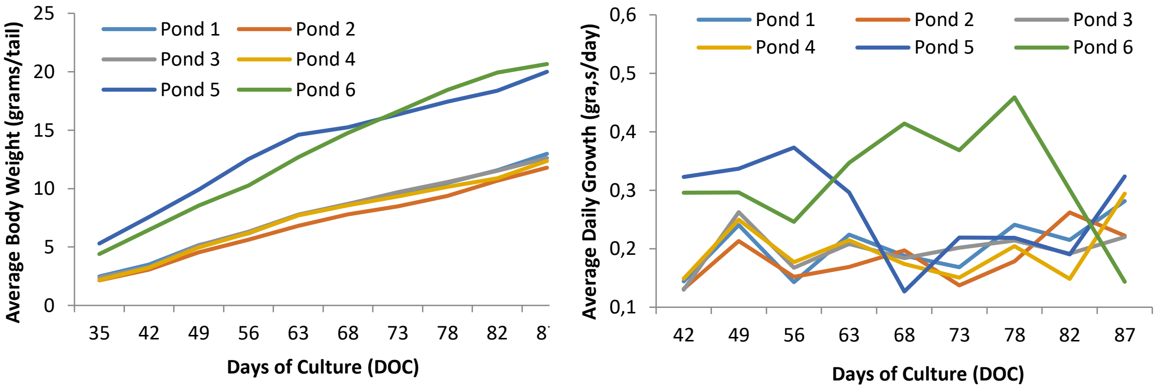
No	Parameters (Unit)	Measured Water Quality						Measurable Optimum
		Pond 1 min–max mean±std	Pond 2 min–max mean±std	Pond 3 min–max mean±std	Pond 4 min–max mean±std	Pond 5 min–max mean±std	Pond 6 min–max mean±std	
1	Brightness (cm)	20-100 40.96±17.52	30-70 36.12±10.32	30-70 35.59±10.31	20-100 40.96±17.52	30-80 38.11±13.28	30-70 38.27±13.11	25-30 [a]
2	Temperature (˚C)	28.2-31.4 29.71±0.76	25.3-29.3 27.20±0.74	25.2-29.2 27.13±0.76	28.2-31.4 29.74±0.75	25.1-29.3 27.07±0.79	25.3-29.1 27.00±0.78	25-30 [a]
3	Dissolved Oxygen ($mg \cdot L^{-1}$)	3.62-5.74 4.59±0.48	3.46-6.05 4.68±0.60	3.13-6.07 4.73±0.58	3.62-5.74 4.58±0.49	3.14-5.90 4.68±0.60	3.06-5.9 4.81±0.61	4-7.5 [b]
4	power of hydrogen	7.5-9.3 8.12±0.40	7.9-9.2 8.51±0.28	7.6-9 8.19±0.31	7.5-9.3 8.13-0.42	7.7-8.9 8.18±0.29	7.6-8.9 8.18±0.29	7.5-8.5 [a]
5	Salinity (‰)	15-28 20.07±3.57	33-36 35.48±0.85	32-36 35.50±0.90	15-28 19.80±3.70	32-36 35.41±1.05	32-36 35.47±0.89	15-35 [a]
6	Nitrite ($mg \cdot L^{-1}$)	0.01-0.5 0.09±0.15	0.01-0.04 0.02±0.01	0.01-0.05 0.02±0.01	0.01-0.5 0.09±0.15	0.01-0.10 0.02±0.02	0.01-0.03 0.01±0.008	<0.1 [a]
7	Nitrate ($mg \cdot L^{-1}$)	11-25 17.53±4.17	11-25 18.38±4.55	15-30 22.23±5.05	11-25 17.53±4.17	15-30 21.84±5.09	15-28 21.84±4.41	<3 [b]
8	Ammonium ($mg \cdot L^{-1}$)	0.1-4 0.89±1.14	0.1-4 0.56±1.07	0.1-2.5 0.63±0.71	0.1-4 0.89±1.14	0.1-2.2 0.63±0.61	0.1-1 0.30±0.30	<0.1 [c]
9	Ammonia ($mg \cdot L^{-1}$)	0.02-1.2 0.33±0.37	0.01-1.2 0.20±0.33	0.01-1 0.31±0.30	0.02-1.2 0.34±0.38	0.01-1.2 0.20±0.33	0.008-0.5 0.07±0.13	<0.1 [c]
10	Phosphate ($mg \cdot L^{-1}$)	0.1-3 0.98±0.83	0.1-3 0.58±0.79	0.1-1.5 0.70±0.46	0.1-3 1.00±0.82	0.1-3 0.72±0.85	0.1-2.3 0.78±0.75	<0.1 [a]

No	Parameters (Unit)	Measured Water Quality						Measurable Optimum
		Pond 1 min–max mean±std	Pond 2 min–max mean±std	Pond 3 min–max mean±std	Pond 4 min–max mean±std	Pond 5 min–max mean±std	Pond 6 min–max mean±std	
11	Alkalinity ($mg{\cdot}L^{-1}$)	76-116 99.84±12.36	92-136 112.30±15.18	72-172 110.15±23.01	76-116 100.15±12.52	76-144 107.26±19.59	76-168 123.69±32.80	120-180 [b]
12	Total Organic Matter ($mg{\cdot}L^{-1}$)	25.13-120 94.21±24.85	61.93-118.20 93.09±14.26	55.61-120.08 93.53±21.65	25.13-120 90.56±23.38	25.13-120 90.56±23.38	25.13-125.13 93.89±26.08	37-87 [b]
13	Calcium ($mg{\cdot}L^{-1}$)	185-365 308.15±56.08	185-450 310±90.185	195-460 329.23±75.90	185-460 336.23±79.14	185-500 341.23±96.20	185-500 404.61±100.07	134-773 [d]
14	Magnesium ($mg{\cdot}L^{-1}$)	465-990 735±213.36	465-1485 791.92±348.43	420-1435 762.30±346.99	420-1350 803.07±329.86	465-1395 804.23±320.69	465-1485 1062.26±403.69	50-590 [e]
15	Total Vibrio Count ($CFU{\cdot}mL^{-1}$)	70-2800 710±773.30	30-4500 913.8±1462.6	40-4300 1116.9±1231.5	45-1300 622.69±478.5	70-1700 601.53±558.01	100-2800 1129.23±1044.7	<10000 [c]
16	Plankton ($ind{\cdot}mL^{-1}$)	212.5-1725 845.9±469.0	230-1240 761.5±323.94	290-1415 776.57±324.67	222-1725 844.19±463.95	212.5-1725 891.65-434.51	212.5-2242 1020.34±537.98	<1745 [b]

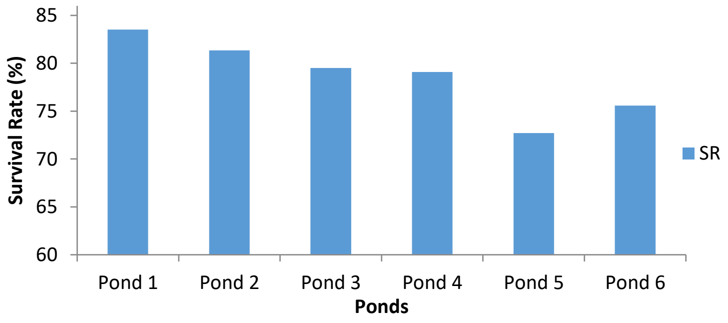
Notes: [a] (Ariadi et al., 2023) ; [b] (Akbarurrasyid et al., 2023) ; [c] (Ministry of Maritime Affairs and Fisheries, 2016) ; [d] (Jaganmohan et al., 2018) ; [e] (Iffat et al., 2018)

Growth and Survival Rate of L. vannamei

L. vannamei performance is the shrimp growth rate based on ABW, ADG, and SR values. Observations of L. vannamei performance (Figure. 1) show varying growth rates in each observation pond. The ABW value during maintenance (DOC 93) increased and was included in the optimal growth category. The highest ABW value was obtained in pond 6 at around 4.4-20.6 (13.27±5.73) gram/tail, while the lowest was in pond 2 at around 2.15-11.78 (7.03±3.19) gram/tail. The highest SR value was obtained in pond 1 at 83.50%, while the lowest was obtained in pond 2 at 72.70%. In general, the highest L. vannamei biomass was obtained in pond 1 at 3.386.82 kg and the lowest in pond 5 at 2.726 kg.



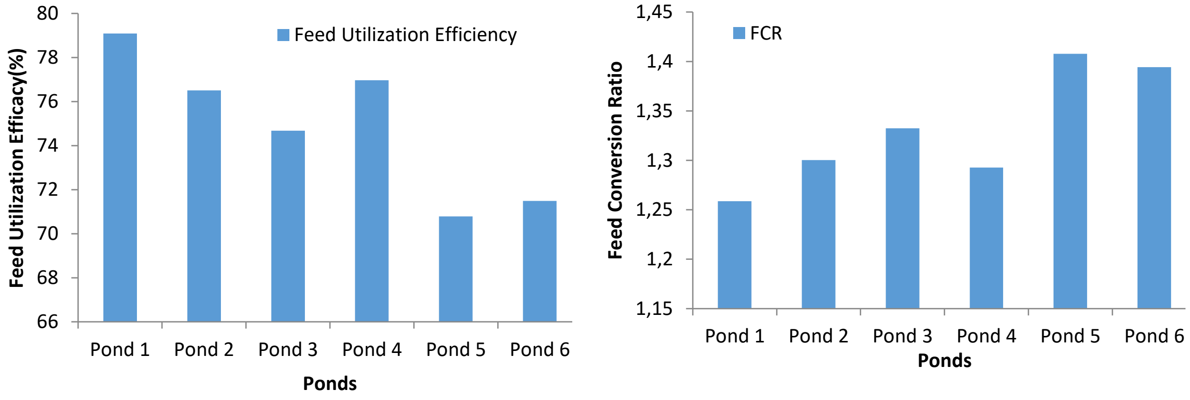
a. ABW b. ADG



C. Survival Rate

Feed Efficiency

L. vannamei cultivation activities. Providing feed in the right and appropriate amount can increase growth. On the other hand, excessive or insufficient feed intake results in low growth and the emergence of various environmental problems in cultivation. The results of observations of efficiency values (FUE and FCR) can be seen in Figure 2.



a. Feed Utilization Efficiency b. Feed Conversion Ratio

Figure 2. Feed Efficiency

L. vannamei Cultivation Business

L. vannamei cultivation business shows varying results for each cultivation pond based on investment costs, production costs and business feasibility. Investment costs consist of maintenance pond components, facilities and infrastructure, and aeration and depreciation systems. Investment costs across all ponds are relatively uniform, despite varying pond sizes, due to the relatively similar stocking densities and cultivation technology used across all ponds. Investment costs are shown in Table 3.

Tabel 3. Investment costs

No	Investment Cost*	Ponds					
		Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6
1	Maintenance Ponds (IDR)	187,500,000	187,500,000	150,000,000	150,000,000	112,500,000	112,500,000
2	Facilities and infrastructure (IDR)	68,704,500	68,704,500	68,109,500	68,109,500	67,514,500	67,514,500
3	Aeration system (IDR)	40,100,000	40,100,000	31,200,000	31,200,000	22,300,000	22,300,000
Total		296,304,500	296,304,500	249,309,500	249,309,500	202,314,500	202,314,500

Note: * = Investment costs in 1 year or 3 cycles of vaname shrimp cultivation

The production costs for the entire pond vary relatively for each component. This is caused by differences in the pond area which impacts the differences in component volume. Production cost components include fixed costs and variable costs. Fixed costs are divided based on the components of employee salary or income, repairs or maintenance and depreciation costs obtained from the results of the investment cost analysis. Meanwhile, variable costs are grouped based on the need for fry/post larvae, feed requirements, certain chemicals and medicines, electricity and water costs and operational costs. Production costs can be seen in Table 4.

Table 4. Production costs

No	Production cost	Ponds					
		Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6
A. Fixed costs*							
1	Employee salary or income (IDR)	72,000,000	72,000,000	72,000,000	72,000,000	72,000,000	72,000,000
2	Harvest Cost (IDR)	680,000	680,000	680,000	680,000	680,000	680,000
3	Repair/maintenance and maintenance (IDR)	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000
4	Depreciation expense (IDR)	337,691	337,691	287,646	287,646	237,601	237,601
Total fixed costs (IDR)		74,817,691	74,817,691	74,767,646	74,767,646	74,717,601	74,717,601
B. Variable Costs**							
1	Post Larvae	15,937,500	15,937,500	12,750,000	12,750,000	9,562,500	9,562,500
2	Feed	76,725,900	70,151,040	60,136,380	56,892,060	69,076,980	73,467,360
3	Certain chemicals and medicines and other needs	8,291,319	8,291,319	6,807,624	6,807,624	5,391,926	5,391,926
4	Electricity and water costs	3,600,000	3,600,000	3,000,000	300,000	2,400,000	2,400,000
Total variable costs per cycle		104,554,719	97,979,859	82,694,004	79,449,684	86,431,406	90,821,786
Total variable costs per year		313,664,157	293,939,577	248,082,012	238,349,052	259,294,218	272,465,358
Total production costs for 1 year		388,481,848	368,757,268	322,849,658	313,116,698	334,011,819	347,182,959

Note: *per year; **per cycle

The components of investment costs and production costs as well as production results or growth are used as the basis for the feasibility analysis of the L. vannamei business. The results of the feasibility analysis of L. vannamei cultivation business can be seen in Table 5.

Table 5. Feasibility of L. vannamei cultivation business

No	Business Feasibility*	Ponds					
		Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6
1	Investment cost (IDR)	296,304,500	296,304,500	249,309,500	249,309,500	202,314,500	202,314,500
2	Production costs (IDR)	388,481,848	368,757,268	322,849,658	313,116,698	334,011,819	347,182,959
3	Total revenue (IDR)	619,789,341	517,003,200	451,324,800	436,448,565	609.267.705	663,042,510
4	Profit (IDR)	231,307,492	148,245,931	128,475,141	123,331,866	275,255,885	315,859,550
5	Break Even Point (BEP)						
	BEP production price (IDR)	38,234	41,012	42,920	42,686	40,842	39,533
	BEP production volume (Kg)	3,184	2,137	1,793	1,754	1,494	1,532
6	R/C Ratio	1.59	1.40	1.39	1.39	1.94	1.90

7	B/C Ratio	1.59	1.40	1.39	1.39	1.82	1.90
8	Payback Period	1.28	1.99	1.94	2.02	0.73	0.64

L. vannamei Cultivation

L. vannamei cultivation shows the level of shrimp production (biomass) based on various related production factors such as water quality, growth and survival, feed utilization efficiency, and cultivation business analysis. The shrimp biomass cultivated was: 2286 kg (pond 1), 2997 kg (pond 2), 2507 kg (pond 3), 2445 kg (pond 4), 2726 kg (pond 5), and 2927 kg (pond 6). The relationship between L. vannamei productivity and productivity factors can be seen in Figure 3.

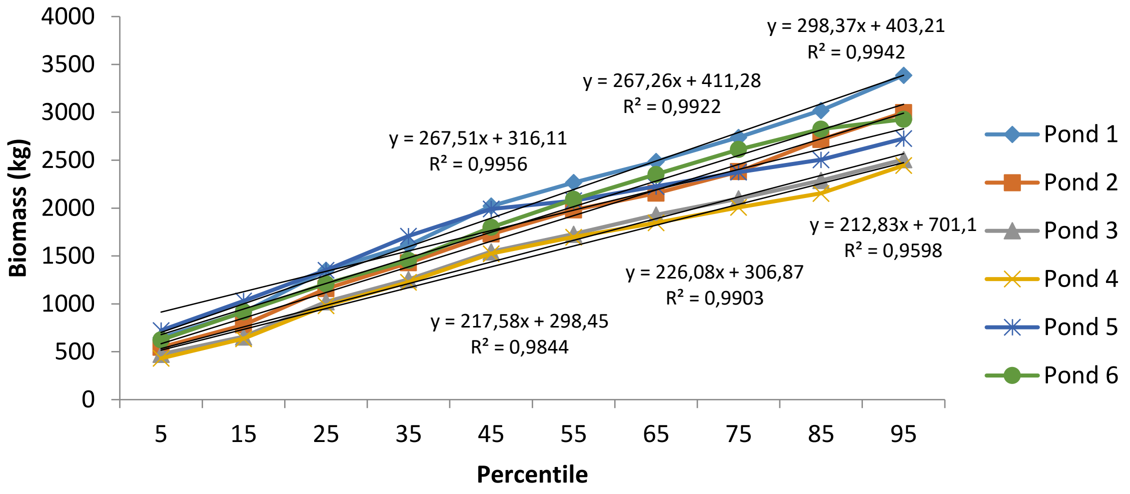


Figure 3. Productivity L. vannamei

DISCUSSION

Water quality plays an important role in physiological and metabolic processes, thus impacting the growth of L. vannamei. Observations show that water quality parameters such as temperature, dissolved oxygen, pH, salinity, alkalinity, calcium, Total Vibrio Count (TVC), and plankton are within the optimal range for growth and support shrimp productivity. While parameters such as brightness, nitrite, ammonium, ammonia, phosphate, Total Organic Matter (TOM), and magnesium. Suboptimal brightness values have an impact on other water parameters such as nitrite and pH. According to Halim *et al.*, (2022), low brightness has an impact on decreasing pH concentration, increasing nitrite concentration, and increasing organic matter that can be toxic to L. vannamei . Brightness values in the pond environment are related to increasing organic matter and nutrients in the pond. Organic matter and nutrients are related to the concentration of nitrite, ammonium, ammonia, phosphate and TOM. The research results show that the concentration of these parameters has a close relationship with organic matter and nutrients. The concentration of organic matter and nutrients originates from intensive cultivation activities characterized by high stocking densities, which impact the organic matter produced. High accumulation of organic matter has detrimental effects on shrimp, such as triggering the presence of other pollutants, which can reduce pond productivity. According to Pratiwi & Arfiati (2021), organic matter concentrations exceeding quality standards can have negative impacts on the aquatic environment, such as increased carbon dioxide and algal blooms .

The research results show that growth and survival factors influence pond productivity. Shrimp biomass increases depend on body weight gain and survival rates during the cultivation period. Increased shrimp body weight and low mortality rates impact total production and population size. Shrimp body weight, based on the ABW and ADG values obtained, is considered good. According to Usman et al. (2023), L. vannamei cultivated up to 107 days old obtained an ABW value of 25.64 grams/tail and an ADG value of 0.32 grams/day. Meanwhile, the SR value obtained is included in the optimal category. The optimal SR value is at least 80% (Lailiyah *et al*., 2018) . The optimal ABW, ADG, and SR values are caused by various important factors during cultivation activities such as stocking density, cultivation time, and feed and metabolic waste. According to Akbarurrasyid et al., (2024) cultivation time causes the potential for increased cultivation waste originating from the accumulation of metabolic waste (feces) and unutilized feed waste. Feed is an important factor in shrimp cultivation activities and an important component in determining productivity levels. Feed components in shrimp farming can be tracked based on the FUE (Feed Utilization Eficiency) and FCR (Feed Convertion Ratio) values during cultivation. The FUE value is the ratio of the shrimp body weight produced to the amount of feed consumed. This indicates the level of effectiveness or conversion of nutrients contained in the feed into meat or body mass. The FCR, on the other hand, is the cumulative amount of feed given to the shrimp biomass produced.

Low FUE and FCR values indicate a good level of feed efficiency. The FUE values produced during cultivation activities ranged from 74.67% (pond 3) to 79.08% (pond 1), while the FCR values obtained ranged from 1.25 (pond 1) to 1.40 (pond 5). According to Supono *et al*., (2021), the ideal FUE value for shrimp cultivation activities is 74.9%, while the FCR value is 1.3. Feeding in cultivation activities must be managed properly and appropriately. Inadequate feeding can inhibit growth and increase mortality in shrimp, which impacts productivity. According to Ulumiah et al., (2020), appropriate feeding can stimulate optimal growth and development of L. vannamei , thereby increasing productivity. Meanwhile, excessive feeding or unutilized feed can increase pond water pollution, resulting in changes in water quality and inhibiting biological processes within the pond environment. According to Albab et al., (2025), excessive feeding can cause changes in water quality instability. In addition, excessive feeding also increases production costs and hinders the productivity of L. vannamei cultivation efforts. Cultivation efforts cannot be separated from various technical and non-technical factors such as prices and costs incurred during cultivation production activities. In general, these factors are related to productivity levels. The productivity of L. vannamei cultivation is determined by production components such as investment costs, production costs, and business feasibility. Investment costs are a crucial component before starting a business and are largely recorded at the start of production, such as the costs of constructing maintenance ponds, facilities and infrastructure, and aeration systems. Column printing costs are the highest component of investment costs, ranging from IDR 112,500,000 (area 1500 m^2) – IDR 187,500,000 (area 2500 m^2). According to Wiranata et al., (2022), ponds require high investment costs because they require large areas of land, expensive pond construction costs, and installation of pond facilities and infrastructure that support cultivation activities. Other investment cost components have small amounts based on the size of the production pond. In general, the investment costs incurred are higher based on the production capacity implemented. Production capacity is related to production costs. According to Syah et al., (2017), optimal production capacity is needed to achieve minimal production costs with maximum profit levels.

L. vannamei production costs are divided into fixed and variable components. Fixed costs include employee salaries or wages, harvesting costs, repairs/maintenance, and depreciation costs (Akbarurrasyid et al., 2024) . Fixed costs are costs calculated over a period of one year and are fixed. Meanwhile, variable costs include costs incurred for operational activities such as fry/post larvae, feed, chemicals, certain medicines, and other needs, as well as electricity and water costs (Ulumiah et al., 2020) . Variable costs tend to be dynamic based on the activities or production capacity implemented. The research results show that the higher the production capacity, the greater the impact on increasing variable costs in the cultivation cycle. The L. vannamei cultivation cycle takes place in three cycles so that the production costs incurred are analyzed in annual units. The production costs ranged from IDR. 388,481,848 (pond 1) to IDR. 3,131,166,98 (pond 4). Production cost components are used for business feasibility analysis.

The results of the business feasibility analysis obtained total revenue ranging from IDR. 663,042,510 (pond 6) to IDR. 4,364,485,65 (pond 4). The results showed that pond size and a higher initial stocking rate impacted revenue factors, this was caused by various factors such as growth, survival, and shrimp selling price. According to Ulumiah et al., (2020), the selling price of L. vannamei was influenced by shrimp weight, the maintenance process, and feeding. The amount of revenue was related to profits. The highest profit value was IDR. 315,859,550 in pond 6, while the lowest was IDR. 123,331,866 in pond 4. BEP Value The research results show that the BEP production price ranges from IDR. 38,234 (pond 1) – IDR. 42,000. 920 (pond 2), while the BEP value for production volume ranges from 1,494 kg (pond 5) to 3,184 kg (pond 1). The low BEP value for production price and production volume indicates a break-even point that must be met to prevent losses from non-production activities (Rosid et al., 2025) .

The R/C Ratio value for all ponds ranges from 1.39 (ponds 3 and 4) – 1.90 (pond 6). R/C ratio value >1 indicates the feasibility and efficiency of L. vannamei cultivation activities. According to Agustina et al., (2025), L. vannamei cultivation is considered profitable if the R/C ratio exceeds 1 (R/C > 1) . The R/C ratio is directly proportional to the B/C ratio. The research results obtained a B/C ratio ranging from 1.39 (ponds 3 and 4) to 1.90 (pond 6). A B/C ratio value >1 indicates a feasible business with a payback period of around 0.64 (pond 6) – 1.99 (pond 2). According to Prawitasari & Rafiqie, (2022) a low payback period indicates a relatively shorter return on investment. Overall, the value of L. vannamei cultivation business is inseparable from technical and non-technical factors that impact cultivation productivity. The results of the productivity analysis show that water quality, growth and survival, feed efficiency and business analysis factors have a close relationship with the resulting shrimp biomass. The level of productivity relationship with related factors (R^2), namely: 0.9942 (pond 1), 0.9922 (pond 2), 0.9956 (pond 3), 0.9598 (pond 4), 0.9903 (pond 5) and 0.9844 (pond 6). The correlation value of money approaching 1 indicates a very strong level of relationship (Adianto et al., 2024) .

CONCLUSION

L. vannamei cultivation production is influenced by technical factors (water quality, growth and survival, and feed efficiency) and non-technical factors such as business analysis (investment costs, production costs, revenue, profits, Break Evant Point (BEP), R/C ratio, B/C ratio, and payback period). The results showed that water quality was mostly within the optimal range except for the parameters of brightness, nitrite, ammonium, ammonia, phosphate, Total Organic Matter (TOM), and magnesium. The growth values of ABW and ADG were very good with low mortality rates or high SR and optimal feed efficiency throughout the pond. The results of the business analysis show a positive value on the productivity of L. vannamei. In general, productivity factors such as water quality, growth and survival, feed efficiency and business analysis are related to biomass production with R2 values , namely: 0.9942 (pond 1), 0.9922 (pond 2), 0.9956 (pond 3), 0.9598 (pond 4), 0.9903 (pond 5) and 0.9844 (pond 6).

ACKNOWLEDGEMENT

The author would like to thank the Politeknik Kelautan dan Perikanan Pangandaran and all parties who have supported and facilitated the implementation of research activities related to Productivity of Whiteleg Shrimp (Litopenaeus vannamei) Cultivation Based on Water Quality, Growth, Feed Efficiency, And Business Analysis Factors

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