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Research Article

Vaname Shrimp Cultivation (*Litopenaeus vannamei*) on High Stocking Densities in Controlled Ponds

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ABSTRACT

Efforts to increase the productivity of ponds can be done by increasing stocking densities accompanied by providing excellent input and adequate technological support. Three stocking densities are 750; 1,000; and 1,250 individu/ m^2, applied to ponds with an area of 1,600 m^2 with water depth of 2.0 m, equipped with aeration systems in the form of windmills and root blowers, submersible pumps, automatic feeders, central drain and collector drain as well as wastewater treatment plants. The capacity of the aeration system is 500 kg of shrimp/HP biomass. Shrimp kept for 110 days. The results showed that the stocking density applied resulted in a final shrimp weight which was relatively the same range 15.50-16.45 (15.60 ± 0.40) g/individual with a daily growth value of 0.165-0.185 (0.17 ± 0.01) g/day. The production obtained is 13,714 kg; 18,285 kg; and 21,942 kg. Value of feed conversion ratio 1.42, 1.39, 1.54 and electricity needs 3.21, 2.53, 2.42 kw/kg of shrimp and 2.25 water requirements, 1.65, 1.63 m^3/kg shrimp. The lowest shrimp production cost is IDR. 30,526/kg of shrimp on a stocking density of 1,000 individu/ m^2 with an operating profit of IDR 585,142,857.14/year. The stocking density of 1,000 individu/m^2 produces better performance, so it is recommended to be a reference for high stocking densities for vaname shrimp farming.

Keywords: Aquaculture; Vaname shrimp; High stocking; Controlled pool

INTRODUCTION

One of the fisheries commodities that has become a strategic foundation to be developed in order to achieve the national shrimp production target is vaname shrimp cultivation. One technology that can be applied is super-intensive vaname shrimp farming into the orientation of future aquaculture systems that use less land and have high stocking densities. Cultivation technology uses pond plots ranging from 1,000 - 1600 m^2 to facilitate work and is easily controlled; water depth of 2-3 m; high stocking density; high productivity; equipped with a clean water supply system and wastewater treatment system to prevent contamination from various possible outbreaks of disease. A controlled aquaculture environment with good management of aquaculture waste is expected to become a vaname shrimp culture system that has high productivity and is sustainable.

Vaname shrimp cultivation with high stocking density has been carried out with stocking densities of 300-800tails/m^2, then on stocking densities of 1100 heads/m^2 [1], then using an area of 40 m^2 with stocking densities of 500 heads/m^3 [2]. Existing data indicate that the cultivation of vaname shrimp with high stocking densities is carried out in small containers <100 m^3 with an in-door system. Since 2011, in Indonesia a super-intensive vaname shrimp culture has been developed on a 1,000 m^2 pond with a stocking density of 1000 individuals/m^2.

High stocking densities applied in intensive cultivation systems are expected to be followed by increased production, but there are certain limits where the carrying capacity of ponds is no longer able to sustain shrimp life in a certain amount of biomass [3]. Therefore, it is necessary to determine the optimal stocking density in order to obtain a production cost with a minimum level of maximum income so that the shrimp products produced are highly competitive and sustainable [4].

Stocking density is a determinant of the level of technology and input needed in a culture system. The allocation of stocking over the carrying capacity of the environment can affect the cultivation system that characterizes crop failure due to excess waste loads above the assimilation capacity of the aquatic environment. This study aims to obtain data and information on the performance

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of super intensive vaname shrimp culture on different stocking densities as a reference to determine the optimal stocking density of vaname shrimp on super intensive technology. It is hoped that the optimal application of stocking density will impact on maximum productivity and profit with a sustainable production system [5,6].

MATERIALS AND METHODS

The research data was obtained from P.T. Esaputlii Perkasa Utama, located in Balusu District, Barru Regency, South Sulawesi Province. Three 1,600 m^2 pond plots equipped with aeration system in the form of windmills and blowers and one 1,600 m^2 pond plots are used as reservoirs. The amount of aeration is determined based on the research results of Hopkins et al. that aeration with a strength of 1 HP can facilitate feeding as much as 16 kg per day by maintaining oxygen levels up to 3 mg/L with a target biomass of shrimp harvested as much as 550-600 kg per HP. The amount of aeration capacity (HP) installed in ponds is thus determined based on shrimp biomass production as a response to the applied stocking density divided by the capacity of the aeration to sustain shrimp life optimally.

Pond water filling as high as 100 cm followed by lime dolomite application 20 ppm, application of 40 ppm chlorine, fertilizing with urea 32 kg/plot and SP-36 16 kg/plot, plankton allowed to grow for two weeks, and probiotics were applied at a dose of 75 g/plot. Spread fries done after a week of application of probiotics.

The PL-10 vaname shrimp seeds that have been certified free of WSSV, Taura, and IMNV. Shrimp seeds are obtained from P.T. Esaputlii Perkasa Utama which has been ISO 9001: 2008 certified. Adaptation to the temperature and salinity of the waters is done before the fries are spread on the pond. The stocking density applied was 750 heads/m^2 (plot A), 1,000 heads/m^2 (plot B), and 1,200 heads/m^2 (plot C). Determination of stocking density is the development of previous experiments which is 600 fish/m^2 [7]. P.T. Esaputlii Perkasa Utama can be seen in Figure 1.

Feed with 40% protein content is given manually until the 60th day, then the feed is given with automatic feeder tools starting on Day Old Culture (DOC) -61 until harvest. The dosage of feed is adjusted to the development of shrimp growth and shrimp conditions in the pond. Anco installation of 8 pieces in each pond plot is intended as a tool to monitor the response of shrimp to the feed given.

During maintenance, water management includes disposal of sludge from central drainage and filling of pond water according to pond water shrinkage. Commercial probiotics are applied according to standard operating procedures (SOP) and the dosage is adjusted to the development of shrimp weights and the total bacterial population conditions. Variables observed during maintenance included shrimp growth measured every five days by weighing shrimp using an electronic scale that had an accuracy of 0.01 g. A total of 100 shrimp obtained from trap fishing and or nets were used as samples. Periodic weighing data for shrimp is used to calculate daily feed requirements.

Water quality parameters including temperature, salinity, dissolved oxygen, and pH are monitored daily on the pond using a DO meter model Lutron DO 5510, while TSS, BOT, total ammonium nitrogen (TAN), nitrite, nitrate, phosphate are measured every two weeks in a quality laboratory water.

Figure 1: Super intensive cultivation trial location.

Harvesting is done partially as much as 20-30% of shrimp biomass on the 70th and 90th day of maintenance, while the total harvest is done on the 105th day. Production data, survival rate, feed conversion ratio (RKP), water requirements, electricity needs, and shrimp diversity calculated at the end of the study. Shrimp size at harvest is determined based on sampling as much as 20 kg, then counted the number of individuals as a divisor.

The data obtained were analyzed descriptively to determine the effect of stocking densities on the biological response of shrimp and the environmental characteristics of the pond waters. Cost analysis is carried out to determine the level of profit from super intensive vaname shrimp farming activities. Feed with 40% protein content is given manually until the 60th day, then the feed is given with automatic feeder tools starting on Day Old Culture (DOC) -61 until harvest. The dosage of feed is adjusted to the development of shrimp growth and shrimp conditions in the pond. Anco installation of 8 pieces in each pond plot is intended as a tool to monitor the response of shrimp to the feed given.

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RESULTS AND DISCUSSION

The weight of vaname shrimp during maintenance shows the same relative weight value for the three stocking densities. At DOC-70, shrimp weight 9.42 ± 1.82 g/head; DOC-90, shrimp weight 13.85 ± 2.24 g/head; and DOC-110, shrimp weight 16.79 ± 2.57 g/head. There is a tendency for variations in the size of the shrimp's weight to shrink so that it indicates a uniform size of shrimp at harvest. Vaname shrimp growth in stocking densities of 750-1,250 tails/m^2 is considered to be within normal growth limits. Daily weight gain fluctuates considerably. In DOC-31-60, the daily weight gain of shrimp on the stocking densities of 750, 1,000, and 1,250 animals/m^2, respectively were 0.11-0.35 (0.18 ± 0.08); 0.10-0.36 (0.18 ± 0.09); and 0.11-0.31 (0.18 ± 0.07) g/day, while in DOC-61-110, the daily weight gain of each treatment was 0.05-0.28 (0.19 ± 0.09); 0.12-0.33 (0.22 ± 0.06); and 0.10-0.28 (0.22 ± 0.07) g/day. Some research results indicate that vaname shrimp growth is influenced by stocking densities with a 50-61 individu/m^2 stocking application [8], 40-80 individu/m^2 [9], 150-450 individu/m^2 [3], and 200-400 individu/m^2 [9]. However, in this study, the stocking density of 750-1,250 individu/m^2 actually produced relatively similar shrimp growth. The same thing happened in the stocking density of 500 and 600 individu/m^2 which resulted in daily weight gain of 0.14 g/day [10], 0.18 ± 0.01 g/day on a stocking density of 530 individu/m^2 [11], 0.19 ± 0.01 g/day on the stocking density of 450 individu/m^2; 0.26 ± 0.01 g/day on stocking densities of 500 head/m^3 and 0.21 ± 0.01 g/day on stocking 390 individu/m^3 [12], 0.22 ± 0.07 g/day (1,111 individu/m^3); and 0.19 ± 0.03 g/day on solid stocking 1,602 individu/m^3 [13]. The available data shows that vaname shrimp is very tolerant of high stocking densities and has no effect on shrimp growth. It is suspected that the ability of vaname shrimps to utilize all water columns and is supported by excellent water quality and availability of good nutrition, provides a response to shrimp growth that is relatively the same and is not affected by the stocking density applied. Andi et al. [14], reported that vaname prawns wrapped for 35 days with a stocking density of 1,500-6,000 individu/m^2 gave a compensatory growth response that was not significantly different after being maintained with a stocking density of 300 animals per m^2 for 20 days.

The stocking density of 750 individu/m^2 produced the highest survival rate of 87.3%, followed by the stocking density of 1,000 and 1,200 individu/m^2, respectively 82.9% and 79.1% (Table 1). The higher the stocking density, the lower the vaname shrimp survival rate. Krummenauer et al. [3], reported that the stocking density of 150 individu/m^2 produced 92.0% survival rate, followed by the stocking density of 300 and 450 individu/m^2, 81.2% and 75.0% respectively. Increased stocking densities will reduce the survival of vaname shrimp also reported by Susilowati et al. [10]. On the contrary, it received 85.6% and 92.4% survival rate at 500 and 600 tails/m^2 stocking densities. While Samocha et al. reported the survival rate of vaname shrimp varied by 83.0% (390 individu/m^2) respectively; 95.5% (450 pieces pieces/m^3); 81.6% (500 individu/m^2); and 82.3% (530 pieces/m^3). In stocking density 1,111 individu/m^3 and 1,602 animals/m^3 produced survival rates of 85.9 ± 9.6% and 78.9 ± 20.7%, respectively [14]. This explains that there may be an optimal stocking density which will result in a maximum response to vaname shrimp survival because it is related to space use competition, contact opportunities between individuals related to cannibalism and pathogen distribution, and competition for feed. The high survival rate obtained in this study shows that the environment pond water is still conducive to support the life of shrimp until the stocking density of 1,200 individu/m^2.

Feed conversion ratio (FCR) indicates the ability of shrimp to utilize feed rations. RKP in plot C was 1.55 higher than in plot A and B, respectively 1.40 and 1.36. The high RKP on plot C can be caused by inaccurate estimation of population or shrimp biomass, which can lead to excess feeding, especially when changing shrimps. Observation of feed through trap net is still an alternative in feed management. Previous studies with stocking densities of 500 and 600 individuals/m^2 resulted in FCR of 1.59 and 1.39 [13]; 1.53-1.60 in stocking densities 450 pieces/m^3 and 1.21-1.40 in stocking densities 530 heads/m^3 [12]; 1.77 (390 pieces/m^3), 1.48 (500 individuals/m^2) [12,15].

Super intensive vaname shrimp culture has consequences on the high weight of shrimp biomass in ponds. Control of the biomass weight of shrimp populations in order to remain within the limits of the carrying capacity of the pond environment is a necessity in the management of super intensive ponds, through partial harvesting. The purpose of partial harvesting is (1) controlling shrimp biomass not to exceed the carrying capacity of the pond's environment, (2) providing opportunities for shrimp that are left behind to grow

Table 1: Performance of super intensive culture of shrimp vannamei.

Variables	Stocking density (ind/m^2)		
	750	1000	1200
Final weigh (g/ind)	15.55	16.33	15.48
Survival rate (%)	87.3	82.9	79.1
Average daily gain (g/day)	0.19	0.21	0,20
Production (kg/pond)	7.862	10.699	12/163
Productivity (kg/m^2)	7.9	10.7	12.2
Feed convention Ratio	1.40	1.36	1.55
Electrical used (kw/kg shrimp)	3.01	2.50	2.25
Water Used m^3/kg shrimp)	2.50	1.50	1.45
Peddel whell productivity (kg/hp)	262	669	640
Cost (Rp/kg shrimp production	507.26	673.0	806.5

better due to reduced crowding conditions and reduced waste load so that shrimp live more comfortably. Partial harvests have been carried out by Effendy et al. [16] in the intensive ponds of vaname shrimp and Suantika et al. [17] in super intensive vaname shrimp culture with a recirculation system. A well-managed partial harvest can increase productivity and profits in high density shrimp farming [18,19]. While the system tools decision support for partial harvests in cultivation activities has been developed by Martinez et al. [17] and Diation et al. [20] who say that partial harvests are more profitable than single harvests.

The first partial harvest was carried out on DOC-75 by harvesting as much as 20-30% of the total biomass in the pond, ranging from 2,271-4,109 kg with a size of 104-108 head/kg of shrimp. The second partial harvest was carried out on DOC-90 totalling 1,585-3,604 kg with a size of 71-84 head/kg of shrimp, while the final harvest was carried out at DOC-110 as many as 4,006-4,863 kg with the size of 62-69 tail/kg of shrimp.

Shrimp diversity at the first, second or final partial harvest shows the same relative diversity values for all plots. The coefficient of variation of the three stages of harvest between 13.04 - 21.78%, but there are indications that the coefficient of variation is getting smaller in the total harvest between 11.13-16.87%. This indicates that more than 80% of the size of the shrimp harvested has a relatively uniform weight. [21] Get grades coefficient of variation 12.7-14.6% on the stocking density of 600 individuals/m^2. The level of uniformity of shrimp size at harvest is one indicator of fry quality. Shrimp diversity at the first, second or final partial harvest shows the same relative diversity values for all plots. The coefficient of variation of the three stages of harvest between 13.04 - 21.78%, but there are indications that the coefficient of variation variation is getting smaller in the total harvest between 11.13 -16.87%. This indicates that more than 80% of the size of the shrimp harvested has a relatively uniform weight. [21] Get grades coefficient of variation 12.7-14.6% on the stocking density of 600 individuals/m^2. The level of uniformity of shrimp size at harvest is one indicator of fry quality.

Important parameters to consider in the partial harvest of vaname shrimp are (a) the growth rate and survival rate that will determine the amount of shrimp biomass in the farm plot, (b) the percentage of shrimp to be harvested, (c) the size and time of partial harvest, (d) the amount partial harvests that will be carried out during cultivation, and (e) price of shrimp on the size of the harvest both partial and total harvest.

The main energy consumption is for operational needs aeration. The maximum number of windmills used during the study in plots A, B, and C were 18, 0 and 22 units, respectively, plus a 5.5 kw root blower used for the three plots with the assumption of the same usage. During the cultivation period, the amount of electrical energy for the aeration system and pump reached 26,539-29,926 kw. Electricity demand to produce one kilogram of shrimp tends to decrease with increasing stocking densities ranging from 2.25-3.01 kw/kg of shrimp with electricity costs between IDR. 4,045-4,852/kg shrimp. These results are relatively similar to previous studies, which are between 2,371-2,826 kw/kg of shrimp on stocking densities of 600 animals/m^2 (Table 1). The higher the shrimp production, the lower electricity demand per kg of shrimp. The results of Naegel et al. [22] get electricity needs of 4.35 kw/kg of shrimp at a production level of 13,600 kg/ha. Cultivation with a closed recirculation system requires greater electricity which is 15.4 kw/kg of shrimp on a stocking density of 450 individuals/m^3 [12]. Electricity demand in super intensive vaname shrimp farming is dominated by aeration systems, ranging from 84,929-88,487%. While the use of electricity for water pumps is around 5-15%, indicating that the electricity demand for water pumps in super intensive production systems is relatively low. The use of 1 HP wheel on vaname shrimp farming is expected to support shrimp biomass between 550-600 kg/HP [23]. In this study produced 523-697 kg/HP with an average value of 602 ± 50 kg of shrimp/HP. The main energy consumption is for operational needs aeration. The maximum number of windmills used during the study in plots A, B, and C were 18, 20 and 22 units, respectively, plus a 5.5 kw root blower used for the three plots with the assumption of the same usage. During the cultivation period, the amount of electrical energy for the aeration system and pump reached 26,539-29,926 kw. Electricity demand to produce one kilogram of shrimp tends to decrease with increasing stocking densities ranging from 2.25-3.01 kw/kg of shrimp with electricity costs between IDR. 4,045-4,852/kg shrimp. These results are relatively similar to previous studies, which are between 2,371-2,826 kw/kg of shrimp on stocking densities of 600 animals/m^2. The higher the shrimp production, the lower electricity demand per kg of shrimp. The results of Naegel et al. [22] get electricity needs of 4.35 kw/kg of shrimp at a production level of 13,600 kg/ha. Cultivation with a closed recirculation system requires greater electricity which is 15.4 kw/kg of shrimp on a stocking density of 450 individuals/m^3 [12]. Electricity demand in super intensive vaname shrimp farming is dominated by aeration systems, ranging from 84,929-88,487%. While the use of electricity for water pumps is around 5-15%, indicating that the electricity demand for water pumps in production systems is relatively low. The use of 1 HP wheel on vaname shrimp farming is expected to support shrimp biomass between 550-600 kg/HP. In this study produced 523-697 kg/HP with an average value of 602 ± 50 kg of shrimp/HP.

The use of water to produce super intensive vaname shrimp is 2.50 m^3/kg shrimp (plot A) and 1.50 m^3/kg shrimp (plot B) and 1.45 m^3/kg shrimp in plot C. The water requirements in plot C are more efficient than plot A because the productivity level of plot C is higher than plot A and B. The high-water demand in the cultivation system is due to the daily disposal of waste at a frequency of three times a day, obtained a water requirement of 2.25 m^3/kg of shrimp at a production level of 15,000 kg/ha. Super intensive cultivation method with a recirculation system without water change, requires a volume of water of 100 ± 20 L/kg of shrimp on a stocking density of 500 fish/m^3 with shrimp productivity of 9.75 ± 0.20 kg/m^3 and 150 ± 8 L/kg of solid shrimp stocking 550 tails/m^3 with productivity of 8.50 ± 0.75 kg/m^3 or 4.75 ± 0.30 kg/m^2 [12]; 157.6 ± 7.9 L/kg of shrimp on stocking of 500 individu/m^3 and productivity of 9.58 ± 0.18 kg/m^3; and 158.1 ± 8.5 L/kg of shrimp on a stocking density of 390 head/m^3 and productivity of 8.36 ± 0.32 kg/m^3 [12]. Water use of 130 L/kg shrimp with a production rate of 6.92 kg/m^2 on a stocking density of 581 individu/m^3. Water requirements of less than one cubic meter generally occur in closed cultivation systems by applying zero water exchange. So, the difference in water requirements used is caused by the cultivation system and water management applied as well as the scale of the culture container used. The use of water to produce super intensive vaname shrimp is 2.50 m^3/kg shrimp (plot A) and 1.50 m^3/kg shrimp (plot B) and 1.45 m^3/kg shrimp in plot C. The water requirements in plot C are more efficient than plot A because the productivity level of plot C is higher than plot A and B. The high-water demand in the cultivation system is due to the daily disposal of waste at a frequency of three times a day. Boyd & Clay obtained a water requirement of 2.25 m^3/kg of shrimp at a production level of 15,000 kg/ha. Super intensive cultivation method with a recirculation system without water change, requires a volume of water of 100 ± 20 L/kg of shrimp on a stocking density of 500 individu/m^3 with shrimp productivity of 9.75 ± 0.20 kg/m^3 and 150 ± 8 L/kg of solid shrimp stocking 550 tails/m^3 with productivity of 8.50 ± 0.75 kg/m^3 or 4.75 ± 0.30 kg/m^2 [12]; 157.6 ± 7.9 L/kg of shrimp on stocking of 500 head/m^3 and productivity of 9.58 ± 0.18 kg/m^3; and 158.1 ± 8.5 L/kg of shrimp on a stocking density of 390 head/m^3 and productivity of 8.36 ± 0.32 kg/m^3 [12]. Water requirements of less than one cubic meter generally occur in closed cultivation systems by applying zero water exchange. So, the difference in water requirements used is caused by the cultivation system and water management applied as well as the scale of the culture container used.

Experimental pond water quality

During the cultivation period, water temperatures varied between 25.5-31.5°C with an average value of the three ponds 28.15 ± 1.05°C. Vaname shrimp will grow well at water temperatures of 28-32°C [24]. While dissolved oxygen ranges from 0.5-10.5 ppm with an average value of the three ponds of 5.50 ± 1.30 ppm. Dissolved oxygen becomes one of the most important water quality variables to sustain shrimp life. Therefore, the aeration system is the most important thing in the shrimp production system as a supplier of dissolved oxygen in pond water for shrimp life and supports the aerobic decomposition of organic matter and nitrification by bacteria. Aeration also produces water flow and the stirring process of pond water mass so that it can maintain bacteria and other microorganisms in suspension conditions.

Pond water salinity ranged from 22.5-22.9 ppt at the beginning of stocking increased to 28.5-29.9 ppt at the end of maintenance, but this variation did not affect shrimp growth. The average salinity value of the three ponds was 25.6 ± 2.2 ppt, meaning that the salinity of the three ponds was relatively the same fluctuation. Efforts to maintain daily water pH in the cultivation of super-intensive vaname shrimp are a must so that the stability of water quality can be maintained properly. If the pH of the water can be maintained in the range of variation <1, the other water quality variables do not experience shaking and are in a condition suitable for shrimp life. During shrimp rearing, pond water pH ranged from 6.5 to 8.5 with the daily average value of the three ponds was 7.5 ± 0.2.

In super intensive shrimp farming, high TAN excretion occurs, because many shrimps use protein as an energy source. If the amount of excreted N is added + N in the feces and leftover feed, the value is around 75%, or only about 25% N is retained in the body of the farm animal. Value of N feed in the cultivation of vaname shrimp with a stocking density of 500 tails/m^2 ranging from 38.75 to 42.40%; meaning more than 60% of the feed will be wasted in the environment. Organic N_2 in the rest of the feed and feces will then form a TAN after going through the process of decomposition by bacteria. TAN is toxic if it accumulates to a certain degree, so that in intensive aquaculture frequent water must be changed frequently to remove the TAN. The feed used has a protein content of 35-40% so it is sufficient to make a significant contribution to the TAN concentration which reaches the range of 0.0675-18.9225 ppm. Then, the nitrification process becomes a major factor and nitrifying bacteria quickly convert ammonia nitrogen into nitrate. Ammonia concentrations above 4 or 5 ppm will be toxic to shrimp [24]. In this study, nitrite concentrations were between 0.0062-40.2500 ppm and nitrates between 0.0795-54.8500 ppm, but nitrates were not toxic to shrimp at concentrations below 50 ppm [24].

Cost analysis

Based on the analysis used in the super intensive vaname shrimp aquaculture process, it was found that the lowest production cost of vaname shrimp was on the stocking density of 1,000 individu/m^2 of IDR. 40,550/kg shrimp (Table 1). The highest cost component in the production process of vaname shrimp is feed around IDR. 20,135-22,650/kg which contributed between 60.50% to 65.14%, followed by frying needs (13.50-13.80%) and electricity (9.60-12.98%). The highest operating profit in two growing seasons per year, obtained in plot C (1,200 individuals/m^2) of Rp. 1,755,428,571.43 followed by plot B (1,000 individu/m^2) and A (750 individu/m^2) each IDR. 1,462,857,142.86, - and Rp. 1,097,142,857.14, - the three stocking densities still produce an R/C ratio of >1 which means the business is economically feasible. Respectively, foreign stockpile resulting in an annual operating profit of IDR. 438,857, 142, - IDR. 585,142,857 and IDR. 702,171,428 and the balance of revenue (R/C) respectively 1.45 and 1.61.

Application of stocking of 1,000 head/m^2 resulted in a payback period of 0.86 years and a BEP value of IDR. 625,803,100, - lower than the other two treatments. Likewise, the R/C value of 1.43 is higher than other treatments. Increased stocking densities are not followed linearly by either production or operating profit. This indicates that the stocking density of 1,000 individu/m^2 produces the highest level of business feasibility and can be used as a reference for stocking densities in the operational operations of super-intensive vaname shrimp farming.

CONCLUSION AND SUGGESTION

Vaname shrimp cultivation with high stocking densities is technically feasible, economically profitable, and acceptable to the farming community. Based on the payback period, R/C ratio, and BEP, the stocking density of 1,000 animals/m^2 produces the best cultivation performance and is considered the most feasible to be applied.

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