# Growth performance, survival rate and economic efficiency of barramundi cultured in HDPE-lined ponds with high densities

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**Abstract**. This experiment aimed to assess the impacts of high stocking densities on growth performance, survival rate and economic efficiency of barramundi (*Lates calcarifer*) intensively cultured in HDPE-lined ponds. The experiment was designed with two treatments of stocking density of 10 and 15 fish $m^{-2}$. Each treatment had one replicate. Barramundi with an initial total length of 10.50±0.09 cm and weight of 20.60±0.44 g was stocked in HDPE-lined ponds with area of 40 $m^2$ and water depth of 1.5 m. The fish was fed with pelleted feed containing 48% crude protein, minimum 10% fat, maximum 10% ash, maximum 2% crude fibre, and maximum 10% water. Water quality parameters including water temperature, dissolved oxygen, pH, salinity, nitrite, transparency, total organic matter, and ammonia concentration were measured once a week. Barramundi was sampled for length and weight measurement at every 10-day interval. Costs were recorded for economic efficiency estimation. Results of the study showed that the water quality parameters were in suitable ranges for the growth and development of barramundi. There was no significant difference ($p > 0.05$) between means of final length, final weight, daily weight gain, and specific growth rate of the treatments. Capital efficiency increased with the increase in stocking density from 10 to 15 fish $m^{-2}$ by 33.6 and 48.9%.
**Key Words**: barramundi, economic analysis, intensive culture, pond.

**Introduction**. Aquaculture continues to grow more rapidly than all other animal food-producing sectors (FAO 2007). World fisheries production reached 178 million tons in 2020, consisting of 51% (90 million tons) from capture fisheries and 49% (88 million tons) from the aquaculture sector (FAO 2022). Also, fish consumption increased from an average of 9.9 kg per capita in the 1960s to a high record of 20.5 kg per capita in 2019, while in 2020 it decreased slightly to 20.2 kg per capita (FAO 2022). In Indonesia, from 2015 to 2020, barramundi (*Lates calcarifer*) culture in coastal area produced 20,792 tons, while pond culture reached 22,503 tons (KKP 2022). Barramundi is interesting to culture because of its high growth rate, growing to large sizes, and can be spawned in controll container (Cheong 1989). The demand for barramundi is very high, which is to meet the demand of the local market for consumption, but also to meet the demand for further culture (pre grow out) in the floating net cage in the sea (Kumaran et al 2021). The grow-out phase for fish production can be defined as the growth of fish greater than 100 mm in length. Depending on the final market size, grow-out can be as short as three months for a marketable size fish of 250 grams or up to 18 month for a fish of more than 3 kg suitable for filleting (Schipp et al 2007) and according to Hajirezaee et al (2015) the marketable size of barramundi is an average weight (AW) of 252.1±30 g. As an aquaculture business, barramundi continues to grow followed by the demand for fish feed (pellets) which also increases. Some of the advantages of pellets are their stability in water, floating, and high nutritional value.

Barramundi culture and economic analysis have been carried out in earthen ponds or floating net cages in the sea (Cheong 1989; Peker & Ertekin 2011; Singh et al 2012; Hajirezaee et al (2015); Petersen et al 2016; Daet 2019; Kumaran et al 2021; Nhan et al 2022). In ponds, barramundi can be cultured with a monoculture or polyculture system with tilapia (*Oreochromis mossambicus* or *O*. niloticus) (Cheong 1989). Ghosh (2019) has reported the barramundi cultured in freshwater ponds. Barramundi culture has been studied in a recirculating aquaculture system with different densities (Ezhilmathi et al 2022). Stocking density is one of the important factors that affect the production and health status of fish in aquaculture. In shrimp farming, culturing in ponds lined with high-density polyethylene (HDPE) is known to offer benefits over earth ponds, including increased yield (Prawitwilaikul et al 2006). Barramundi are generally cultured at a salinity of 10-30‰ (Cheong 1989). Other water quality parameters that are suitable for culturing barramundi according to Kungvankij et al (1985) are pH 7.5-8.5; dissolved oxygen 4-9 mg $L^{-1}$; ammonia ($NH_3$-N) < 1 mg $L^{-1}$; $H_2S$ < 0.3 mg $L^{-1}$; and turbidity < 10 mg $L^{-1}$. Research on barramundi cultured in HDPE-lined ponds intensively and its economic efficiency has not been carried out. Therefore, the aims of this study is to obtain the performance of barramundi which is cultured in intensive HDPE-lined ponds with high stocking density and economic efficiency.

## Material and Method

***Experiment set up***. The experiment was conducted in 2021 from March to July at Gundil instalation belonging to the brackishwater aquaculture development centre (BADC) of Situbondo, East Java, Indonesia. This study was conducted 2 treatments and 1 replicate. The two stocking densities treatments were, namely D10 treatment: 10 fish $m^{-2}$ or 100.000 fish $ha^{-1}$, and D15 treatment: 15 fish $m^{-2}$ or 150.000 fish $ha^{-1}$.

The ponds used were in the form of HDPE-lined ponds with an area of 40 $m^2$ each with a water depth of 1.2 m. The HDPE material used had a thickness of 0.75 mm. Pond preparation for maintenance was carried out by removing water and cleaning from dirt attached to HDPE-lined ponds and then drying. Water filling was done by filtering water through a porous filter bag (mesh size) of 1 mm. The growth of plankton in the pond uses fertilizer and after the plankton grows stably, it takes approximately 10 days for the barramundi to be stocked in the morning according to the stocking density of each treatment.

The barramundi used in this study were obtained from the BADC facility in Situbondo. The fish for this study had an average weight of 20.60±0.44 g and an average length of 10.50±0.09 cm. Barramundi was selected to obtain uniformity in weight, length, and healthy condition. Barramundi was first cultured in a nursery pond (Islam et al 2023) to a size of 20 g $ind^{-1}$ before being used as a test fish. During the study the barramundi was cultured for 70 days.

The pellet for this study was commercial pellet for barramundi with a protein composition of 48%, fat minimum 10%, ash maximum 10%, crude fibre maximum 2%, and water maximum 10%. The dosage and frequency of pellet administration were adjusted according to the instructions of the pellet manufacturer. Pellets were applied slowly at one point in the pond.

***Water parameters***. Water parameters were measured every day for water temperature and oxygen with dissolved oxygen (DO) meter type YSI Pro 20-USA, pH with pH meter, salinity with refractometer model Atago New S-100-Japan and water transparency with Secchi disk at 07.00 AM and 16.00 PM. Other water parameters were measured weekly: by spectrophotometer method for nitrite ($NO_2$) and ammonia ($NH_3$), and by titrimetric method for total organic matter following the procedures described by APHA (1992).

***Growth index***. At ten-day intervals, 40 fish individuals of each treatment were randomly sampled for size (total length and weight) measurement using a ruler with mm scale and an electronic balance with 0.5 g accuracy. At the end of the trial, all fish in the ponds were collected for survival rate estimating. The daily weight gain (DWG) was calculated using the equation: DWG (g day$^{-1}$) = $(W_2-W_1)/(t_2-t_1)$, with $W_1$ = fish weight (g) at $t_1$, $W_2$ = fish weight (g) at $t_2$. The specific growth rate (SGR) was calculated according to Mehrara et al (2009) using the equation: SGR (% day$^{-1}$) = 100 $(\ln W_f-\ln W_i)/t$, with $W_i$ = initial fish weight (g), $W_f$ = final fish weight (g), t = experiment period (day) and ln = natural logarithm. The feed conversion ratio (FCR) was calculated using the equation as reported by de Silva & Anderson (1994): FCR = $W_{IF}/(W_E-W_I)$, with $W_{IF}$ = total feed consumed by fish (kg), $W_E$ = total fish biomass at the end of the experiment (kg) and $W_I$ = total fish biomass at beginning (kg). The survival ratio was expressed as the percentage of surviving fish over initially stocked fish. Condition factor (K) was calculated as: K =100(W/L$^3$), where W = fish weight (g) and L = total length (cm) as reviewed by Froese (2006). Average feed intake (AFI) and extrapolated yield (T ha$^{-1}$) were calculated using the following equations: AFI (g fish$^{-1}$ day$^{-1}$) = $W_{IF}/(F_F x T)$, with $F_F$ = number of fish harvested (fish) and extrapolated yield (T ha$^{-1}$) = 250 $AW_E$ with $AW_E$ = average of $W_E$ of the treatment in T unit.

***Economic efficiency***. Economic efficiency was estimated based on total cost and revenue for 1 ha crop$^{-1}$ as following: benefit = total revenue – total cost, and capital efficiency (benefit-cost ratio, BCR, %) = 100*benefit*(total cost)$^{-1}$ (Sarker et al 2022).

***Data analysis***. Means and standard deviations of final length, final weight, daily weight gain (DWG), and specific growth rate (SGR) were calculated. Differences ($p < 0.05$) between the two types of ponds were analyzed using the T-test (Independent Samples Test) by IBM SPSS Statistics 22 version.

**Results**

***Growth index***. In general, the growth of fish length increased gradually from DOC 1 (days of culture 1) to the end of the study (DOC 70) (Figure 1). Fish weight growth also increased rapidly from DOC 1 to DOC 70. The results of the study showed that the growth of fish weight in both D10 and D15 treatments had the same tendency (Figure 2), there was no significant difference ($p > 0.05$) in the average weight of the two treatments (Table 1). Growth performance in terms of total length and weight of fish throughout the culture period was quite similar between D10 and D15 treatments.

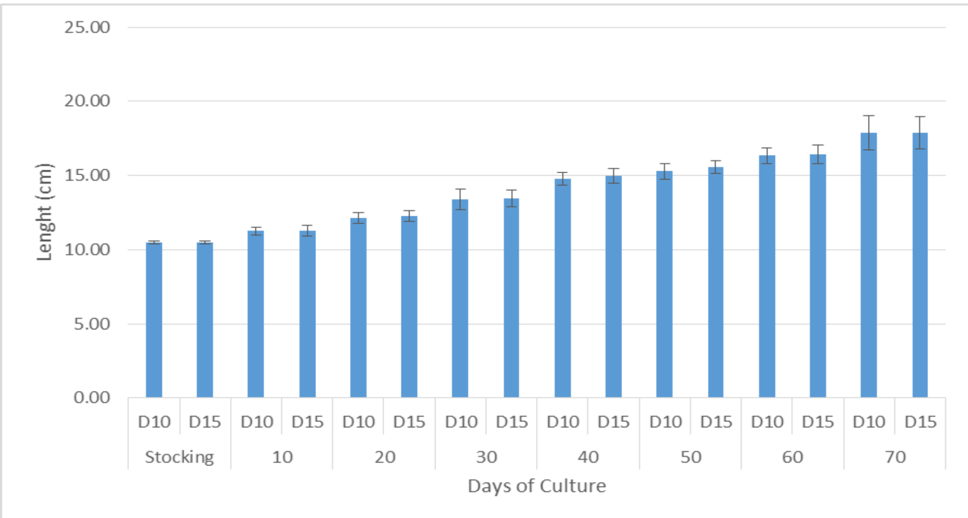

Figure 1. Growth in length of the fish in the experiment.

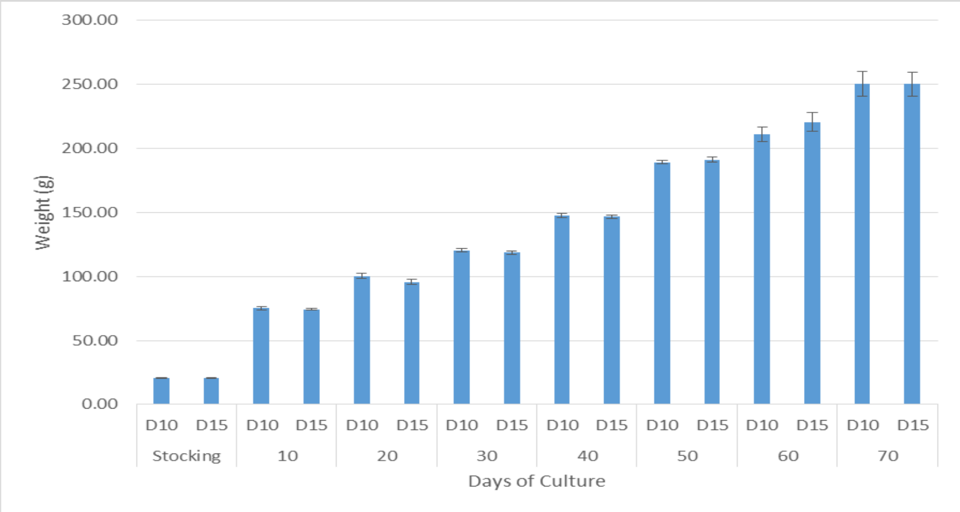


Figure 2. Growth in weight of the fish in the experiment.

Daily weight gain (DWG) of D10 and D15 treatments at DOC 10 was higher during experiment, then decreased and tended to be stable until the end of the experiment (Figure 3). The specific growth rate (SGR) of both treatments showed the same results at the end of the experiment (Figure 4). However, DWG and SGR were no significant different ($p > 0.05$) between the two treatments (Table 1).

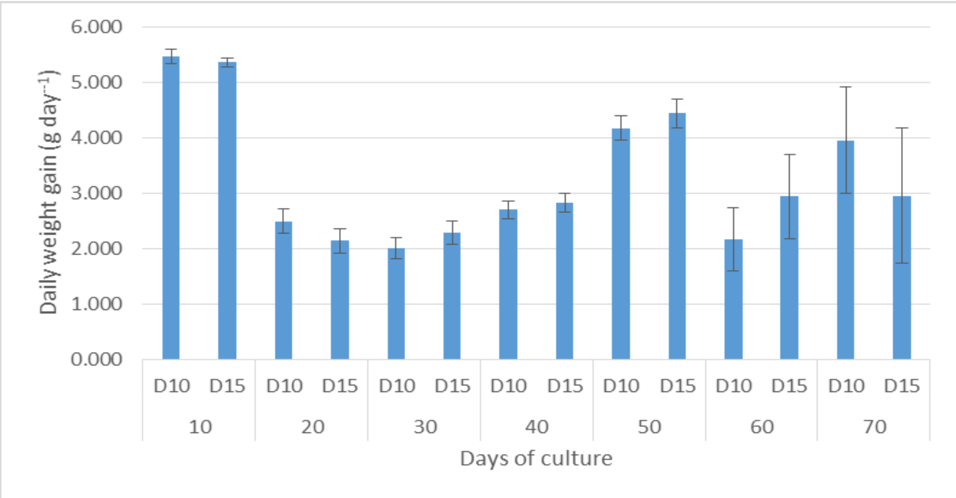


Figure 3. Daily weight gain (DWG) of the fish in the experiment.

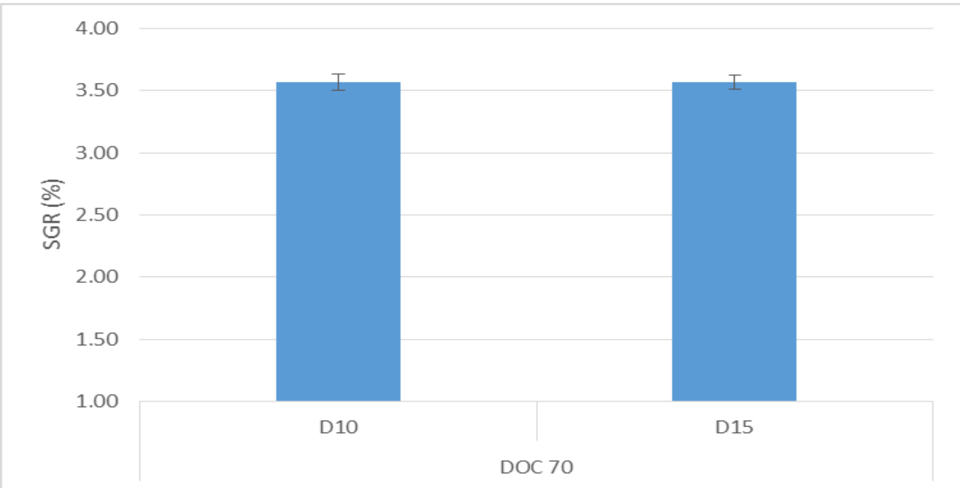


Figure 4. Specific growth rate (SGR) of the fish in the treatments.

Table 1

Growth performance of barramundi cultured at different densities in HDPE-lined ponds

| Parameters | Treatments | |
|---|---|---|
| | *D10* | *D15* |
| Initial length (cm) | 10.50±0.09 | 10.50±0.09 |
| Initial weight (g) | 20.60±0.44 | 20.60±0.44 |
| Final length (cm) | 17.90±1.15[a] | 17.90±1.09[a] |
| Final weight (g) | 250.60±9.51[a] | 250.20±9.48[a] |
| Daily weight gain-DWG (g $day^{-1}$) | 2.30±0.30[a] | 3.28±0.42[a] |
| Specific growth rate-SGR (% $day^{-1}$) | 3.57±0.06[a] | 3.57±0.06[a] |

Note: Means within the same row with same superscript letters are no significantly different at $p > 0.05$.

***Feed conversion ratio***. The total weight of the harvested fish and the total consumed feed in the D15 treatment were higher than that of the D10 treatment (Table 2). Besides, AFI and FCR of D10 treatment were higher than that of the D15 treatment (Table 2).

Table 2

Feed utilization of the fish cultured of different densities in HDPE-lined ponds

| Parameters | Treatments | |
|---|---|---|
| | *D10* | *D15* |
| Total stock fish biomass (kg) | 8.240 | 12.357 |
| Total harvest fish biomass (kg) | 80.190 | 124.600 |
| Total consumed feed (kg) | 159.481 | 218.53 |
| Average feed intake-AFI (g $fish^{-1}$ $day^{-1}$) | 7.120 | 6.269 |
| Feed conversion ratio-FCR | 2.22 | 1.95 |

***Survival rate***. The results showed that the SR at D15 was higher than that of D10 treatment. High stocking density and high SR resulted in higher extrapolated yield at D15 compared to D10 treatment (Table 3). The average condition factor (K) of fish in D10 treatment was slightly higher than that of D15 treatment. The low coefficient of variation (CV) of fish weight in D10 and D15 treatment (3.79) was related to the uniform weight of harvested fish. However, there was similar between the means of CV of weight the two treatments. Higher coefficient of variation (CV) of length of the two treatments expressed body length of the harvested fish of the D10 and D15 treatments were 6.43 and 6.07 respectively (Table 3), CV of body length of D10 treatment being higher than CV of body length of D15 treatment.

Table 3

Culture efficiency and biometric indices of harvested fish in HDPE-lined ponds

| Parameters | Treatments | |
|---|---|---|
| | *D10* | *D15* |
| Extrapolated yield (T $ha^{-1}$) | 20.048 | 31.150 |
| Survival rate-SR (%) | 80 | 83 |
| Condition factor-K | 4.47±0.86 | 4.46±0.87 |
| CV of final length (%) | 6.43 | 6.07 |
| CV of final weight (%) | 3.79 | 3.79 |

***Water quality***. The water quality parameters of HDPE-lined ponds during the study were presented in Figure 5. Most of the water quality parameters fluctuation in both treatments were the same throughout the study. The concentration of dissolved oxygen (DO) was stable, in the afternoon it was higher than in the morning and always more than 4 mg $L^{-1}$. Water temperature in both treatments fluctuates between 29.1 to 30.3°C. pH of the ponds fluctuated in ranged from 6.7 to 8.1. Salinity was fluctuated in range of 25-30‰, low at the beginning of the experiment (about 25‰), gradually decreased and reached a highest value (around 30‰) in the end of experiment period. The water transparency of the ponds tended to decrease towards the end of the experiment. The total organic matter and ammonia of the ponds tended to increase towards the end of the experiment.

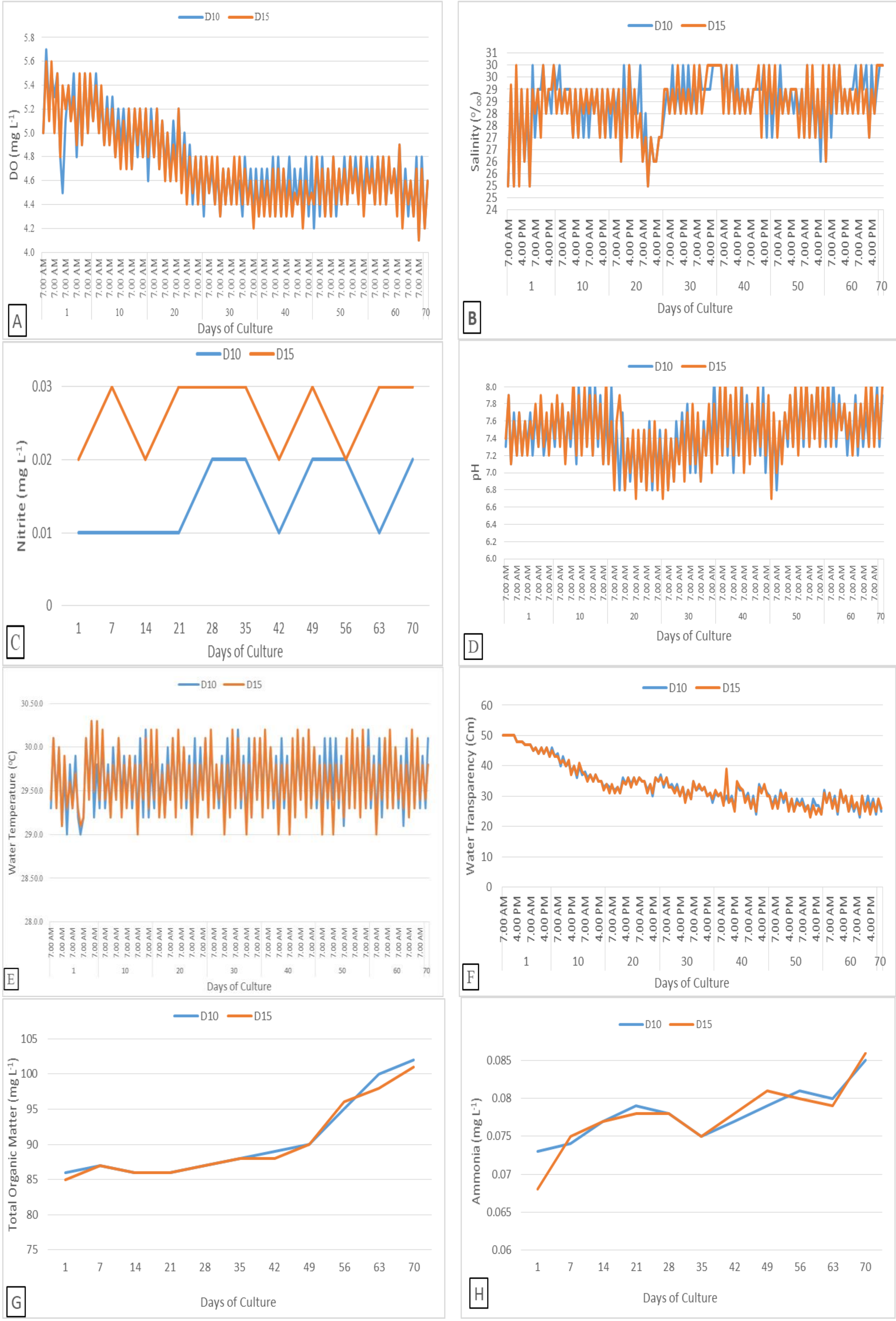


Figure 5. Effect of stocking densities (D10 and D15) of cultured Barramundi on different water parameters (A) dissolved oxygen, (B) salinity, (C) Nitrite, (D) pH, (E) water temperature, (F) water transparency, (G) total organic matter, (H) ammonia during the experimental period of 70 days.

***Economic efficiency***. Economic efficiency of barramundi farming at different stocking densities in HDPE-lined ponds is presented in Table 4. The increase in the stocking density resulted in higher fixed costs (depreciation of ponds, aerators and pump), variable costs (fingerling, feed, labour, energy, drugs and chemicals) and total costs, as well as production costs. Among the total cost, variable cost occupied 98.03% and 98.46% for D10 treatment and D15 treatment respectively. Ratio between the feeding cost and variable cost of D10 treatment and D15 treatment were 71.12% and 69.62% respectively. Higher stocking density also increased total revenues, production costs, and capital efficiencies.

Table 4
Costs, revenue, benefit and capital efficiency of barramundi culturing in HDPE-lined ponds for 70 days

| | *Items* | *D10* | *D15* | *Notes* |
|---|---|---|---|---|
| 1 | Yield production (kg $ha^{-1}$) | 20047.620 | 31149.962 | 70 days of culture |
| 2 | Fixed costs | 1462.759 | 1573.103 | Depreciation cost |
| 3 | Variable costs | 81172.423 | 113619.725 | |
| 3.1 | Fingerling | 21724.138 | 32586.207 | 0.217 USD $fish^{-1}$ |
| 3.2 | Feed | 57493.501 | 79107.284 | 1.448 USD $kg^{-1}$ |
| 3.3 | Labor and management | 275.862 | 275.862 | |
| 3.4 | Electricity | 1167.846 | 1372.934 | |
| 3.5 | Chemicals and drugs | 272.414 | 277.586 | |
| 4 | Other | 172.414 | 206.897 | Repair, maintenance |
| 5 | Total cost | 82807.595 | 115399.725 | (2) + (3) + (4) |
| 6 | Production cost (USD $kg^{-1}$) | 4.1 | 3.7 | |
| 7 | Total revenue | 110602.720 | 171854.342 | Farm gate price 5.517 USD $kg^{-1}$ |
| 8 | Benefit | 27795.124 | 56454.617 | |
| 9 | Capital efficiency (BCR, %) | 33.6 | 48.9 | |

Note: calculation is based on one ha $crop^{-1}$; finance unit is USD. 1 USD = 14,500 IDR.

**Discussion**. The stocking density of barramundi in this study was higher than the study conducted by Nhan et al (2022) with stocking densities of 6, 8, and 10 fish $m^{-2}$ cultured in earthen ponds. Besides, the stocking density of this study was lower than that of the study by Yasmin et al (2023) that cultured barramundi in brackish water ponds with stocking densities of 10, 15, and 20 fish $m^{-2}$. This study showed that there was no effect of high densities on the growth of barramundi cultured in HDPE-lined ponds (Table 1). The results of this study were different from those conducted by Nhan et al (2022) which showed that the stocking density of 8 fish $m^{-2}$ had better growth than the stocking density of 6 and 10 fish $m^{-2}$ in barramundi cultured in earthen ponds. Research conducted by Nhan et al (2022) showed that DWG decreases as stocking density increases, but the results of this study showed that DWG increases as stocking density increases. Besides, the SGR of this study was the same between treatments, namely 3.57% $day^{-1}$, this result was higher than the study of Nhan et al (2022) which were 1.59, 1.62, and 1.65 % $day^{-1}$; Wijayanto (2023) that studied barramundi in freshwater and feed enriched with *Curcuma xanthorrhiza* with SGR 1.87-2.11% $day^{-1}$; Wijayanto et al (2020) that cultured barramundi in low salinity (0.5, 5, and 10‰) with SGR of 1.35, 1.37, and 1.51% $day^{-1}$ respectively; and also, Yasmin et al (2023) that studied barramundi in brackish water ponds with stocking densities of 10, 15, and 20 fish $m^{-2}$ with SGRs of 1.25, 1.15, and 1.05% $day^{-1}$ respectively. In this study, the application of changing water, probiotic, lime, and aeration could maintain high DO concentration (> 4 mg $L^{-1}$) as recommended (4-9 mg $L^{-1}$) by Kungvankij et al (1986). The seasonal variation in temperature reported to influence the amount of food diverted to growth and the amount of maintenance requirement (Lagler et al 1977). Also, the temperature has been reported to induce differences in growth since temperature affects metabolism and food consumption (Lagler et al 1977). No significant different ($p > 0.05$) in growth performance in this study (final weight, DWG, and SGR) showed that the two stocking densities were in the carrying capacity of the HDPE-lined ponds ecosystem until DOC70. According to Bacher et al (1997) carrying capacity can be defined as the maximum biomass maintained by an ecosystem in a given period. The FCR of this study of D10 and D15 treatments were similar (Table 2), the fish were fed according to feeding program and in suitable environmental conditions leading to be similar in FCR. In this study, AFI of D10 and D15 treatments were 7.120 and 6.269 respectively, similar to the result of the study of Nhan (2022) on barramundi cultured in earthen ponds with high densities of 6, 8, and 10 fish $m^{-2}$ and AFI were 6.34, 6.75, and 7.05, respectively. In this study, covariance (CV) of final length and covariance (CV) of final weight of two treatments were similar (Table 3). A low CV of final weight in both treatments (3.79%) indicates that the fish are uniformly weighted. In this study, CV of final weight was better than the study of Hajirezaee et al (2015) which resulted in a non-uniform final weight measure between 100 and 600 g $fish^{-1}$. In this study, the CV of final weight of harvested fish was as low as studied by Nhan et al (2022) that had the CV of final weight of 3.95, 4.11, and 5.16%.

The range of water quality parameters in D10 and D15 treatments during experiment were as follows: dissolved oxygen 4.1-5.7 mg $L^{-1}$, salinity 28-30 ppt, nitrite 0.01-0.03 mg $L^{-1}$, pH 6.7-8.1, ammonia 0.081-0.086 mg $L^{-1}$, total organic matter 85-102 mg $L^{-1}$, water temperature 29.0-30.3°C, and water transparency 30-60 cm, in accordance with the range required by Kungvankij et al (1986) in barramundi cultured, namely pH 7.5-8.5, dissolved oxygen 4-9 mg $L^{-1}$, salinity 10-30‰, temperature 26-32°C, and ammonia < 1 mg $L^{-1}$. The moderate water temperature, alkaline pH, dissolved oxygen > 4 mg $L^{-1}$ promote good growth of barramundi in ponds (Singh et al 2012). The range of water temperature in this study was the same at 29.0-30.3°C (Figure 5), this result was slightly higher than the result reported by Biswas et al (2010) that examined the culturing of barramundi in brackish water ponds that water temperature fluctuated between 26 and 31°C. Dissolved oxygen levels in D10 and D15 treatment ranged from 4.1 to 5.7 and from 4.1 to 5.6 mg $L^{-1}$ respectively (Figure 5). According to Monwar et al (2013), the DO concentrations in barramundi ponds could vary widely, ranging anywhere from 3.9 to 8.9 $L^{-1}$, these values being higher than the present study. The pH in this study ranged from 6.7 to 8.1. Biswas et al (2010) reported a result that was between 7.70 and 8.07. The range of salinity values in this experiment was 28-30 ppt, being higher than Monwar et al (2013), that the salinity ranged from 0 to 6‰ in barramundi pond. At the end of the experiment, there was a tendency to increase total organic matter caused by fish metabolism and waste material accumulation. The increase in the total value of organic matter affects the decrease in water transparency caused by the increase in the amount of algae even though the water has been changed. However, the range of water quality parameters in both treatments during the study was still within the range suitable for fish rearing (water temperature 26-32°C, DO ≥ 4 mg $L^{-1}$, pH 7.5-8.5, and ammonia ($NH_3$-N) < 1 mg $L^{-1}$ (Boyd 1998)). However, the two treatments were well managed by means of application of HDPE-lined pond, water exchange, aeration, application of probiotics, and application of lime, as a result the water quality could be maintained at proper conditions. According to Prawitwilaikul et al (2006) ponds lined with polyethylene could obtain high production and could be applied in areas of high porosity, sand and mineral acid soil. They also showed low levels of total ammonia-nitrogen and abundance of plankton.

In this study, the SR of the fish were high (80 and 83% respectively) (Table 3), better than the result of Yasmin et al (2023) that examined barramundi with stocking densities of 0.2, 0.4, and 0.5 fish $m^{-2}$ in brackish water ponds with SRs of 59.67, 53.33, and 47.00% respectively, and also a study by Hajirezaee et al (2015) that studied barramundi in net cages in brackish ponds with stocking densities of 0.4 fish $m^{-2}$ with a SR of 66%. The SR in this study was higher than the study of Monwar et al (2013) which studied barramundi in polyculture with tilapia in brackish water ponds. However, the results of this study were lower than the study conducted by Nhan et al (2022) that studied barramundi in brackish water ponds in stocking densities of 6, 8, and 10 fish $m^{-2}$ with SRs of 94.33, 92.00, and 90.67%, respectively. In this study, the high stocking densities and SR resulted in very high yield. However, the increase of stocking density was equivalent to the increase of yield (Table 3). In this study, the yield were 20,048 and

31,150 T ha$^{-1}$, this result is lower than a study conducted by Nhan et al (2022) that studied barramundi in brackish domestic ponds in stocking densities of 6, 8, and 10 fish m$^{-2}$ with a yield of 65,799, 80,325, and 91,226 T ha$^{-1}$, respectively. In this study, the yield of D10 and D15 treatments was higher than the study conducted by Yasmin et al (2023) which produced a yield of 610.24-681.69 kg ha$^{-1}$ yr$^{-1}$. Condition factor-K of the harvested fish of D10 and D15 treatments showed the fish were in good condition (K = 4.47 and 4.46 respectively) and similar (Table 3). In this study, the condition factor of the two treatments was higher than the study by Nhan et al (2022) which was 1.69-1.75 and also higher than the study conducted by Biswas et al (2011) that studied barramundi in brackish water ponds with two different feeding systems with condition factors of 1.285 and 1.402.

One of the most important economic parameters to assess a barramundi culture business is economic efficiency. In this study, the variable cost in D10 and D15 treatment were similar, occupying about 98% of total cost, while the feed cost in D10 treatment about 71% and in the D15 treatment about 70% of variable cost. Compared to the study by Nhan et al (2022), the percentage of variable cost and total cost in this study was the same, but the ratio of feed cost and variable cost was lower (84%). In this study, production cost in D10 treatment of 4.1 USD kg$^{-1}$ and D15 treatment of 3.7 USD kg$^{-1}$ (Table 4). In this study, the increase in stocking density resulted in an increase in total cost and total revenue of 28.26% and 35.64%. Cheong (1989) reported that in Thailand the production of barramundi in earthen ponds was 14 tons ha$^{-1}$ year$^{-1}$ with a production cost of US$ 2.40 to produce a kilogram of fish. In Turkey, sea bass (*Dicentrarchus labrax*) cultured in earthen ponds produced a financial profitability of 20.16%, an economical profitability of 20.71%, and a production cost of 4.91 USD kg$^{-1}$ (Peker & Ertekin 2011). In this study, production costs were higher than production costs in Thailand, but lower than production costs in Turkey. In this study, the capital productivity of D10 and D15 treatments was 0.73 and 0.66 respectively, higher than the study conducted by Philipose et al (2013) which cultured barramundi in cage culture in open sea with a capital productivity of 0.20. In this study, benefits increased with the increase in stocking density from D10 to D15 treatment by 102% and capital efficiency (BCR) also increased (Table 4), this indicates that there is no potential loss in higher levels (15 fish m$^{-2}$). In this study, the capital efficiency was higher than Nhan et al (2022) with capital efficiency of 27.20-34.20%. Barramundi production costs vary depending on several factors including the culture system, culture techniques, location, culture season, and environment management. Barramundi prices also vary depending on supply and demand which changes at any time. Barramundi fish farmers can apply this culture technique in HDPE-lined ponds that are not too large (40 m$^2$), but are economically very profitable. Based on the information obtained from the study it is highly recommended that further research is needed to standardise the stocking densities culture in HDPE-lined pond, since an optimum density is mandatory for economical production. Studies along alternative feed sources and stock grading to prevent cannibalism should also be explored.

**Conclusions**. The average weight of harvested fish at the density of 10 and 15 fish m$^{-2}$, survival rate and feed conversion ratio of the fish were similar. However, barramundi cultured at the density of 15 fish m$^{-2}$ gained higher capital efficiency compared to the density of 10 fish m$^{-2}$. Barramundi could be cultured on a small scale (40 m$^2$) and in short period cultured (70 days), and it was economically very profitable. The HDPE-lined pond could promote the growth performance and survival rate of barramundi. Water parameters of the HDPE-lined ponds in this trial were fluctuated over farming period but always met the requirements for the growth and development of barramundi. Cultivating barramundi in HDPE ponds could be a solution for providing food security and a profitable form of aquaculture business.

**Acknowledgements**. The authors would like to thank The Ministry of Marine Affairs and Fisheries Republic of Indonesia, Directorate General of Aquaculture-Brackishwater Aquaculture Development Center Situbondo for their support and funding by the allocation of research funds from the government of the Republic of Indonesia during the research.

**Conflict of interest**. The authors declare that there is no conflicts of interest.

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Received: 14 November 2024. Accepted: 11 December 2024. Published online: 19 February 2025.
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How to cite this article:
Hardanu W., Hanggono B., Suriawan A., Mahardika K., Syahidah D., Subaidah S., Sumarwan J., Muzaki A., Ismi S., Mastuti I., Astuti N. W. W., Zafran, Suprapto R., Dharma T. S., Mindarwati E., 2025 Growth performance, survival rate and economic efficiency of barramundi cultured in HDPE-lined ponds with high densities. AACL Bioflux 18(1):477-488.