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Production performance improvement of white shrimp *Litopenaeus vannamei* culture with integrated multi trophic aquaculture system in Seribu Islands, Jakarta, Indonesia

Verdian A.H.[1,3*]; Effendi I.[2]; Budidardi T.[2]; Diatin I.[2]

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Abstract

Integrated multi-trophic aquaculture (IMTA) system can increase production of aquaculture with additional economic value in addition to a biological purification of the effluent from the float net cage (KJA). This study aims to evaluate daily growth, feed conversion rate, and survival rate of marine commodities in KJA that are implemented through the IMTA system. This research was conducted in waters of Karang Lebar Semak Daun Island, Seribu Islands, Jakarta, Indonesia. The IMTA model developed is a combination of white shrimp (*Litopenaeus vannamei*), rabbit fish (*Siganus doliatus*) and seaweed (*Euchema cottonii*). The results showed that for 60 days maintenance period of white shrimp cultivated by IMTA system showed better effect than shrimp cultivation with monoculture system. The daily growth of white shrimp, rabbit fish, and seaweed was 0,12±0,001 g day^{-1}, 0.10±0.013 g day^{-1} and 14.30±4.33 g day^{-1}. The conversion rate of white shrimp feed was 2.73±0.73%, and the survival rate of white shrimp was 71.00±14.53% and for rabbit fish was 84.39±1.00%. The results of this study indicate that IMTA model of IMTA system is more effective in improving the performance of shrimp productivity and visible effects of mutual benefits between organisms incorporated in IMTA system and can be applied as a model of development of sea cultivation that is environmentally sound.

Keywords: Growth performance, IMTA system, Floating net cage, Shrimp productivity

1-Aquaculture Science, Postgraduate Program, Bogor Agricultural University, Bogor, West Java, Indonesia

2-Department of Aquaculture, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University, Bogor, West Java, Indonesia

3-Program Study of Aquaculture, Politeknik Negeri Lampung, Lampung, Indonesia

*Corresponding author's Email: aldihudaverdian@gmail.com, irzalef@gmail.com

Introduction

As one of the world's major shrimp production countries, Indonesia needs efforts to increase production through intensification and extensification of cultivation. One of the aims to improve production by the government of Indonesia is to develop shrimp farming in the sea using floating net cages (KJA) system to meet the high demand of shrimp in the world market which continues to increase every year. According to FAO (2017) world, shrimp demand is rising with significant importers coming from the United States, European Union, Japan and Vietnam with each growing market by 8%, 12%, 7% and 30%, respectively by 2017. Imports from the United States 268,000 tons, 323,900 tons European Union, Japan 100,000 tons and China 49,200 tons in 2017. Shrimp farming using KJA at sea has several advantages compared to shrimp farming in ponds. These advantages include high water circulation resulting in good water quality where suspended solid waste does not accumulate around the cages, then the availability of organic materials can increase the shrimp growth rate (Zarain-Herzberg *et al.*, 2010). By zoning, the cultivation of white shrimp in sea KJA aims to exploit the potential of the sea that is still very wide, so it needs to be utilized optimally (Effendi *et al.*, 2016) water quality in a thousand archipelagic waters for shrimp aquaculture is within the optimum range, but changing dynamics of seawater can affect the water quality.

In its application, marine aquaculture activities have several obstacles which include biofouling which inhibits water circulation in cultivation containers, causes of pathogens, and causes of damage to cultivation containers (Fitridge *et al.*, 2012). Biofouling is the attachment and accumulation of living organisms attached to the surface of the substrate; biofouling can be divided into two, i.e., microfouling which forms biofilms (bacterial colonization and microalgae) and macrofouling or macroorganism attachment of invertebrate and macroalgae colonization which can be destructive. Another obstacle is the intensity of light that can interfere with the growth of shrimp. The sea water is relatively five meters high in contrast to the ponds of 0.3-0.4m, the shrimps during the day tend to hide in the base and when the shrimp accumulate in the bottom of a potential competition of space and feed causing shrimp stress (Effendi *et al.*, 2016). The ecological problems of cultivation activities can arise as a result of metabolite waste disposal and the waste of food wasted directly into the water. Related to some of these constraints, aquaculture cultivation with the application of integrated multi-trophic aquaculture (IMTA) system can be a solution by utilizing biological aspects and cultivation space that has not been optimal (Lekang, 2013). IMTA aims to balance the ecosystem and cultivate a variety of species with different trophic levels that can increase economic added value and be able to reduce cultivated waste (Chopin, 2006).

White shrimp (*Litopenaeus vannamei*), rabbit fish (*Siganus doliatus*) and seaweed (*Euchema cottonii*) are cultivated commodities that have good economic value. If all three are cultivated IMTA, it can increase the productivity of cultivated land and income. Rabbit fish is one of the marine fish commodities that can be cultivated and integrated with several other commodities (Suharyanto, 2008; Abalos, 2015; Parunutu, 2015). Rabbit fish is a herbivorous fish in the IMTA system and can be used as a by-product commodity which is expected to increase productivity and other functions such as the utilization of residual feed and biofouling attached to the net wall. Thus, rabbit fish in addition to improving the reception also serves to enhance the quality of KJA media and minimize damages to ecosystems caused by cultivation waste. In the cultivation activity with IMTA system, the addition of seaweed can become a shelter from the high light intensity, if the light intensity condition decreases because there is a shelter covering it, then the process of eating will be well (Riani and Dana, 2003). Seaweed acts as a natural substrate that can provide a natural feed source for shrimp growth, the impact on the environment was reduce from shrimp farming activities (Lombardi *et al.*, 2006). Seaweed has an ecological roles in cultivation maintenance, which can absorb nitrogen in the form of NH_3 and NO_3 through the thallus, and capable of photosynthesis that can produce oxygen (Boyajian and Carreira, 1997). On the other hand, seaweed can also be a source of the substrate where the natural feed assembled and biomass producers of economic value.

This study aims to evaluate daily growth, feed conversion rate, and survival rate of aquaculture commodities in KJA applied through an integrated marine aquaculture system or IMTA. The results can be a superior mariculture model for developing aquatic commodity cultivation in Seribu Islands, Jakarta to increase food security and nutrition, cultivation income, and local revenue.

Materials and methods

The experiment has conducted for 60 days from August to October 2017 in the Sea Farming Center for Coastal and Marine Resources Studies – Bogor Agricultural University, Karang Lebar, Seribu Islands, Jakarta, Rep. of Indonesia. Deep of water in this area is about 7 to 10 m and the distance of shoreline is about 1.5 km from Karya Island. The geographic locations of experimental are (106^{o}35'0"E-106^{o}35'30"E, 5^{o}43'30"S- 5^{o}44'0"S) Norhten Jakarta

IMTA culture model

IMTA model applied is the integrated cultivation of white shrimp (*L. vannamei*) as primary commodities combined with rabbit fish (*S. doliatus*) and seaweed (*E. cottonii*).

This research is a field experiment using complete randomized design (RAL) with three treatments, i.e., shrimp+seaweed+rabbit fish 0 tail m^{-3} (A), shrimp+seaweed+rabbit fish three tail m^{-3} (B) and shrimp+seaweed+rabbit fish six tail m^{-3} (C) for each plot of KJA, each repeated three times. The size of KJA have used in this study was 3×3 m with the deep and surface of cage was 3 m^2 for the first net for rabbit fish culture and for the second net the deep and surface of cage was 2 m^2. KJA has been used in this study, was occupied two-tiered nets, consisting of the low nets for shrimp and seaweed cultivation and outer nets used for rabbit fish cultivation. Substantial stocking of rabbit fish with a density of 4-8 tail m^{-3} (Parunutu, 2015). In each plot of KJA, the shrimp is stocked with 500 heads m^{-2} which refers to the best stocking density on shrimp production at sea KJA (Effendi, 2016) and seaweed 500 g m^{-2} installed using ropes one meter deep in the shrimp culture KJA net.

The mean weight of shrimp was 2.03±0.09 g and a length of 5.58±0.48 cm derived from a hatchery in Banten Province, already maintained to DOC 62 in KJA. In this study, 18,000 shrimp seeds have been used with stocking densities of 500 heads m^{-2} for each treatment replication. Rabbit fish used for 1,026 heads for stocking solids (A), 3 (B), and 6 (C) tails m^{-3} and Seaweed seeds as much as six kilograms with a weight of 500 g m^{-2} installed using a rope with a depth of one meter.

This study was conducted for 60 days of maintenance. During maintenance, water quality, feeding, and shrimp sampling have been performed. The feed is given by putting the feed into a modified net using hapa at the bottom of the net so that the feed has not easily lost; daily feeding rates were 5-7% biomass day^{-1}. Shrimps have been fed by commercial feed with 30% crude protein four times per day at 2 a.m., 8 a.m., 14 p.m. and 20 p.m.

Data collection

Shrimp sampling was done every ten days; growth test parameters include production parameters consisting of survival rate, specific growth rate, daily growth rate, feed conversion rate, and coefficient of diversity. Water quality test parameters include measurements of temperature, pH, salinity, dissolved oxygen (DO) and current have been done in situ at morning, noon and night. Total ammonia nitrogen (TAN), nitrites and nitrates have been measured at the beginning, the middle and the end of the experiment.

Data analysis

Growth data of cultivation commodity (shrimp, seaweed, and rabbit fish) used in this research is statistically tested and water quality parameters analyzed descriptively is presented in a table. The growth trends of each commodity have been analyzed using several calculations using formulas (Steel and Torrie, 1993; Zonneveld *et al*., 1991).

Survival rate (%)=(number of individuals at the end of testing period/initial number of individuals stocked)×100

Specific growth rate (SGR in weight) (%/day)=[(final weight –initial weight) ×100]/days of experiment

Growth rate (GR) (g day^{-1})=(final weight-initial weight)/days of experiment

Feed conversion rate (FCR)=feed consumed (dry weight)/[(final biomass+death biomass)-initial biomass]

Coeficient of Variance (%)=(standar deviation final weight/mean final weight)×100

Production (kg/m^2)= (Biomass/1000)

Statistical analysis

The results were expressed as the mean±standard deviation (SD). Data were analyzed using one-way analysis of variance (ANOVA). Mean differences were compared by Duncan's multiple range tests at the level of 0.05. Statistical analyses were carried out using a statistical package of SPSS version 23.

Results

Production performance includes survival rate, absolute growth rate, daily growth rate, feed conversion ratio, diversity coefficient and production on white shrimp (*L. vannamei*), rabbit fish (*S. doliatus*) and seaweed (*E. cottonii*) in IMTA system, can be seen in Tables 1, 2 and 3.

Table 1: Growth performance *Litopenaeus vannamei* in IMTA system

Parameters		Treatment		
		A	B	C
Weight (g)	Initial	2.15 ± 0.04^a	2.09 ± 0.02^c	2.00 ± 0.02^b
	Final	8.66 ± 0.12^c	9.63 ± 0.03^a	8.92 ± 0.05^b
Survival rate (%)		63.13 ± 4.89^a	60.13 ± 7.90^a	71.00 ± 14.53^a
Spesific growth Rate (%)		2.35 ± 0.05^c	2.72 ± 0.02^a	2.51 ± 0.02^b
Growth rate (g day^{-1})		0.11 ± 0.002^c	0.13 ± 0.001^a	0.12 ± 0.001^b
Coeficient of variance (%)		20.74 ± 0.26^a	18.54 ± 3.45^a	23.95 ± 5.23^a
Feed convertion ratio (%)		3.17 ± 0.38^a	2.84 ± 0.42^a	2.73 ± 0.73^a
Production (kg m^{-2})		1.98 ± 0.24^a	2.42 ± 0.30^a	2.73 ± 0.33^a

Values are expressed as mean±SD. Values in the same row with different letters are significantly different (p<0.05).

Table 2: Growth performance *Siganus doliatus* in IMTA system.

Parameters		Treatment		
		A	B	C
Weight (g)	Initial	-	23.60 ± 0.83^a	22.02 ± 0.85^a
	Final	-	34.60 ± 0.19^a	28.28 ± 0.10^b
Survival Rate (%)		-	60.13 ± 7.90^a	70.90 ± 2.00^b
Growth Rate (g day^{-1})		-	0.18 ± 0.015^a	0.10 ± 0.013^b
Coeficient of Variance (%)		-	35.52 ± 0.81^b	19.74 ± 0.92^a
Production (kg m^{-2})		-	0.07 ± 2.12^b	0.14 ± 1.65^b

Values are expressed as mean±SD. Values in the same row with different letters are significantly different (p<0.05).

Table 3: Growth performance *Eucheuma cottonii* in IMTA system.

Parameters		Treatment		
		A	B	C
Weight (g)	Initial	2001.33 ± 1.67^a	2002.67 ± 2.02^a	2012.00 ± 1.63^a
	Final	2373.33 ± 8.36^c	2434.67 ± 9.81^b	2584.00 ± 7.61^a
Growth Rate (g day^{-1})		9.30 ± 5.24^a	10.80 ± 6.93^a	14.30 ± 4.33^a
Production (kg m^{-2})		0.59 ± 52.54^a	0.61 ± 72.28^a	0.65 ± 43.49^a

Values are expressed as mean±SD. Values in the same row with different letters are significantly different (p<0.05).

Table 1 shows that the average shrimp weight at the end of maintenance has increased in all treatments. The highest end weight was obtained at B treatment which increased by 7.54 g followed by C (6.92 g) and A (6.51 g) treatments. The mean value of survival rate based on the analysis of variance did not differ significantly between treatments. The highest survival rate has found in C treatment at 71.00±14.53%, and the lowest value in B treatment has found 60.13±7.90%. The average amount of total shrimp growth rate was significantly different in each treatment (p<0.05). The highest value of absolute growth rate has obtained at B treatment of 2.72±0.02%, and the lowest has obtained on A treatment of 2.35±0.05%.

The average daily growth rate was significantly different in each treatment (p<0.05). The highest value has obtained at B treatment of 0.13±0.001 g day^{-1}, and the lowest in the A treatment has found 0.11±0.002 g day^{-1}. The average value of shrimp diversity coefficient tends to increase with different treatment. The highest value of the ratio of diversity has found in C treatment of 23.95±5.23%, and the lowest in B treatment has found 18.54±3.45%. However, based on the analysis of variance, the feed conversion value of the A treatment is not significantly different from B and C treatments. The average of shrimp feed conversion tends to decrease with different treatment. The highest feed conversion of this research is in A treatment of 3.17±0.38% and the lowest C treatment of 2.73±0.73%. However, based on the analysis of variance, the conversion value of A treatment was not significantly different from B or C treatments.

In Table 2, the mean final weights of rabbit fish increased in both treatments (B and C) at the end of maintenance. There was a significant increase in B treatment (11 g) while the rise in the C treatment (6.26 g).

Based on the analysis of variance, the survival rate of rabbit fish on B treatment was significantly different with the C treatment (p<0.05). The highest average survival rate of rabbit fish has found in C treatment of 84.39±1.00%, and the lowest value in B treatment has found 70.90±2.00%. The highest average value of daily growth rate of rabbit fish was obtained at B treatment of 0.18±0.015 g day^{-1}, and the lowest at the C treatment was 0.10±0.013 g day^{-1}. Based on the analysis of variance, the value of daily growth rate of B treatment is significantly different from the C treatment (p<0.05).

Seen in Table 3, the final weights of seaweed tend to increase with maintenance. The highest increase has obtained at the C treatment (572 g) followed by B (432 g) and A (372 g) treatments. The highest average value of final weights of seaweed has obtained at the C treatment of 2584.00±7.61 g and the lowest on the A treatment of 2373.33±8.36 g. Based on the analysis of variance, the final weight of treatment was significantly different between A, and B or C treatments. While the highest mean value of daily growth rate of seaweed that is at C treatment equal to 14.30±4.33 g day^{-1} and the lowest that is at A treatment of 9.30±5.24 g day^{-1}. Based on the analysis of variance, the daily growth rate of A treatment was not significantly different from the C treatment but significantly different with B treatment (p<0.05).

Of the three treatments given in this IMTA system, obtained an increase in shrimp production with an increasingly dense stocking of rabbit fish. Shrimp production results tend to increase with treatment differences although these three treatments are not significantly different. The highest average value of white shrimp production in this study was obtained at the C treatment of 2.73±0.33 kg m^{-2}, and the lowest was in A treatment of 1.98±0.24 kg m^{-2}. The highest yield of rabbit fish production is at the C treatment of 0.14±1.65 kg m^{-3}, and the lowest value is in B treatment of 0.07±2.12 kg m^{-3}. Based on the analysis of variance, the result of B treatment was significantly different from the C treatment (p<0.05). While the highest average value of seaweed production is at the C treatment of 0.65±43.49 kg m^{-2} and the lowest is on A treatment of 0.59±52.54 kg m^{-2}. Based on the analysis of variance, the yield of A treatment was not significantly different with B and C treatments.

The value of water physico-chemical parameters measured during the study was directly in floating net cages (KJA) for ten days. In cultivation of white shrimp should always pay attention to water quality because white shrimp will be able to grow well if the environmental conditions by the ability of its life. The results of observation of water quality during maintenance of white shrimp at sea by using KJA include DO, temperature, pH, salinity, NH_3, NO_2, NO_3, and PO_4 can be seen in Table 4.

Table 4: Water parameters measured in experimental treatments.

Parameters	Treatment			
	A	B	C	Environment
Dissolved oxygen (mg L^{-1})	6.2-6.4	6.1-6.3	6.1-6.2	6.3-6.4
Temperature (^{o}C)	29.0-29.2	29.0-29.2	29.0-29.2	29.0-29.2
pH	7.9-8.,2	7.8-8.2	7.9-8.2	7.9-8.3
Salinity (ppt)	32-33	32-33	32-33	32-33
Ammonia (mg L^{-1})	0.003-0.013	0.003-0.013	0.003-0.013	0.003-0.010
Nitrite (mg L^{-1})	0.051-0.037	0.035-0.051	0.032-0.049	0.035-0.114
Nitrate (mg L^{-1})	0.060-0.153	0.052-0.142	0.042-0.120	0.040-0.084
Fosfor (mg L^{-1})	0.185-0.479	0.181-0.452	0.173-0.438	0.158-0.500

Discussion

Shrimp farming in the sea is one solution to address the issue of intensification and extensification of shrimp ponds. The waters of Karang Lebar, Semak Daun Island, Seribu Islands, Jakarta is relatively more dynamic that can be seen from changes in temperature, salinity, and seawater density. In general, the water quality at the study sites is feasible for white shrimp so that the character of waters of Karang Lebar can be said to support the growth performance of white shrimp. Performance of shrimp growth as the primary commodity cultivated on KJA in waters of Karang Lebar with IMTA system showed good results. Increased shrimp and fish growth shown in Table 1 results indicate that shrimp growth maintained for 60 days with IMTA system with the density of rabbit fish six tail m^{-3} (C) is the best treatment with an average weight gain of 8.92±0.05 g and SR 71.00±14.53%. These results have indicated that the growth performance of white shrimp cultivated in the sea with IMTA system is better compared to cultivated shrimp in monoculture system (Effendi, 2016) FCR results of all treatments are still above 2% different from the research (Effendi, 2016; Zarain-Herzberg *et al*., 2010) this is because the shrimp feed have been contain 30% protein lower, so that shrimp growth is not as fast as the existing research.

As one of the marine commodities that has an economic value, rabbit fish farming needs to be developed to meet market demand. In the application of IMTA system, rabbit fish is used as a side commodity capable of utilizing the remaining shrimp feed and biofouling which inhibit shrimp growth. Rabbit fish in addition to increasing revenue results, on IMTA cultivation activities, serves to improve the quality of KJA media because it utilizes biofouling that grows in the net as one source of natural food. Rabbit fish utilize algae as a natural food source in the nets (Fox and Bellwood, 2008). The results showed that rabbit fish cultivated with IMTA system with the density of three tails m^{-3} (B treatment) had significantly different growth performance when compared with rabbit fish cultivated with the density of six tails m^{-3} (C treatment) with a mean weight of end 28.28±0.10 g and SR 84.39±1.00%. The illustrates that rabbit fish can grow and cultivate with IMTA system, this is by (Shah *et al.*, 2017) stating that fish with different trophic levels can be cultivated by the IMTA system. When viewed from the final weight of rabbit fish cultivated with a density of six tails m^{-3} (C treatment) is lower than the density of three tails m^{-3} but has a higher SR value, this is alleged because the rabbit fish live in clusters so that the survival is more elevated. Differences in the growth of low the C treatment is possible on food sources in the form of biofouling that grows attached to the net wall has been used up by the rabbit fish as a source of food, it is also assured at the end of maintenance performed surgery to the hull rabbit fish found that the contents of the stomach are biofouling that has become small particles. While in (A treatment) without any rabbit fish, biofouling grows and covers the net and disrupts the water exchange cycle from outside KJA media.

In the food chain of the IMTA cultivation system, seaweed commodity is the primary producer located at the bottom of the trophic system and used as a supplier of oxygen through the process of photosynthesis during the day and can absorb excess nutrients. Seaweed integration into the cultivation of shrimp polyculture and rabbit fish in an integrated manner is one of the right application. Aquaculture activities play an essential role in the nutrient cycle in the waters (Li *et al.*, 2016). The availability of nutrients in waters dramatically affects the growth of seaweed. The presence of additional nutrients derived from shrimp and rabbit fish aquaculture in this system can help the growth of seaweed, on the other hand, the presence of seaweed can also eliminate the negative impact of nutrient abundance and toxic contaminants in the aquatic environment. The effectiveness of seaweed in absorbing nutrients from cultivated wastes in the IMTA system at sea has been proven by several previous studies (Troell *et al.*, 1997; Hayasi *et al.*, 2008; Akhrari, 2013; Yuniarsih *et al.*, 2014; Putro *et al.*, 2015).

Seaweed removes dissolved nitrogen and other inorganic compounds from water (Mata *et al.*, 2010; Chopin *et al.*, 2012; Castelar *et al.*, 2015). By absorbing reactive nitrogen, seaweed improves water quality and reduces the environmental impact of nitrogen. Nitrogen is a crucial component of the plant growth cycle, and as a result, seaweed uses nitrogen for growth. Seaweed can remove up to 93% of ammonium nitrogen from water in intensive systems and over 50% in open water systems (Wu *et al.*, 2017). The results of this study indicate that the cultivation of seaweed can be done with a polyculture system. Seaweed cultivated with shrimp and seaweed are cultivated with shrimp and rabbit fish both show growth that is not significantly different. The proves that seaweed can utilize nutrient from cultivation waste in the waters for its growth. Also, seaweed can become a shelter from high light intensity during the day and become a substrate where the natural food gathered. The reinforces the results of (Zhang *et al.*, 2010) stating that the shrimp survival rate can increase with the addition of substrate which is used as a place of natural food gathered by shrimp. According to Raja *et al.* (2014), seasons also affect the survival, average weight, and feed conversion ratio of shrimp feed.

The cultivation process of white shrimp which is the primary commodity in the IMTA system is expected to produce a trend of growth performance which is almost same as the cultivation of white shrimp in monoculture. From the results of the study, it has been showed that the growth performance of white shrimp cultivated with the IMTA system has a better growth performance. The existence of seaweed and rabbit fish proved to affect the growth performance of white shrimp as the primary commodity. Secondary commodity biomass of seaweed can utilize organic waste from the cultivation of white shrimp so that can be added value of cultivation production which is added benefit from IMTA system (Barrington *et al*., 2009).
Another factor that adds value is that IMTA system was proven able to give positive function to the aquatic environment in reducing the pollution caused by cultivation activities by utilizing soft commodities of organic and inorganic materials that can absorb cultivated waste into the waters (Irisarri *et al.*, 2015). With better water conditions expected shrimp as a primary commodity on the IMTA system can provide better performance than the monoculture system. The evidenced by the final weight of white

shrimp in the IMTA system of 9.28±0.05 g and the final weight of white shrimp with the monoculture of 8.66±0.12 g; this indicates that the growth performance with IMTA system is better than monoculture.

During the study, the appearance of KJA nets in polyculture treatment has seen as cleaner than KJA in the monoculture system (control treatment), this was caused by the eating habits of rabbit fish eating biofouling attached to the net, so the nets became cleaner and water circulation in KJA being better. On the contrary, the net condition of shrimp cultivated with monoculture system (without rabbit fish) has water circulation which is not smooth in KJA because the remaining feed which is not eaten by shrimp and the rest of the metabolism become the source of nutrient for biofouling growth which will cover the net wall and inhibit the water exchange. Improper water quality due to obstruction of water exchange and accumulation of feed residue and metabolic waste will affect shrimp growth.

According to (Abreu *et al.*, 2009), the application of integrated cultivation systems has the potential to reduce water environmental problems caused by the impact of feed have been used in cultivation activities and combine seaweed in the IMTA system can help in utilizing high ammonia from the aquatic environment which is a waste of cultivation activities. Shrimp farming using the IMTA system can promote growth and sustainability to the environment (Troell *et al.*, 2003; Sharawy *et al.*, 2016; Aghuzbeni *et al.*, 2017). For 60 days the maintenance of white shrimp cultivated by the IMTA system have showed better results than shrimp cultivated by monoculture system, where daily growth of white shrimp, rabbit fish, and seaweed was 0.12±0.001 g day^{-1}, 0.10±0.013 g day^{-1} and 14.30±4.33 g day^{-1}, the conversion rate of white shrimp feed was 2.73±0.73%, and the survival rate of white shrimp was 71.00±14.53% and for rabbit fish was 84.39±1.00%.

IMTA model of IMTA system is more effective in improving the performance of shrimp productivity and visible effect of mutual benefit between organisms incorporated in IMTA system and can be applied as a model of development of sea cultivation with the vision of environment.

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