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An Economic Analysis Ecoshrimp White Shrimp (*Litopenaeus vannamei*) Concept on Shrimp Culture with Plastic Pond, Indonesia

Wahyu Puji Astiyani[1], Ega Aditya Prama[1], Muhammad Akbarurrasyid[1], Rani Rehulina T[1], Guntur Prabowo[1], Dinno Sudinno[1], Miao Sha[2]

[1] *Aquaculture Study Program, Pangandaran Polytechnic of Marine and Fisheries, Indonesia*
[2] *National Taiwan Ocean University, Taiwan*
Respondent Email: wahyupujiastiyani@gmail.com

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Abstract

Wahyu Puji Astiyani, Ega Aditya Prama, Muhammad Akbarurrasyid, Rani Rehulina T, Guntur Prabowo1, Dinno Sudinno, and Miao Sha. 2020. An Economic Analysis Ecoshrimp White Shrimp (*Litopenaeus vannamei*) Concept on Shrimp Culture with Plastic Pond, Indonesia. *Aquacultura Indonesiana, 21 (2): 68-73.* This study presents an economic analysis of white shrimp farming at the different size of ponds. Forty white shrimp farms were selected from two different size of ponds. The sample sizes then were categorized into two scales small size was <1000 m^2, and a large size was >1000 m^2. The first set was the biological, survival rate, and feed conversion ratio, whereas the second set was the economic type, which consisted of input intensity. Multivariate statistical concepts were applied, which included multivariate analysis (MANOVA) is a generalized from of univariate analysis of variance (ANOVA) and principal component analysis. The results showed that both ponds set was significant different (P>0.05) on biological and economic variable. As a result, three major input cost (feed, labor, electricity) were considered in the analysis as they represented more than 80% of the total production cost in the system. The principal component analysis showed that large ponds farm had higher intensity in overall input than a small pond. The study also reported the small size pond was much better according to its overall performance in the benefit cost ratio.

Keywords : Economic, Plastic pond, Statistical, Size of pond, White shrimp

Introduction

Shrimp is the most famous seafood species entering international trade, with about one-third of global shrimp production coming international trade. Worldwide production is approaching three billion MT. Sources include 40 countries, of which 15 produce 80% of the shrimp. Major nations include India, China, the United States, Indonesia, Thailand, Taiwan, and Mexico (Liao & Chien, 2011).

Concerning aquaculture, one of the main species of interest in Indonesia is shrimp L. *vannamei*, or white shrimp is the dominantly farmed species. Introduction of *L. vannamei* has revitalized the industry and bolstered shrimp's position as Indonesia's main fishery export commodity by value. It is estimated that as of 2011, shrimp contributes approximately USD 1.5 billion in exports compared to around 1 billion and 0.2 billion for fish and seaweed exports respectively. With its combination of the highest export value and fastest growth rate among primary aquaculture commodities, shrimp aquaculture could prove to be attractive to companies looking to bolster growth (Halim, 2017).

The objective of our research was to evaluate the interaction effect of two kinds of ponds were small (400 - 600 m^2) and large ponds (1000 m^2) using plastic ponds HDPE (*High-density polyethylene)* in the Pacitan district, East Java Indonesia. Such information should be of interest in the present and future development of white shrimp culture. Some variables (measurements) were taken on each farm in this study for use. All studied variables were interrelated in such a way that their different effect cannot meaningfully be interpreted separately. Our statistical analysis was therefore done using multivariate techniques. Our goal was to provide suggestions on improving white shrimp culture management and thus increasing the profitability of white shrimp in Indonesia.

Material and Method

Data Source

One site, Pacitan district was investigated a major white shrimp using plastic ponds producing area in Pacitan. The research was conducted from July to September 2017. The reason of this study was to evaluating the economics of white shrimp through two different kind of ponds size. To assess and compare the effects of production scale on profitability, production cost and input intensity, the farms were categorized based on kind size of farms were small size <1000m^2 and large size >1000 m^2. A structured questionnaire was used to collect information about economics of the white shrimp. The total of data were 40 farms, were divided into two kind of farms, they are 20 small size <1000 m^2 and 20 large size >1000 m^2) of farms through interview from different location among area in Pacitan district. The data collected from 40 farms contained economic and biological types. The economic data included total revenue (according to unit price and annual production collected) and annual production. The annual production cost was separated into two parts, fixed and variable cost. Depreciation on the capital invested in facilities and equipment was included as fixed cost in the annual operation cost. The variable cost included feed, labor cost and electricity. The biological data consisted of stocking density, survival rate and feed conversion ratio.

Multivariate Statistical analysis

Multivariate analysis of variance of MANOVA is a generalized from of univariate analysis of variance (ANOVA). It is used when there are two or more dependent variables. A one-way multivariate analysis of variance (MANOVA) (Johnson and Wichern, 1998); Stevens, 2002) was applied to examine the effect of biological variable and economic variable on the economic performance of white shrimp. A principal component analysis (Manly, 2004) was further conducted to evaluate the individual economic performances with quantitative comparisons. A computer software developed by SAS enterprise guide 5.1 was used for the preceding analysis with a significant level set at P>0.05.

Result and Discussion

The result showed that the stocking density and survival rate of small and large ponds were significantly different (Table 1) respectively. The production cost of white shrimp farming in the small and large size ponds can be divided into fixed cost and variable cost. The result of economic variable was significant different between two of ponds (Table 2). A principal component analysis was applied by using the three original variables such as: feed, labor, and electricity. After standardization two principal component by using the major input intensity variables I_1 and I_2 (Table 3). For the function I_1 overall input intensities had high coefficients at feed (0.4614), labor (0.6199), electricity (0.0702) respectively. Regarding in function I_2, the coefficient of feed (0.8843), labor (-0.3781), and electricity (0.6874) (Table 3). Furthermore, two principal components in variable biological had been maintained due the percentage they accounted for out of total variation, were I_1 the coefficients of stocking density (0.7831), survival rate (-0.4059) and feed conversion ratio (0.4709). Considering the function I_2 the coefficients of stocking density (-0.0317), survival rate (0.7302) and feed conversion ratio (0.6824) (Table 4). For the function I_1 Benefit Cost Ratio were feed (0.6106), labor (0.5719), and electricity (0.5477), therefore for the function I_2 were feed (-0.1162), labor (-0.6194) and electricity (0.7763) (table 5).

Table 1. ANOVA of biological for two scales farming (small and large ponds)

Factor (s)	*F Value*	*Pr>F*
Stocking Density	59.15	<.0001
Survival Rate	6.73	0.0134
Feed Conversion Rate	2.25	0.1418

Table 2. ANOVA of economic variable for two scales farming (small and large ponds)

Factor (s)	*F Value*	*Pr>F*
Seed cost	59.15	<.0001
Feed cost	4.27	0.0456
Labor cost	26.28	<.0001
Electricity cost	171.10	<.0001
Construction cost	143.46	<.0001

Table 3. Principle component analysis of input cost variable

Principal Component	*Input intensity*		
	Feed (FD)	Labor (LR)	Electricity (EL)
I_1	0.4614	0.6199	0.0702
I_2	0.8843	-0.3781	0.6874

Table 4. Principle component analysis of biological variable

Principal Component	*Biological Variable*		
	Stocking Density	Survival rate	FCR
I_1	0.7831	-0.4059	0.4709
I_2	-0.0317	0.7302	0.6824

Table 5. Principle component analysis of benefit cost ratio

Principal Component	Benefit Cost Ratio		
	BCR feed	BCR labor	BCR electricity
I_1	0.6106	0.5719	0.5477
I_2	-0.1162	-0.6194	0.7763

The average of stocking density in small size was 125.150 m^2 and average of stocking density in large small size was 252.500 m^2. It was high density for both of ponds. There were had reason why the farmer used high density in both ponds which stocking in the morning or evening (calm weather). Farming or culture shrimp using HDPE (High Density

Polyethylene) become popular right now in Indonesia. In some countries, culture in ponds lined with HDPE plastic liners has been proven to be effective as Indonesia faces disease and acid soil problems. In this study, the farmer in both small and large size ponds choose HDPE technology to culture white shrimp because it's easy, can maintain high density of shrimp, and used biofloc to culture become proper management.

The survival rate in both small and large ponds was significantly different from each other in shrimp farming the growth and production of shrimp species depend on population density (Shakir et al, 2014). It is a critical factor for the farmer to determine the optimum stocking density of the animals reared to maximize production and profitability. Two ponds had high density, which affected in survival rate. In the small ponds the survival rate average was 90%, and in the large ponds was 89%. The highly survival rate can reach 80-100% (Duraippah et al., 2000) ,whereas according to (Boyd & Clay, 1998) the survival rate can reach until 91 %. The highly survival rate can achieve because of broods-tock domestication program. It has been initiated to develop shrimp stock that is best suited for the unique cultural conditions of the operation. All shrimp used in the grow-out operations originated from Specific Pathogen Free (SPF) brood-stock from the company High Health Aquaculture.

A summary of feed conversion ratio (FCR) for two scales farming. No significant differences in FCR were detected between farms. In this study both farming had the same on time to give feed in each pond. Timing to feeding shrimp in two farming was in the morning, afternoon, and night. The feed conversion ratio (FCR) of white shrimp in both farming small pond sizes and large pond sizes was high. Although high FCRs indicated that feed was wasted and not consumed by shrimp, pond water quality did not appear to be affected significantly. The production cost of white shrimp farming in small and large sizes ponds can be divided into fixed and variable costs. Therefore, the variable cost includes four individual costs: seed, feed, labor, and electricity. Seed costs between small and large sizes ponds was highly significantly different. In this study, we can know that a large pond has high seed cost compared with the small pond. Differences between small and large size of ponds in seed cost because of the quantity and size of ponds. Bigger in the size ponds higher in the seed cost. White shrimp seed in Pacitan region is mainly supplied by government owned hatcheries either regional or local area with the quality of the seed and SPF (Specific Pathogen Free). The preferred size stocked by the producer was post larva 12 in both of ponds. The seed price in both ponds was the same, was 45 rupiah. Consequently, the seed intensity in Pacitan region farms was higher.

The other two important costs were feed and labor. Both small and large ponds had significant differences in feed cost. The price of feed in both of ponds was the same 15.000 rupiah/kg respectively. Feed management in both of ponds such as small size and large size was had feed dosage 3-4% of the total biomass, which feed proteins contain 34-36%, used feed supplement was vitamin C. Feed is one of the essential inputs to increase shrimp production. Growth of shrimpis is primarily dependent upon an adequate supply of feed, in terms of quality and quantity. The average feed cost (Rupiah/kg) constituted the highest operation cost of large size pond and followed small size pond. (Hatch, 1997) found that intensive farming is characterized bylow fixed costs per kilogram,but have high variable cost mainly for feed and water quality maintenance. Additionally, the feed intensity between scales also revealed that large scale ponds had the highest cost. Therefore, large scale ponds had higher input intensity.

Additionally, white shrimp culture requires intensive labor for daily chopping, feeding, taking care and harvest. Table 2 showed that had profoundly different between small size pond and large size pond. Differences in both of the ponds because of size and area. Regarding the labor input between two ponds were the small size and large size, in large size of pond made labor working extra hours to handle more ponds and contributed to higher labor input. Hence, proper management of labor is needed and the use of modern technology could be directed to created to create work efficiency.

The other significant cost in small and large ponds is electricity. There were extremely significant different 0.<0001 between small size pond and large size pond. In this study, we can see that large size pond had the highest cost compare with small size ponds. In many cases, they account for more than 50% of the total production cost (Shang, 1990). Hence this same case with construction cost between small size pond and large size pond. The large size pond needs more cost to build construction in pond compare with small size pond.

A principal component analysis was applied by using the three original variables such as : feed, labor, and electricity. After standardization two principal component by using the major input intensity variables (I1 and I2), had been maintained based on the table 3. As a result of the table 3, any farms had higher in feed, labor and electricity. Therefore, I_1 could be referred as an index of measuring intensity of feed, labor and electricity. Regarding in function I_2 (table 3) determine not only an absolute quantity of I_2 but also a direction (with a sign of plus or minus). An increasing pattern of I_2 indicated that any farm or two kind of ponds had high score in I_2 would be spending more unit input in labor, but decreasing pattern indicated that conversely. Therefore, the function I_2 can be defined as an index of an input intensity contrast between feed, labor and electricity for a given farm.

Furthermore, two principal components in variable biological had been maintained due the percentage they accounted for out of total variation (Table 4). In the case I_1 (Table 4) were had positive and minus value. That is meaning the coefficients of stocking density and feed conversion ratio had more weighing effect compare survival rate. As result I_1 can be defined as a contrast between stocking density and survival rate. The related position of ponds in the plot I_1 and I_2 most of large size of ponds located at the I_2, that had high stocking density and feed conversion ratio and small in survival rate. As we know that higher in stocking density it will less in the survival rate on the white shrimp culture. It because they had competition in the life.

A principal component analysis was also applied to benefit cost ratio variables (Table 5). For the function I_1 BCR (Table 5) were all positive and high. That means the value of the function I_1 is mainly determined by coefficient of BCR feed, BCR labor and BCR electricity. Therefore, this function can be defined as an index of overall benefit cost ratio for a given ponds. These two kinds of ponds, the small size pond was much better according to its overall performance in the benefit cost ratio based on their score of I_1.

Concerning both small and large ponds we can explain that large pond had the highest input intensity for overall input intensity variables: seed, feed, labor, electricity and fix cost as mention costruction in this study; whereas the small size pond had the lowest input intensity for the overall variables. Indeed, the framers who operated or culture white shrimp in small pond farms had lower input cost per unit area (m^2) than those who operated large size pond farms in the Pacitan district. This could be explained by the price of labor, electricity and mostly for feed input, which could vary according tp the size of the farm.

Reference

Boyd, C.E., & Clay, J.W. 1998. Shrimp aquaculture and the environment. America: Scientific American. 58-65p.

Duraippah, Israngkura A., & Sae Hae, S. 2000. Sustainable Shrimp Farming: Estimation of Survival Fuction. CREED Publicion. 31p.

Halim, D. 2017. Indonesia's Aquaculture Industry. Ipsos Business Consulting.

Hatch, U., and T.C. Feng. 1997. A survey of Aquaculture Production Economics and Management. Aquaculture Economics & Management, 1(2):13-27.

Johnson R.A., & D.W Wichern. 1998. Applied Multivariate Statistical Analysis, 2nd edn. Prentice-Hall, Englewood Cliffs, NJ. 607p.

Liao. I. C.,& Chien. Y. H. 2011. The Pacific White Shrimp, Litopenaeus vannamei, in Asia: The World's Most Widely Cultured Alien Crustacean. In the Wrong Place-Alien Marine Crustaceans: Distribution, Biology and Impacts 10:489-519.

Manly, B.F.J. 2004. Multivariate statistical methods: a primer (3rd edition ed.). New York: Chapman and Hall. 159p.

Shakir C., Lipton A. P., Manilal A., Sugathan S., Selvin J. 2014 Effect of stocking density on the survival rate and growth performance in Penaeus monodon. Journal of Basic & Applied Sciences 10:231-238.

Shang, Y. 1990. Aquaculture economic analysis: an introduction In: Advances in World Aquaculture. Baton Rouge, LA. World Aquaculture Society.

Steven, J.P. 2002. Applied multivariate statistic for the social sciences. Mahwah, New Jersey. Lawrence Erblaum Associate. Inc.