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Litopenaeus vannamei Shrimp Aquaculture Development Strategy in Patutrejo Village, Purworejo Regency, Central Java

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Abstrak: Desa Patutrejo merupakan desa yang berbatasan langsung dengan Samudra Hindia di bagian selatan sehingga mendukung kegiatan budidaya tambak udang vaname. Namun beberapa tahun terakhir, petambak mulai menghadapi kendala tingginya intensitas gagal panen sehingga jumlah petambak di lokasi menurun. Minimnya informasi yang didapatkan petambak mengenai penanganan penyakit dan teknik budidaya yang baik juga memperparah kondisi budidaya di lokasi penelitian. Berdasarkan hal tersebut tujuan dari penelitian ini yaitu (1) menganalisis pendapatan budidaya udang vaname, (2) menganalisis faktor-faktor yang memengaruhi keputusan petambak untuk melanjutkan budidaya, (3) menyusun strategi pengembangan budidaya. Metode penelitian yang digunakan adalah analisis pendapatan, regresi logistik dan *anaylthical hierarchy process*. Analisis pendapatan dengan asumsi harga yang digunakan adalah harga dan volume rata-rata pada siklus pertama 2024 didapatkan hasil bahwa R/C rasio lebih dari satu, sehingga budidaya udang vaname di Desa Patutrejo masih menguntungkan. Analisis regresi logistik biner mengungkap bahwa luas lahan dan pendapatan petambak menjadi faktor utama yang memengaruhi keputusan petambak dalam menlanjutkan budidaya udang vaname. Upaya untuk meningkatkan pendapatan dan minat petambak berbudidaya dapat dilakukan dengan menurunkan angka gagal panen. Strategi untuk mencapai tujuan tersebut dilakukan dengan pelatihan budidaya ikan yang baik dan penyebaran informasi penanganan penyakit udang.

Kata Kunci: analytical hierarchy process, faktor keputusan budidaya, manajemen penyakit, R/C rasio

Abstract: *Patutrejo Village, which is directly adjacent to the Indian Ocean in the south, is suitable for vaname shrimp aquaculture. However, in recent years, farmers began to face the problem of high-intensity harvest failure, resulting in a decline in the number of farmers in the location. The lack of information obtained by farmers regarding disease management and good cultivation techniques also exacerbates the condition of cultivation in the study location. The aims of this study are (1) to analyze the income of vaname shrimp farming, (2) to analyze the factors that influence farmers' decision to continue shrimp aquaculture, and (3) to develop a strategy for shrimp aquaculture development. The methods used to answer the research question are income analysis, logistic regression and an analytical hierarchy process. Income analysis with the assumption of average price and harvest volume in the first cycle of 2024 gives results that the R/C ratio is more than one, so vaname shrimp farming in Patutrejo Village is profitable. Binary logistic regression analysis revealed that land area and farmer income were the main factors influencing farming decisions to continue shrimp aquaculture. Reducing the number of harvest failures could increase farmers' income and farming interest. In the preparation of aquaculture development strategies based on the RPJMN and Purworejo District Strategic Plan, the Analytical Hierarchy Process (AHP) recommends training in good fish farming and dissemination of information on shrimp disease management.*

Keywords: analytical hierarchy process, farming decision factors, disease management, R/C ratio

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INTRODUCTION

Purworejo Regency is one of Central Java Province's regencies with potential fishery resources because it has an extensive coastline area of 21.5 km, most of which is sandy (Bappedalitbang, 2023). Shrimp aquaculture is growing in the southern region of Purworejo Regency, and the specific commodity is vaname shrimp. These farmers utilize the south coastal area for aquaculture activities. According to statistical data in 2023, Purworejo District shrimp farming was ranked fifth in Central Java with shrimp production of 3,039,492 kg and a production value of Rp159,035,341. This value contributed 11.09% of the total value of shrimp production in Central Java in 2023. The low productivity and value of shrimp production in Purworejo Regency compared to four other districts in Central Java is due to the need for more optimization of main commodities on the south coast of Java. According to Fatimah (2021), the low economic growth in the southern coastal areas of Java is due to difficult infrastructure access and coastal areas that are very prone to disasters, especially high sea waves, causing infrastructure development to be less rapid than in the northern coastal areas of Java. In addition, shrimp farming in Purworejo also faces challenges such as rising production costs and disease outbreaks (Santosa et al., 2022). Vaname shrimp farming activities in the southern coastal of Purworejo are also considered to cause negative impacts of waste pollution (Airawati *et al*., 2023).

Patutrejo Village is one of the villages in Grabag Subdistrict, Purworejo Regency, Central Java, which has a coastal area and directly face the south with the Indian Ocean. Vaname shrimp farming is conducted semi-intensively with a seed stocking density of 80-100 fish/m^2 and a 300 m^2 - 1,200 m^2 pond size. Vaname shrimp farming in Patutrejo village has been operating since 2009, but in the past four years, farmers began to face several challenges that have caused harvest failure. This is reflected in the results of the volume and value of shrimp aquaculture production in Purworejo Regency from 2017-2023, which tends to decline (Dinkominfo, 2023)

One of the obstacles faced by pond farmers is the disease outbreak that attacks shrimp. According to research conducted by Airawati *et al.,* (2023) and Hanifah (2017), one of the diseases that attack vaname shrimp in Patutrejo Village is WSSV (White Spot Syndrome Virus), better known as white spots and WFD (White Feces Disease). This disease can arise due to low levels of Dissolved Oxygen (DO) and high concentrations of ammonia (Alfionita, 2022). Based on interviews with the Purworejo Regency Fisheries Service, the absence of wastewater disposal facilities is one of the causes of contaminants from shrimp waste being carried back with seawater into new pond preparation containers. Since the beginning of its development until now, shrimp pond waste in Patutrejo Village has only been discharged directly into the sea without any special treatment. The lack of shrimp farmers' knowledge regarding treating shrimp disease causes harvest failure.

Harvest failures that occur cause the low production, which decreases farmers' incomes. The costs incurred for operational activities are not proportional or greater than the income received by farmers. Suppose there is a continuous harvest failure without any capital assistance, farmers must stop doing vaname shrimp farming activities because they need more capital to provide farming inputs. In 2023, according to data from the Patutrejo Village Office, only 47 shrimp farmers remained. The number of farmers who chose to stop shrimp farming is reflected in the number of former farming ponds that are no longer used for vaname shrimp farming in the research location. In addition, the low level of understanding of shrimp farming in a controlled environment is reflected in the small number of farmers who get the CBIB (Good Aquaculture Practices) certificate. The certification results of some farmers indicate that vaname shrimp farming in Patutrejo Village is still in the adequate category, which means that the process of vaname shrimp farming activities in the research location still needs to be improved. The limited understanding of farmers regarding good shrimp maintenance is also reinforced by the results of research conducted by Nugroho *et al*., (2018) where farmers use ineficient feed and probiotics in their aquaculture practices.

Based on information provided by the Purworejo Regency Fisheries Service in 2024, the minimum number of fisheries extension workers to conduct counseling and supervision activities is also one of the obstacles that occur. Only now have farmers received much assistance from various parties in handling these constraints, especially diseases that attack shrimp. Therefore, the stakeholders especially related agencies need to provide technical guidance and capital assistance for the aquaculture development to sustain and expand vaname shrimp farming. Based on the background, this research are aimed to answer this following questions; 1) What is the income of vaname shrimp farmers in Patutrejo Village?; 2) What factors influence people's decision to farm vaname shrimp in Patutrejo Village?; 3) What strategies are formulated to develop vaname shrimp farming in Patutrejo Village?.

METHODS

Location and Time of Research

This research was conducted in Patutrejo Village, Grabag District, Purworejo Regency, Central Java. Data were collected from March to June 2024. This location is chosen because farmers in this location facing the problem of limited capital and a substantial risk of crop failure. However, there is potential possibility that vaname shrimp aquaculture can continue to grow because the price of shrimp in the region is stable as well as the southern coastal region has abundant water discharge.

Type and Source of Data

The types of data used in this study are primary and secondary. Primary data was obtained through direct observation and interviews using questionnaires to Vaname shrimp farmers for the first and second objectives. Then, to answer the third objective, primary data was obtained from questionnaires sent to key persons. Secondary data is complementary data of primary data sourced from relevant literature.

Sampling Methods

The data collection method used was purposive sampling, aimed only at farmers who were still actively conducting Vaname shrimp farming business until the first cycle in 2024 and farmers who had been doing aquaculture in the research location for at least one year. Sample in this study is determined with census method according to the number of vaname shrimp farmers in Patutrejo Village in 2023. There are 33 farmers which will be assessed for their shrimp aquaculture practice. Meanwhile the sample to answer the second objective using *snowballing* sampling as many as 17 people. Determination of the development strategy of vaname shrimp aquaculture in this study using data from interviews with questionnaires with representatives of the Department of Environment and Fisheries Purworejo District, former head of the aquaculture group, as well as representatives of shrimp wholesalers.

Data Processing Methods

Income Analysis

Farm income is the difference between the revenue earned by farmers and all costs incurred by farmers. According to Soekartawi (2002), farming income can be formulated as follows:

$$\Pi = TR - TC \quad (1)$$

where

Π = Income vaname shrimp farming aquaculture (Rp)
TR = Total revenue of vaname shrimp aquaculture (Rp)
TC = Total cost of vaname shrimp aquaculture (Rp)

Revenue is the result of multiplying the amount of production by the selling price of the product. Farm revenue, according to Soekartawi (2002), is expressed in the formula:

$$TR = P \times Q \quad (2)$$

where

TR = Total revenue of vaname shrimp aquaculture (Rp)
Q = Vaname shrimp production volumes (kg)
P = Vaname shrimp price (Rp/kg)

In revenue analysis, the average volume of shrimp production is calculated based on the average survival rate (SR) multiplied by the initial number of fry in one culture pond. SR calculation is expressed in the following formula (Haliman & Adijaya, 2005):

$$SR = \frac{Nt}{N0} \times 100 \quad (3)$$

where
SR = Survival Rate (%)
Nt = Quantity of shrimp at harvest (heads)
No = Quantity of initial stocking density (heads)

Costs are all that incurred for the use of production factors to produce specific outputs. Cash costs are costs farmers incur in buying inputs, while non-cash costs are the value of using goods and services from farming activities. Cash costs can be formulated as follows (Firdaus, 2008):

$Bt = TFC + P_{X1} . X1 + P_{X2} . X2 + P_{X3} . X3 + P_{X4} . X4 + P_{X45} . X5 + P_{X6} . X6 + P_{X7} ..X7$ ……………………………............(4)

where
Bt = Cash Cost (Rp)
TFC = Total Fixed Cost (Rp/1.000m^2)
P_{X1} = Shrimp Fry Price (Rp/head)
P_{X2} = Shrimp Feed Price (Rp/kg)
P_{X3} = Probiotics Price (Rp/litre)
P_{X4} = Plankton Mineral Grower Price (Rp/litre)
P_{X5} = Vitamin Price (Rp/kg)
P_{X6} = Chalk Price (Rp/kg)
P_{X7} = Gasoline Price (Rp/litre)
X1 = Quantity of Shrimp Fry (head/1.000m^2)
X2 = Quantity of Feed Price (kg/1.000m^2)
X3 = Quantity of Probiotics (litre/1.000m^2)
X4 = Quantity of Plankton Growing Mineral (litre/1.000m^2)
X5 = Quantity of Vitamin (litre/1.000m^2)
X6 = Quantity of Chalk (kg/1.000m^2)
X7 = Quantity of Gasoline (litre)

Other cash costs in this study include electricity, laboratory costs, maintenance of water pumps and generators, and non-family labour. In the calculation of feed costs, the feed conversion rate (FCR) formula was used to see the end-of-harvest feed conversion rate. The FCR value is used to assess the effectiveness of farmers' feeding. The FCR calculation can be formulated as follows (Ridlo & Subagiyo, 2013):

$FCR = \frac{F}{W}$ ………………………...(5)

where
FCR = *Feed Conversion Rate*
F = Total feed (kg)
W = Volume of total harvest (kg)

Non-cash costs include depreciation and intra-family labour, calculated using HOK. Depreciation costs can be formulated as follows:

$\text{Depreciation cost} = \frac{Nb-Ns}{N}$ …………………...........……..…………..........….....(6)

where
Nb = Purchase Value of Aquaculture Tools (Rp)
Ns = Residual Value of Aquaculture Tools (Rp)
N = Economic Life of Aquaculture Tools (year)

Labor in vaname shrimp farming is calculated based on person-days (HOK). Labor costs in farming can be calculated using the following formula (Mahdalia, 2012):

$HOK = \frac{JK\ total}{JKS}$ ……………………………………..…………………….................(7)

where
HOK = Working days
JK total = Total working hours (hours)
JKS = Standard working hours (8 hours)

The R/C ratio is the ratio between revenue and costs incurred in farming. If the R/C ratio value exceeds 1, every rupiah spent on vaname shrimp farming activities will generate more significant revenue than one. The greater the R / C ratio value obtained, the greater the profit farmers will obtain. The calculation of the R / C ratio can be calculated using the following formula Soekartawi (2002):

R/C rasio = $\frac{Revenue}{Cost}$ ………………………………………………………………………………………………(8)

Logistic Regression Analysis

Logistic regression is used to model the relationship between two categories (binary) of outcome variables (dependent/ independent variables) and two or more explanatory variables (independent/binding variables). The dependent variable (Y) of this study consists of two possibilities, i.e., farmers continue farming (Y=1) or farmers stop farming (Y=0).

$Y = \ln [\frac{P}{1-P}] = \beta 0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$ ………………………………………………………………………………(9)

Where;

Y = Farmer's decision

(Y=1) = aquaculture farmers continue to cultivate; (Y=0) = aquaculture farmers stop to cultivate

β0 = Contant/Intercept

$\beta_{1,2,3,4}$ = Regression coefficient

X_1 = Age of active and inactive aquaculture farmers (year)

X_2 = Educational level (year)

X_3 = Land area (m^2)

X_4 = Aquaculture income (Rp/cycle)

The binary logistic regression model will be evaluated with several statistical tests to understand whether the variables and models used are meaningful individually or as general model. According to Ghozali (2006), research generally uses a 1%, 5%, or 10% significance level. The statistical tests that are tried are as follows:

a. Goodness of Fit Testing
   To understand the goodness of fit of the model used, Hosmer and Lemeshow's Goodness of Fit Test with the Chi-square ($\chi 2$) approach is required. The test criteria state that if the sig. Hosmer and Lameshow Test>α, there is no difference between observations and predictions, or the model is suitable.
b. Odds Ratio
   The odds ratio measures risk or the skewed odds of facing a particular event between categories. A positive coefficient indicates an odds ratio value greater than one, which means the chance of a successful event is greater than the chance of an unsuccessful event (Juanda, 2009).
c. Wald Test
   The Wald test is used to determine whether or not the effect of each variable coefficient is natural. The test criteria are that if the sig value>α, the independent variable does not affect the dependent variable.

***Anaytical Hierarchy Process* (AHP)**

In determining the development strategy of vaname shrimp farming in Patutrejo Village, the research used the Analytical Hierarchy Process (AHP) method. According to Saaty (1990) at the problem decomposition stage. The first step that must be done to determine the development strategy of aquaculture is to structure the problem into a hierarchy consisting of several levels (Saaty, 1990). The first level is the goal expected from the analysis: developing sustainable and environmentally friendly vaname shrimp farming. At the next level for the criteria are development strategies that include 1) Shrimp disease management, 2) Increased income of farmers, and 3) Increased sustainability of fisheries resources. Then, the last level is an alternative program that can be held to support the development strategy of vaname shrimp farming. Elements at the first level to the last level in this study were prepared based on the framework of the National Medium-Term Development Plan (RPJMN) 2020-2024, which is reinforced by the Strategic Plan (Renstra) of Purworejo Regency 2021-2026 regarding the development of aquaculture areas.

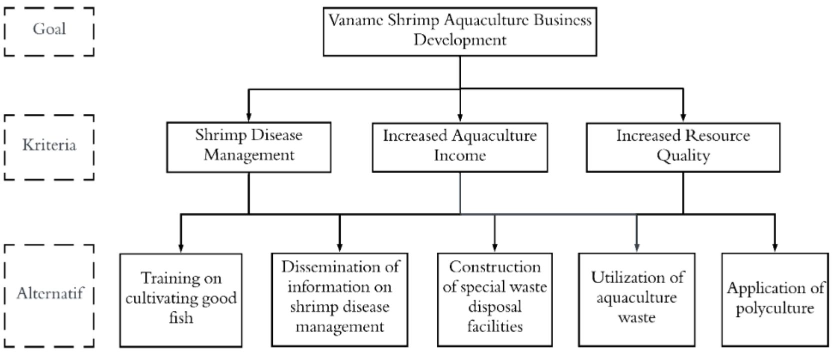

Figure 1. AHP Hierarchy Structure

The assessment used in this study results from the assessment of key persons using a scale representing the level of importance of the available alternative options. The scale of importance refers to the scale developed by Saaty (1990), as shown in Table 1.

Table 1. Element Importance Scale

Scale	Description
1	Choice (A) is as important as choice (B)
3	Option (A) is a little more important than option (B)
5	Option (A) is more important than option (B)
7	Option (A) is very important compared to option (B)
9	Choice (A) is definitely more important than choice (B)

Source: (Saaty, 1990)

This process of assessing between options continues for all criteria. The last step of the AHP method is synthesizing assessment results, where each choice obtains the sum of the weights on each criterion after being given a weight. The higher the value of an option, the higher its priority, and vice versa.

RESULTS AND DISCUSSION

Income Analysis of Vaname Shrimp Farming

Aquaculture Revenue

The income from farming activities received by the shrimp farmers varies from one farmer to another. The income received by the pond farmers comes only from the sale of harvested vaname shrimp. In this study, the calculated revenue is the average revenue of 33 respondents per 1,000 m^2 pond based on farming cycle in 2024.

Table 2. Vaname Shrimp Harvest Analysis Data

Description	Units		Total
Pond mapping	m^2	A	1.000
Stocking densities	heads/m^2	B	104
Survival Rate (SR)	%	C	45,84
Size	heads/kg	D	47
Harvest Yield	kg	((a*b)/c)/d	1.014
Period	Days		100

Based on the data in Table 2, in a 1,000 m^2 pond area, the average shrimp survival rate (SR) is 45.84%. Based on the Indonesian Good Agriculture Practices (GAP) reference reflected through SNI 8037.1: 20.14, the standard SR for vaname shrimp culture with a rearing period of 80-100 days is more than 80% (SNI, 2014). Low SR can be caused by poor seed and water quality, so the shrimp fry fails to adapt (Dewi et al., 2022). The average survival rate (SR) value obtained shows that the average production volume farmers can produce is 1,014 kg.

Table 3. Vaname Shrimp Aquaculture Revenue

Size	SR (%_	Quantity (kg)	Price (Rp/kg)	Revenue
40 – 60	90%	912,90	68.182	62.243.260
>60	10%	101,43	50.000	5.071.659
	Total Revenue (Rp)			67.314.920

Based on the data in Table 3, the average selling price of vaname shrimp from the first cycle in 2024 was Rp 68,182/kg. Vaname shrimp farming in Patutrejo Village produces size 40-60 shrimp per kg, with a weight per shrimp reaching 16-25 grams. The harvest time is 100-110 days with a selling price of Rp60,000 to Rp80,000 per kilogram. Based on the farmers interview, the percentage of harvested shrimp with size 40-60 is only 90% of the total harvest volume, and the rest is BS (below standard) quality shrimp, which has a size below the average criteria and has defects in the shrimp body. These BS shrimps are usually sold directly to the local market by farmers for Rp50,000/kg. According to research conducted by Utami et al. (2014) the volume of shrimp production varies every cycle depending on land area, feed, stocking density, labour use, and technology used by each farmer.

Vaname Shrimp Aquaculture Costs

Aquaculture costs are all expenses incurred to purchase farming inputs, consisting of cash costs and calculated costs (non-cash costs). Cash costs are costs that are borne by farmers in the form of cash. Meanwhile, non-cash costs are costs that are calculated or costs that should be incurred by farmers and converted to cash costs. The cost structure of vaname shrimp aquaculture in Patutrejo Village can be seen in Table 4.

Table 4. Vaname Shrimp Aquaculture Cost Per 1.000 m^2

Description	Cost (Rp/cycle)	Percentage (%)
1.) Cash Cost		
Shrimp fry	5.573.665,28	10,94%
Shrimp feed	33.351.590	65,44%
Probiotics	857.496,26	1,68%
Plankton Growing Minerals	250.389,62	0,49%
Vitamin	431.020,26	0,85%
Dolomite Chalk	24.341,10	0,05%
Limestone Chalk	118.583,18	0,23%
Omya Chalk	109.515,52	0,21%
Power	9.134.835	17,93%
Laboratory	192.000	0,38%
Machine Maintenance	117.879	0,23%
Gasoline	300.000	0,59%
Non-family labour	500.000	0,98%
Total Cash Cost	**50.961.315**	100,00%
2.) Non-Cash Costs		
Depreciation Cost	1.361.374	19,26%
Family labour	5.705.625	80,74%
Total Non-Cash Cost	**7.066.999**	100,00%
Total Cost	**58.028.314**	

a) Cash Cost

Cash costs are costs incurred directly by the farmer. The average use of fry in vaname shrimp aquaculture in Patutrejo Village was 104,092 fry per 1,000 m2 with an average fry price of Rp54/head. The overall average use of feed in vaname shrimp aquaculture in Patutrejo Village was 1,981.75 kg, with an average feed price of Rp19,000/kg for powdered feed and Rp16,800/kg for granular and pelleted feed. The feed is the cost component with the highest percentage. In this study, feed cost is the most significant component in cash costs, amounting to 65.44% of total cash costs expended by farmers. This result align with research conducted by Khatimah (2019), where feed costs are the most significant component in vaname shrimp aquaculture, which amounted to 66.50% of total operational costs. Based on the calculation, the feed conversion ratio (FCR) value at the end of harvest, it was found that the feed conversion value was 1.95. The high FCR indicates that the feed could have been more efficient because the feed remains and has not been entirely eaten by shrimp. Based on research conducted by Ariadi et al. (2019), it was found that the FCR value has a positive effect on the operational costs of farmers, if the FCR value is low, the operational costs will be more efficient. This is because ≥50% of the operational costs of aquaculture activities are feed costs. The average use of probiotics in vaname shrimp aquaculture in Patutrejo Village was 17.08 litre, with the price of probiotics amounting to Rp50,194/litre. The average use of plankton growth minerals in one cultivation cycle per 1,000 m2 is 8.78 litre, and the price of these minerals amounts to Rp28,530/litre. The average use of vitamins is 2.92 kg, and the average price is Rp147,485/kg. The average volume of dolomite chalk used per cultivation cycle per 1,000 m2 was 22 kg, and the price of dolomite chalk was Rp1,121/kg. The average volume of omya chalk was 36 kg, with an average price of omya chalk of Rp3,049/kg. The average volume of chalk used was 77 kg, with a chalk price of Rp1,545/kg. Electricity is used to power the waterwheel in 24 hours for 90 days. The total cost of electricity required in one cycle is Rp9,134,835/cycle. Farmers conduct routine water quality checks once a week. The total laboratory costs required by farmers in one cycle amounted to Rp192,000/cycle. The average water pump engine maintenance cost required in one cultivation cycle amounted to Rp117,879/cycle. The average volume of gasoline needed to drive a water pump for 5 days in one cultivation cycle is 30 litres with a gasoline price of Rp10,000/litre. Non-family labour is responsible for netting and clean the sediment pond. The average cost required to pay the wages of these non-family labourers in one day of harvesting is Rp80,000 - Rp100,000/day/person.

b) Non-Cash Costs

In vaname shrimp aquaculture, non-cash variables include family labour and depreciation costs. Conduct vaname shrimp aquaculture activities with a land area of 1,000 m2, which can be done with only 1 person, starting from land preparation to shrimp enlargement. All labour activities during the cultivation process are converted into HOK units (Person Days of Work). The average cost of family labour incurred by farmers per 1,000 m^2 per cultivation cycle is Rp5,705,625. Agricultural tools calculated in depreciation include water pump machines, waterwheels, HDPE (High-Density Polyethylene) tarpaulins, nets, water pipes, and spiral hoses. Assuming that cultivation activities are conducted three times a year, the total depreciation cost of cultivation is Rp1,361,374/cycle.

Aquaculture Income

Income is the net revenue received by farmers. Details of vaname shrimp aquaculture income analysis in Patutrejo Village can be seen in Table 5.

Table 5. Vaname Shrimp Aquaculture Income

Desciption		Total (Rp/1000m²/year)
Revenue	A	67.314.920
Cash Cost	B	50.961.315
Non-cash Cost	C	7.066.999
Cash Income	**a – b**	**16.353.605**
Total Income	**a - (b+c)**	**9.286.606**
Cash R/C Ratio	a/b	1,321
R/C Ratio Total	a/(a+b)	1,160

Based on the data in Table 5, the average income on cash costs obtained by farmers is Rp16,353,605/1,000m2/cycle, while the average income on total costs obtained by farmers is Rp9,286,606/1,000 m2/cycle. The R/C ratio value on cash costs of 1.321 indicates that every Rp 1.00 cash cost incurred by farmers in Patutrejo Village will generate revenue of Rp 1.321. Meanwhile, the R/C ratio on total costs of 1.160 indicates that every Rp1.00 spent by farmers in Patutrejo Village will generate revenue of Rp1.160.

Factors that Influence Aquaculture Farming Decisions

Factors influencing farmers to continue vaname shrimp cultivation activities in Patutrejo Village are analysed by logistic regression. Independent variables that are the presumptive factors in the study are age (X1), education level (X2), land area (X3), and farm income (X4). In contrast, the dependent variable is the community's decision to continue the vaname shrimp aquaculture business.

Logistic Regression Results

The dependent variable is the community's decision to continue vaname shrimp aquaculture. It is classified into two groups: people who continue aquaculture activities (Y = 1) and people who stop their aquaculture activities (Y = 0). Logistic regression results in determining the decision of farmers to cultivate can be seen in Table 6.

Table 6. Factors influencing farmers' decision to aquaculture vaname shrimp

Number	Description	Beta Coefficients	Sig. Value	Odds Ratio
1	Farmer’s Age	-6,580	0,420	0,0014
2	Education level	-4,806	0,494	0,0082
3	Land area	4,129	0,071*	62,1109
4	Aquaculture income	5,275	0,056*	195,3256
5	Constant	-42,521	0,380	0,000
	Omnibus test (Sig.)		**0,000000000176**	
	Nagelkerke R Square		**0,890**	
	Hosmer and Lemeshow Test		**0,871**	

*) Significant at 10% confidence level

At a confidence level of 10%, the logistic regression model is based on substituting the estimated coefficients:

$$Y = -42{,}521 - 6{,}580X_1 - 4{,}806X_2 + 4{,}129X_3 + 5{,}275X_4$$

1. Omnibus test significance test. The significant value generated in the Omnibus test is 0.000000000176, which means that the model is significant at a confidence level of 10%, and the independent variables used together affect the model.
2. Nagelkerke R Square test. The Nagelkerke R Square value obtained based on Table 18 is 0.890, so the model's independent variables can explain the dependent variable by 89%, and other variables outside the model explain the rest.
3. Goodness of Fit Test (Hosmer and Lemeshow Test). The significance value obtained is 0.871, so the model is suitable for explaining the dependent variable because it is more significant than the 10% confidence level.

Factors Influencing Farmers' Decisions

Logistic regression with a significant level of 10% is showed that some variables have significant effect on the decision of farmers to continue the farming activities of vaname shrimp farming. The detail description of this significant variable are detailed below:

1. Land area
   The significance value obtained is 0.071, smaller than the confidence level of 10%. The beta value and odds ratio obtained are 4.129 and 62.11. This indicates that the larger land owned by farmer, the probability of farmers continuing the farming activities of vaname shrimp ponds is 62.11 times. This result is in line with research conducted by Afista et al. (2021), which states that land area is one of the factors that positively affect farmers' interest in farming.
   This is reinforced based on data in the field where farmers who stop farming on average only have a land area between 1,000 m^2 - 3,000 m^2, while farmers who continue cultivation activities have an average land area between 2,000 m^2 - 5,000 m^2.
2. Aquaculture income
   The significance value obtained is 0.056, smaller than the confidence level of 10%. The beta value and odds ratio obtained is 5.275 and 195.33. This indicates that the higher the income farmers earn, the

chances of farmers continuing the farming activities of vaname shrimp ponds are 195.33 times larger. These results are in line with research conducted by Jusmadi et al. (2024), where the results show that the income variable has a very positive effect on farmers' interest in farming. According to research conducted by Ambarita et al. (2022), income is considered very influential on the sustainability of farming because income is the primary capital for further farming activities.

Factors That Do Not Influence Farmers' Decisions

Variables that do not have a significant effect on the decision of farmers to continue vaname shrimp aquaculture activities or prefer to stop farming ponds are:

1. Farmer's Age
   The significance value obtained is 0.42, greater than the confidence level of 10%. This is in line with research conducted by Muhammad et al. (2016), where the age variable has no significant effect on farmers' interest in farming. The average age of active farmers and those who have stopped farming ranges from 46-55 years, with minimal participation of young people in vaname shrimp farming. Susilowati (2016) research shows that the number of young farmers is declining because the agricultural sector is considered less prestigious and less financially promising.
2. Education level
   The significance value is 0.494, which is more significant than the confidence level of 10%. Research conducted by Anggraini et al. (2019) also stated that farmers' education level did not affect their interest in farming.

Aquaculture Development Strategy

The designed alternative strategies in this study aims to build efforts to develop vaname shrimp farming activities in Patutrejo Village, Purworejo Regency, using the Analytical Hierarchy Process (AHP) method with Super Decisions V2.X software.

Criteria Level Pairwise Comparison Assessment Results

Based on Table 7, shrimp disease management (50.94%) is ranked as the first compared to other criteria. According to the results of discussions and interviews that have been conducted, until now, farmers have not been able to take care of the shrimp they cultivate if their shrimp is attacked by disease, resulting in the mass death of shrimp. If shrimp disease management is conducted, the risk of decreased productivity of vaname shrimp farming will be more negligible, and farmers' income is expected to increase.

Table 7. Criterion Level Pairwise Comparison Results

Criteria	Normalized	Idealized	Ranking
Shrimp Disease Management	0.509374195	1	1
Increased Aquaculture Income	0.406839893	0.798705346	2
Increased Resource Quality	0.083785911	0.164487938	3

The second rank of the criteria level is the increase in farmers' income (40.68%). The occurrence of increased income is the main reason for farmers to continue to conduct vaname shrimp farming activities. Increased income can be achieved by increasing shrimp production, efficient use of aquaculture inputs, polyculture activities and the utilization of cultivation waste into more valuable goods.

The third rank of criteria is the sustainability of resources (8.38%). In this case, the improvement of resource sustainability is to maintain seawater quality as the primary production input in aquaculture activities. Direct waste disposal to the shore causes the seawater to be polluted with waste. When polluted seawater enters the culture pond, the risk of shrimp disease increases due to high ammonia levels and will lead to crop failure. Therefore, creating a unique location for aquaculture waste disposal away from seawater is necessary.

Alternative Level Pairwise Comparison Assessment Results

The results of processing using Super Decisions V2.X software can be seen in Table 8. The result of pairwise comparison assessment of the highest alternative level is training on cultivating good fish

(19.10%). Good aquaculture training is in the form of continuous intensive technical guidance to farmers over a certain period. The guidance program can be started by providing direction on determining quality fingerlings, efficient feeding according to DOC (Day of Culture) and shrimp weight, probiotic dosing rules, and good shrimp care according to predetermined standards to assist in routine checking of pond water quality. In addition, is important to assist farmers on routine sampling activities to monitor the development of shrimp and reporting through bookkeeping (Amrial & Rahayu, 2021).

Table 8. Alternative Level Pairwise Comparison Results

Alternative	Total	Normalized	Idealized	Ranking
Training On Cultivating Good Fish	0,1910	0,3819	1	1
Dissemination Of Information on Shrimp Disease Management	0,1465	0,2930	0,7671	2
Construction Of Special Waste Disposal Facilities	0,0732	0,1464	0,3832	3
Application Of Polyculture	0,0552	0,1104	0,2889	4
Utilization Of Aquaculture Waste	0,0342	0,0684	0,1790	5

The second alternative is the dissemination of information on shrimp disease management (14.65%). The lack of knowledge of farmers about the signs of shrimp that have been attacked by disease and how to manage shrimp when contaminated with disease causes crop failure. It is necessary to educate farmers about how to manage shrimp disease and to promote early awareness of the symptoms in order to minimize the number of crop failures that occur in the research location.

The third alternative is the construction of special waste disposal facilities (7.32%). Based on research conducted by Airawati et al. (2023), it was found that in the sustainability analysis, the less sustainable dimension is waste treatment, so encouragement is needed to use environmentally friendly and efficient technology. Small-scale aquaculture activities are challenging when implementing complex waste treatment technology, considering the low availability of capital. However, farmers can make special facilities for disposing of aquaculture waste located far from the shore so that seawater is not directly contaminated with waste.

The results of pairwise comparison analysis of the fourth alternative is the application of polyculture (5.52%). Income level is the main reason for farmers' sustainability in aquaculture activities. To increase farmers' income, polyculture activities can be conducted between shrimp and other fishery commodities that do not endanger the existence of shrimp in the pond. In addition to the basic training provided to farmers, training related to innovations in supporting the increase of community income can also be carried out, such as polyculture systems of vaname shrimp and milkfish, which are more profitable than monoculture vaname shrimp aquaculture systems (Lestari *et al*., 2023).

The results of pairwise comparison analysis of the last alternative is the utilization of aquaculture waste (3.42%). Aquaculture waste can be utilized to support circular economy activities and increase farmers' income through other production products besides the main commodity. The drying product of aquaculture can be used as valuable products, such as fertilizer and animal feed. Research conducted by Sari et al. (2023) states that the Mina Bahari Fish Farmer Group of Pasir Sakti Lampung succeeded in processing liquid waste from vaname shrimp farming that could still be used as liquid organic fertilizer.

CONCLUSION

Based on the R / C ratio value, the total cost generated has more than one value, meaning that vaname shrimp farming activities in Patutrejo Village, Grabag District, still provide a profit if done properly. The logistic regression analysis results showed that land area and farming income influence farmers' decision to cultivate additional vaname shrimp in Patutrejo Village. Alternative activities to support the development strategy of vaname shrimp in Patutrejo Village are to provide training on how to cultivate good fish to farmers, to inform shrimp disease management at the farm level, to provide special facilities for disposal of aquaculture waste located far from the shoreline, as well as implementing polyculture between vaname shrimp and other types of commodities.

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