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SUSTAINABLE AQUACULTURE MANAGEMENT OF VANAMEI SHRIMP (*LIPTOPENAEUS VANNAMEI*) IN BATUKARAS VILLAGE, PANGANDARAN, INDONESIA

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Abstract: Vaname shrimp is a superior commodity in aquaculture which continues to increase in demand. The farming of vaname shrimp in Batukaras Village, Cijulang Sub-district, Pangandaran Regency is carried out with semi-intensive technology, the application of this technology is not sustainable due to lack of supporting facilities. This study aims to analyze the physical aspects and the quality of production and the sustainability status also determine the priority strategy for sustainable management of vaname shrimp. Analysis of sustainability status is carried out by surveys and interviews with farmers then processed using the RAPFISH method (The Rapid Appraisal of The Status Fisheries), for physical aspects measurement of water quality is carried out in situ and testing in the laboratory with measured parameters, namely temperature, salinity, DO, pH, nitrite and ammonia. While the preparation of priority programs is processed using the AHP (Analytical Hierarchy Process) method using Expert Choice software. The results of the research are water quality parameter values for temperature, salinity, pH, DO and nitrite and the quality of shrimp according to standard values, but ammonia parameters are far from normal limits. The multidimensional sustainability level of vaname shrimp management in Batukaras Village has a sustainability index of 60,00 which means it is quite sustainable. The choice of the main priority program for the sustainability of vaname shrimp cultivation is the rehabilitation program for fishpond infrastructure with a value ratio of 0,290.

Keywords: AHP, Aquaculture, Pangandaran, Rapfish, Vaname shrimp.

1. INTRODUCTION

Aquaculture has a considerable diversity of potential superior commodities. According to data from the Ministry of Marine Affairs and Fisheries in 2016, the potential for marine aquaculture is 8,3 million ha which consists of 20% for fish farming, 10% for shellfish farming, 60% for seaweed farming, and 10% for others, the potential of brackish water aquaculture or ponds is 1,3 million ha, and the potential of 2.2 million ha of freshwater aquaculture consisting of fish pond with an area of 526,40 thousand ha, public waters (lakes, reservoirs, rivers and swamps) covering 158,2 thousand ha, and rice fields for minapadi covering 1,55 million ha [16].

In 2012, Indonesia ranks 2nd for capture fisheries production and ranks 4th for aquaculture production in the world. This fact illustrates that the potential of aquaculture in Indonesia is very large, so that if managed properly and responsibly this aquaculture can be sustainable and can become one of the main sources of development capital in the present and future [11].

Aquaculture production in Pangandaran Regency such as ponds, ponds and rice fields amounted to 2,002.64 tons. Map of distribution of fisheries production in the Pangandaran Regency is dominated by Pangandaran District with the number of marine fisheries production of 1.351,20 tons, brackish water cultivation of 148.26 tons and freshwater aquaculture of 94.35 tons. Furthermore, Cijulang Subdistrict has a total marine fishery production of 575,54 tons, brackish water cultivation of 366,74 tons and freshwater cultivation of 305,86 tons. Parigi District is ranked third with a total marine fishery production of 289.53, brackish water cultivation of 228.89 tons and freshwater cultivation of 419.36 tons. The fourth-largest amount of production in the Pangandaran Regency is Kalipuncang District with total marine fishery production of 185,20 tons, brackish water cultivation of 25,61 tons and freshwater cultivation of 208,64 tons. Finally, Sidamulih Subdistrict has a total production of brackish water production of 36,62 tons, freshwater cultivation of 164,69 tons and no marine fisheries production [2].

According [8], Freshwater aquaculture has a production target of 120 tons consisting of 40 tons of gourami commodities, 30 tons of tilapia, 15 tons of catfish, 15 tons of carp, 10 tons of tawes, 5 tons of prawns and 5 tons of other fish. From the achievements of production in 2016, Freshwater

farming achieved a production realization of 110,79 tons or equal to 92,32% of the production target. Whereas for brackish water farming, the production target is set at 101,5 tons consisting of 70 tons of vaname shrimp, 10 tons of black shrimp, 10 tons of milkfish, 5 tons of crab, grouper of 1 ton, white snapper and other types of fish of 0,5 tons and 5 tons. The achievement of brackish water farming has succeeded in getting production in 2016 of 122,31 tons or equal to 120,5% of the achievement of the production target. For the main commodity of brackish water, farming is vaname shrimp from the target set at 70 tons which exceeded the target by successfully obtaining a production of 110,43 tons.

The potential for a brackish water farm in Pangandaran Regency is very good. Staying from the local government provides training so that farmers can be more successful in farming. Considering, at this time the farmers only understood just spreading and giving food. While the technical quality of cultivation has not mastered it.

In its management, [12] states that the concept of sustainable fisheries development contains aspects: ecological sustainability, socioeconomic sustainability, community sustainability dan institutional sustainability. According to [14] sustainable development can be divided into four, namely environmental sustainability, economic sustainability, social sustainability, and sustainable development. In this case, the notion of sustainable development is an integration of 3 (three) aspects, namely: social sustainability, environmental sustainability, and economic sustainability.

2. RESEARCH OBJECTIVES

Based on the research background related to Sustainable Aquaculture Management of Vanamei Shrimp (*Liptopenaeus vannamei*) in Batukaras Village, then the purpose of this study can be formulated as follows:

1. Knowing the status of the sustainability of aquaculture in terms of ecological, social, economic, technological and institutional aspects.
2. Determine the management strategy of vaname shrimp culture in Batukaras Village.
3. Knowing the strategy for managing sustainable vaname shrimp farming in Batukaras Village.

3. METHODS

3.1. Research Area

Pangandaran Regency is one of the districts in West Java Province. Pangandaran Regency has only been a District Government since 2012. The Regency has an area of 1,680 Km² consisting of 10 sub-districts with 12 villages with 81 villages with a population of 422.586. The district is strategically located, because it is on a provincial road track, on the beach with a beach length of 91 km. based on its position, Pangandaran borders the Ciamis Regency and Banjar City in the north, Cilacap Regency in the east, Indian Ocean in the south, and Tasikmalaya Regency in the west.

The Batukaras Village locates on Pangandaran Regency on the south coast of West Java Province. Overlooking the Indian Ocean lies on 7°43'17"- 7°43'36" S dan 108°29'37"- 108°29'50" E. The Batukaras Village coastal region consists of the bay and open sea as shown in Fig. 1. Seen from the geographical position of the vaname shrimp pond area in the Village Batukaras in the north is bordered by the mouth of the Cijulang river, in the east it is bordered by the Cijulang river and Nusa Wiru Airport, the southern part is still bordered by the Cijulang river and in the west it is bordered by Parigi Bay which is directly bordered by the Indian Ocean.

Administratively, the vaname shrimp pond area in Batukaras Village is located in Cijulang District, Pangandaran Regency, and West Java Province. Cijulang District has an area of 93,42 km2 which consists of 7 villages. The seven villages are Cijulang Village, Batukaras Village, Kondangjajar Village, Ciakar Village, Cibanten Village, Kertayasa Village, and Margacinta Village. District of Cijulang has the highest potential of brackishwater aquaculture land (ponds) compared to other Districts [2].

3.2. Research Framework

Vaname shrimp farming activities in Batukaras Village began in 2002, which at first were only carried out by a few farmers. This area was originally a land arising from the decline of seawater, this area is owned by the Batukaras village government so that currently each tiller (farmer) must pay rent for the use of this area to the village government. Through this study, the authors intend to analyze the sustainability status of vaname shrimp farming and observe the suitability of water quality and production quality with standardization in vaname shrimp aquaculture. Based on the background above, this commodity has succeeded in achieving production results that exceeded the target, so it can be said that the cultivation of vaname shrimp is the superior farming.

The sustainable management strategy of vaname shrimp farming in Batukaras Village, Pangandaran Regency is prepared by taking into account various aspects that can affect the sustainability of the vaname shrimp farming. The following is the research framework as shown in Fig. 2.

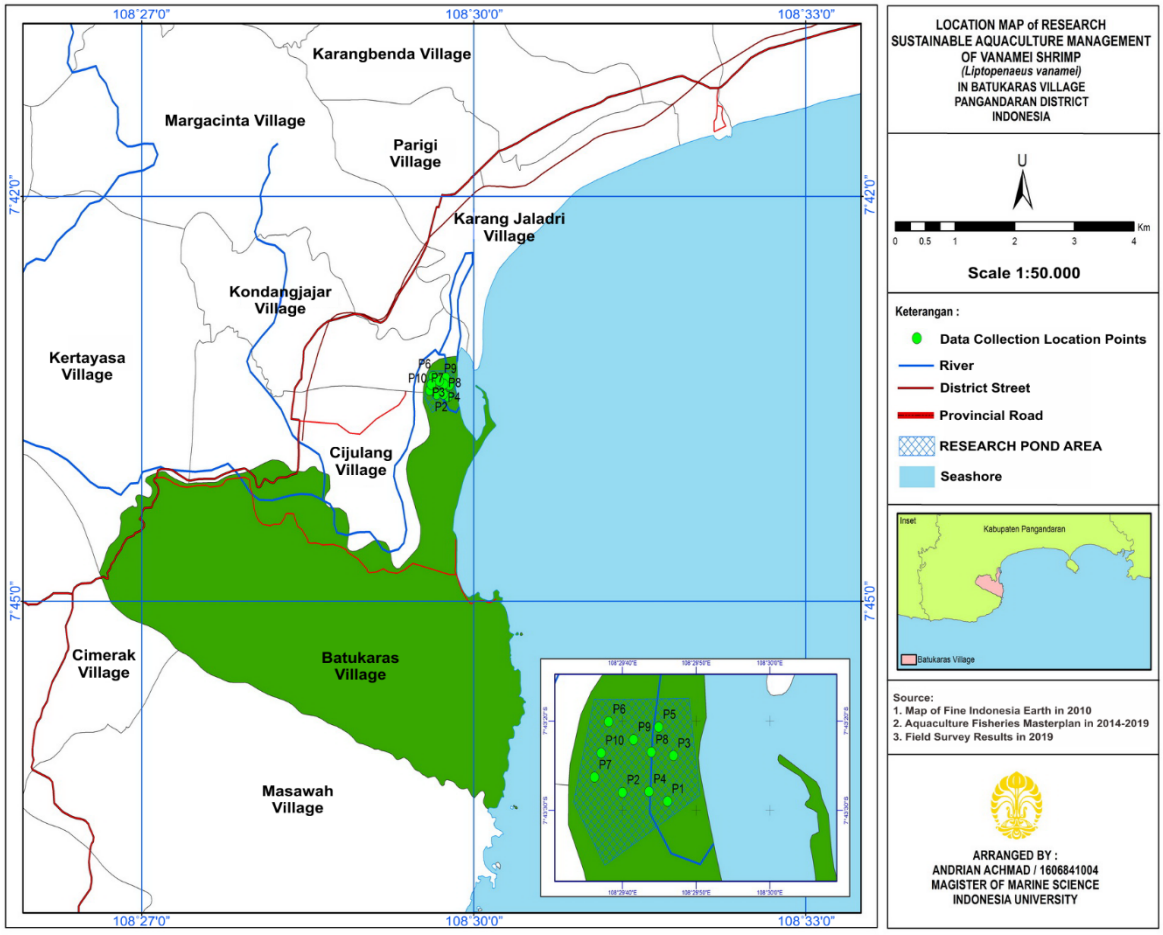

Fig. 1 Area of Research and Sea Open of Batukaras Village

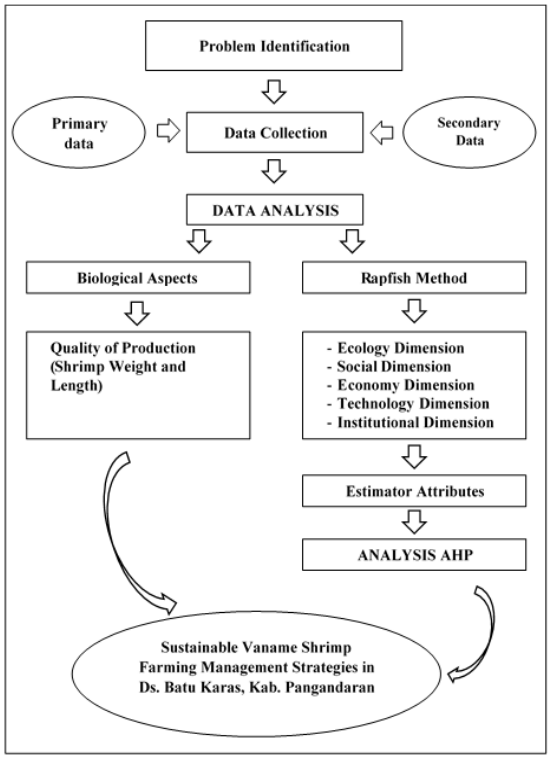

Fig. 2 Research Framework

3.3. Method of Collection and Data Analysis

Measurements of physical aspects were carried out on water quality parameters including temperature, pH, DO, salinity, nitrate and ammonia content and production for shrimp weight and length. This physical data retrieval was carried out in 10 farm plot points which were currently producing vaname shrimp with the taking time on the 0th, 30th and 60th days. Measurement of water quality parameter data is carried out in situ except for the measurement of nitrite and ammonia content. Measurements of ammonia and nitrite content were carried out by taking 200 ml of water samples using plastic sample bottles to be analyzed at the Laboratory of UPTD of Brackish and South Sea Water Fisheries, Pangandaran.

The sustainability status of vaname shrimp was analyzed by Rapfish software with data sources derived from respondents who were farmers (pond owners) in the Batukaras village pond area. The implementation of the interview is assisted by a questionnaire list as a tool for collecting data. The total number of farmers (pond owners) of vaname shrimp in Batukaras Village is 18 people. Calculation of the number of respondents with the

Slovin method obtained a minimum number of respondents as much as 15-25 rounded up to 15 respondents. Farmer who are active in aquaculture chosen as respondents.

The results of the analysis of recapitulated water quality parameters in the data tabulation are then compared with the maximum/minimum standard values of each water quality parameter. The vaname shrimp during production was taken as many as 5-10 tails from each sample plot point to measure the average weight or ABW (Average Body Weight) then it will be compared with the standard value.

RAPFISH is the latest technique developed by the University of British Columbia Canada, which is an analysis to evaluate the sustainability of multidisciplinary fisheries. RAPFISH is based on ordination techniques (placing something on a measured sequence of attributes) using MDS (Multi-Dimensional Scaling).

According to [12], the ordination technique using Multi Dimensional Scaling (MDS) is the basis of Rapfish analysis. The Rapfish analysis procedure begins by setting the attributes then grouping them according to the dimensions to be analyzed. MDS itself is basically a statistical technique that tries to make multidimensional transformations into lower dimensions. The dimensions in Rapfish concern aspects of sustainability from ecology, social, economic, technological and institutional. RAPFISH analysis in this study was carried out through several stages, namely: (1). Scoring by referring to the literature (ecology, social, economic, technological, and institutional) of Rapfish by using MS Excel; (2). Perform MDS analysis to determine the ordination and stress values through ALSCAL Algorithm; (3). Perform "rotation" to determine the position of the fishery in the ordination of bad and good with MS Excel. Goodness of Fit in MDS is reflected in the amount of S-Stress value calculated from the value of S. Low-stress values indicate a good fit, while high S values indicate a bad fit. In Rapfish, a good model is shown if the stress value is smaller than 0,25 (S < 0,25); (4). Perform sensitivity analysis (leverage analysis) and Monte Carlo analysis to take into account aspects of uncertainty.

The sustainability analysis used in this study refers to [20] who divides sustainability into 4 categories, namely: unsustainable (0-25%), less sustainable (25-50%), fairly sustainable (50-75%), and sustainable (75-100%).

Analytical Hierarchy Process (AHP) is a method for solving a complex situation that is not structured into several components in a hierarchical arrangement, by giving subjective values about the importance of each variable relative, and determining which variable has the highest priority to influence the outcome of the situation. Because of its multi-criteria nature, AHP is quite widely used in priority setting. For example, to set research priorities, the management of research institutes often uses several criteria such as the impact of research, costs, human resource capabilities, and also possible implementation time.

4. RESULT AND DISCUSSION

4.1. Physical Condition of Ponds

In this study, the data was taken from a sample of 10 plots of shrimp ponds located in the Shrimp Village of Batukaras Village. The total sample area of the shrimp ponds studied was 14,500 m^2. From these samples, it is expected to represent the results of the research carried out for the whole shrimp farm. The results of the observation of shrimp farms are shown in Table 1 with SNI standard values [1].

Tabel 1. Results of Water Quality Parameters

No	Parameter	Average Value	Standard Value	Results
1	Temperature	29,52 °C	28-31,5 °C	Matching
2	Salinity	17,53 g/l	10-35 g/l	Matching
3	pH	8,11	7,5-8,5	Matching
4	DO	6,7 mg/l	4-6 mg/l	Matching
5	Nitrite	0,6 ppm	≤ 1 ppm	Matching
6	Ammonia	0,26 mg/l	≤ 0,1 mg/l	Not Matching
7	Soil texture	Sandy soil	-	Matching

Source: Data Processing, 2019

4.2. Shrimp Quality

Based on Table 2, the results of the measurement of shrimp quality, the majority of shrimp seed stocked were 9-day post larvae (PL.9), except for plot number 4 ponds using PL.8. The average shrimp weight on the 60th day of production was 10,23 grams. This average weight has met the SNI 01-7246-2006 standard which explains that in 61-75 days old shrimp have a weight range of 8,1-14,0 grams. Shrimp that are around 61 days old have a minimum weight of 8,1 grams. However, there are 3 plots of pond ponds that have not been able to reach the minimum limit, namely in plots P1, P2, and P3. In the three plots of ponds, the development of shrimp appears to be hampered from the 30th day to the 60th day.

According to the results of interviews in the field with farm owners, this is likely to occur because of the threat of shrimp disease which makes shrimp appetite decrease. Allegedly high levels of ammonia are a cause of decreased appetite for shrimp so that shrimp do not develop. This is also seen when feeding, food that is in the container (anco) is still much left. The process of lifting or turning the subgrade should be carried out so that

the rest of the food that has accumulated at the bottom of the pond is lost.

Tabel 2. Shrimp Quality Measurement Results

No. Ponds	Size of Fries	Weight (gr)	Long (mm)
		60th day	
P.1	PL.9	7	94
P.2	PL.9	6,4	87
P.3	PL.9	6,5	90
P.4	PL.8	9,3	115
P.5	PL.9	13,4	130
P.6	PL.9	13	130
P.7	PL.9	10	125
P.8	PL.9	12	130
P.9	PL.9	13,2	134
P.10	PL.9	11,5	130
Average		10,23	116,5

Source: Data Processing, 2019

4.3. Status of Sustainability of Shrimp Pond Aquaculture

4.3.1 Dimension Sustainability

The sustainability status of the vaname shrimp pond aquaculture in Batukaras Village was determined by analyzing 5 (five) dimensions used in the Rapfish method, namely the ecology, social, economy, technology and institutional dimensions. Based on the analysis of the five dimensions, we obtained a sustainability index for shrimp pond aquaculture in Batukaras Village. The assessment of the five dimensions is as follows in Table 3.

The status of sustainability of vaname shrimp farming in Batukaras Village is seen from the ecological dimension, social dimension, economic dimension and institutional dimensions having index values of 51,41, 52,32, 51,62 and 66,13 respectively. The four dimensions fall into a fairly sustainable category. While the dimensions of technology include a sustainable category with an index value of 76,98. From these five dimensions, the technology dimension is the dimension with the best level of sustainability. This means that technologically, vaname shrimp farming is a benchmark for the sustainability of vaname shrimp management in Batukaras Village as shown by Fig. 3.

Tabel 3. Rapfish Ordination Result

No	Dimension	Value Index	R^2	Status
1	Ecology	51,41	0,92	Fairly Sustainable
2	Social	52,32	0,91	Fairly Sustainable
3	Economy	51,62	0,92	Fairly Sustainable
4	Technology	76,98	0,95	Sustainable
5	Institutional	66,13	0,91	Fairly Sustainable

Source: Data Processing, 2019

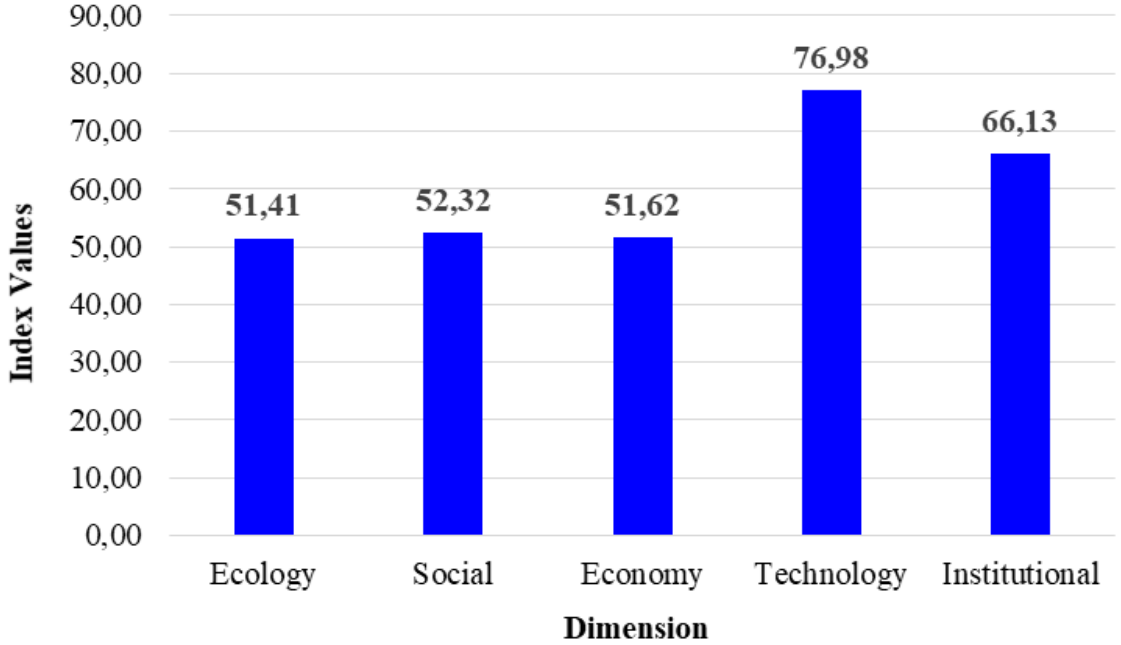

Fig. 3 Sustainability Status Diagram
Source: Data Processing, 2019

4.3.2 Multidimensional Sustainability

According to [5], the assessment of the sustainability status of fisheries management cannot be done by looking at the averages of the five dimensions used as indicators, but it must be done by pairwise comparison tests. A pairwise comparison must be done because each dimension assessed has different weights. Based on the assessment that has been done, a weighted score is obtained as shown in Table 4. The results of pairwise comparison by weighing index values as in Table 4 obtained a weighted index value of 60,00 which is in the range of values 50-75. This means that vaname shrimp farming activities in Batukaras Village are in a fairly sustainable condition.

Tabel 4. Multidimensional Sustainability Index Value

No	Dimension	Values		
		Weight	Index	Weighted Index
1	Ecological	0,06	51,41	3,08
2	Social	0,14	52,32	7,33
3	Economi	0,43	51,62	22,20
4	Technological	0,27	76,98	20,79
5	Institutional	0,10	66,13	6,61
			Total	60,00
			Fairly Sustainable	

Source: Data Processing, 2019

The results of the Rapfish analysis show that all the attributes assessed for the sustainability status of vaname shrimp farming are quite accurate. This can be seen from the stress values ranging from 0,20-0,27 with a relatively large degree of determination coefficient (R2), which is 0,91-0,95 for all dimensions assessed. Based on these values it can be illustrated that the attributes used to assess the sustainability status of each dimension are sufficient, as shown in Table 5.

Tabel 5. Value of RAPFISH, Stress, and Coefficient

No	Dimension	Values			Status
		Index	Stress	R^2	
1	Ecological	51,41	0,24	0,92	Fairly Sustainable
2	Social	52,32	0,27	0,91	Fairly Sustainable
3	Economy	51,62	0,22	0,92	Fairly Sustainable
4	Technological	76,98	0,20	0,95	Sustainable
5	Institutional	66,13	0,26	0,91	Fairly Sustainable

Source: Data Processing, 2019

4.4. Priority Strategy

The sustainability strategy is a step that can be taken to develop and improve the quality and quantity of shrimp production for the sustainability of vaname shrimp culture. Sustainability has the following dimensions: ecological dimension, social dimension, economic dimension, institutional dimension, and technological dimension. The expected sustainability strategy should have a balance between these dimensions. The intended strategy choices are: (1). Rehabilitation of Pond Area Infrastructure; (2). Management of Fish Diseases; (3). Alternative Job Creation; (4). Empowerment of Women/Farmer Wives; (5). Reducing Conflicts of Farmers; (6). Strengthening of Farmer Groups; (7). Supervision of Aquaculture Activities.

The final stage of the AHP analysis in this study is planning priority management of vaname shrimp culture in Batukaras Village which is managed. Priority management of vaname shrimp management is determined systematically by considering all the existing criteria and alternative strategies offered. The analysis of the seven strategies processed by Expert Choice 11.1 software shows are: (1). Pond Area Infrastructure Rehabilitation Program with an interesting ratio of 0,290; (2). Fish Disease Management Program with an interesting ratio of 0,199; (3). Aquaculture Fisheries Group Strengthening Program with an interesting ratio of 0,161; (4). The Farming Activities Supervision Program with an interesting ratio of 0,119; (5). Conflict Reduction Program with an interesting ratio of 0,114; (6). Alternative Employment Creation Program with an interesting ratio of 0,069; and (7). Women's Empowerment/Farmer Wife Program with an interesting ratio of 0,048.

The management of vaname shrimp farming in Batukaras Village is based on 5 (five) criteria derived from the Rapfish dimension. The five criteria, namely: (1). the carrying capacity of the environment; (2). Farmer economy; (3). Education and knowledge of farmers; (4). Farming technology; and (5). Institutional strengthening.

The analysis of the five criteria processed by Expert Choice 11.1 software shows that the economy of the cultivator has the highest importance with a ratio value of 0,300. Followed successively by cultivation technology with a ratio value of 0,295, then education and knowledge of farmers with a ratio value of 0,191, environmental carrying capacity with a ratio value of 0,121, and institutional strengthening with a ratio value of 0,094. With an inconsistency value of 0,06 so that statistically can be trusted as shown in Fig. 5.

5. CONCLUSIONS

1. Water quality and quality of shrimp production in shrimp ponds in Batukaras Village, Cijulang District, Pangandaran Regency have conformed to the standard guidelines for vaname shrimp farming using semi-intensive technology. Suitable water quality parameters include temperature, salinity, pH, DO, and nitrite, while ammonia levels are above the maximum limit for vaname shrimp cultivation.
2. The status of the sustainability of vaname shrimp cultivation in Batukaras Village which was analyzed by the Rapfish method is in a fairly sustainable state. With the technology dimension at the highest level because this dimension is a leverage factor for increasing the production of vaname shrimp cultivation in Batukaras Village.
3. The pond area infrastructure rehabilitation program is a top priority strategy for sustainable management of vaname shrimp culture in Batukaras Village.

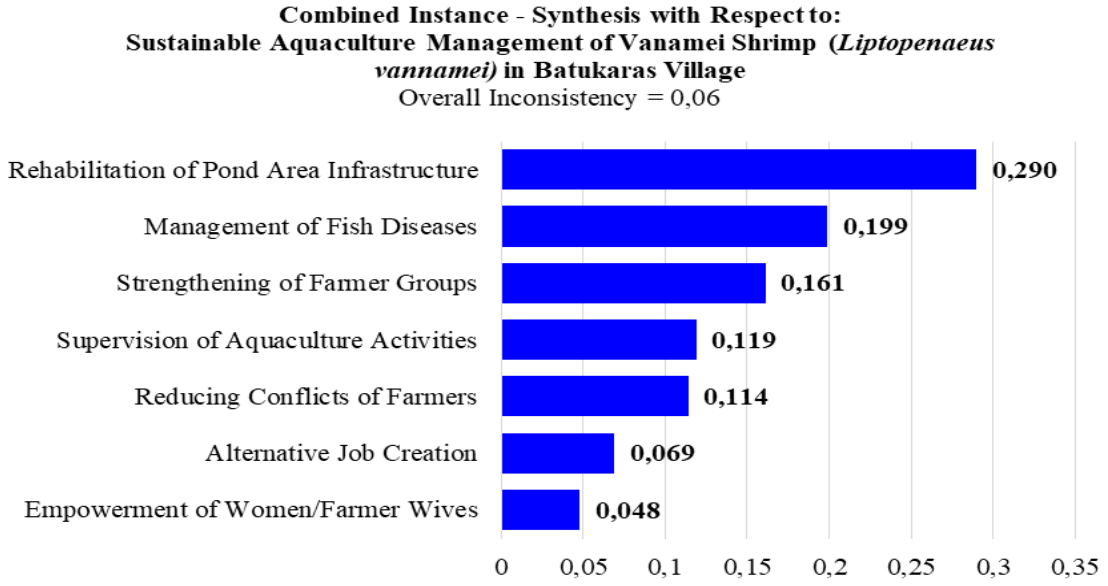

Fig. 4 AHP Output on Strategic Options
Source: Data Processing, 2019

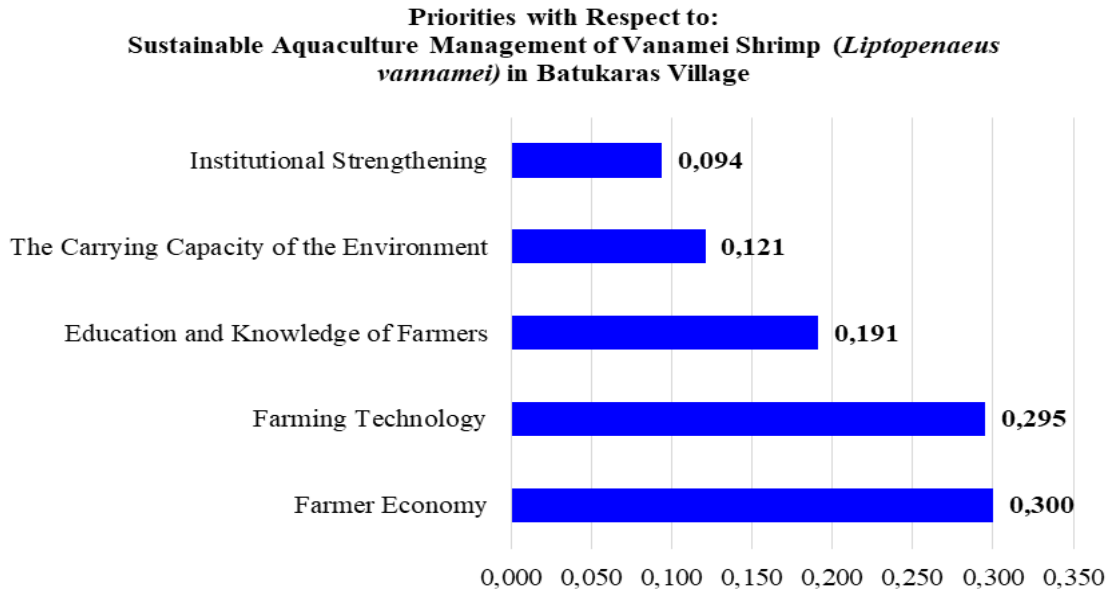

Fig. 5 AHP Output about AHP Analysis Comparison between Criteria
Source: Data Processing, 2019

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