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Indikator Keberlanjutan Berbasis Persepsi pada Budidaya Udang di Lahan Marginal di Pantai Selatan Yogyakarta

Perception-based Indicator for Sustainability of Shrimp Culture in Less Favorable Areas at Southern Coast of Yogyakarta

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Abstrak Budidaya udang telah diintroduksi sejak pertengahan 1980-an di pantai selatan Daerah Istimewa Yogyakarta (DIY), di lahan pasiran (marginal), namun tidak berkembang dengan baik pada tahap awal ini. Upaya pengembangan budidaya udang kembali dilakukan pada awal tahun 2000-an, khususnya di Desa Jangkaran, Kecamatan Temon, Kabupaten Kulon Progo dan Desa Poncosari, Kecamatan Srandakan, Kabupaten Bantul. Upaya ini cukup berhasil dalam beberapa siklus tanam, tetapi kemudian banyak tambak udang gagal karena terserang penyakit dan kekurangan modal untuk bangkit kembali. Menjelang akhir tahun 2013, usaha budidaya udang mengalami ekspansi yang cepat di sepanjang pantai kedua kabupaten tersebut. Studi ini bertujuan untuk mengetahui profil dan pertumbuhan budidaya udang di pantai selatan DIY dan untuk mengidentifikasi aspek teknis, sosial, lingkungan dan ekonomi budidaya udang berkelanjutan. Untuk mengidentifikasi keberlanjutan budidaya udang saat ini, studi ini mengembangkan empat indikator yang terdiri dari indikator teknis (6 sub-indikator), indikator ekonomi (9 sub-indikator), indikator sosial (7 sub-indikator), dan indikator lingkungan (8 sub-indikator). Studi ini dilakukan selama bulan Maret hingga Oktober 2014 dengan menggunakan kombinasi studi literatur dan survei di dua desa terpilih: Desa Jangkaran dan Poncosari. Total 82 responden diwawancarai; terdiri dari pembudidaya udang, masyarakat pesisir, tokoh masyarakat, dan pemerintah daerah. Studi ini menunjukkan bahwa pertumbuhan cepat budidaya udang akhir-akhir ini disebabkan oleh beberapa faktor, antara lain: (1) adanya inovasi teknologi dalam budidaya udang di lahan berpasir (marginal), terutama budidaya udang dengan biaya investasi tambak yang lebih murah, pengambilan air laut yang secara teknis lebih mudah, serta adanya spesies udang budidaya (vanamei) yang menghasilkan produktivitas lebih tinggi; (2) peluang pasar komoditas yang baik, dengan harga udang yang tinggi; dan (3) perubahan dalam lingkungan fisik pantai akibat ancaman erosi pantai yang merusak mata pencaharian nelayan, terutama pantai untuk pendaratan perahu motor tempel, sehingga menuntut strategi adaptasi. Pembudidaya udang rata-rata mengelola lahan seluas 2138 m^2 dan menerapkan teknologi budidaya intensif sampai super intensif, dengan padat tebar rata-rata 144 ekor/m^2. Rata-rata produksi per tahun mencapai 25,9 ton/ha dan menghasilkan pendapatan Rp 286,544,232 per tahun. Total biaya produksi mencapai Rp 210,590,175 per tahun, dan menghasilkan laba bersih sebesar Rp 75,954,057 per tahun. Indikator keberlanjutan berbasis persepsi menunjukkan masalah terkait lingkungan yang secara rata-rata memiliki nilai rendah. Dengan demikian, tata kelola lingkungan budidaya merupakan aspek penting untuk dipertimbangkan dalam kerangka pengembangan budidaya udang berkelanjutan di pantai selatan DIY.

Kata kunci: **Budidaya udang; persepsi; keberlanjutan; pesisir; DIY**

Abstract Shrimp farming has been introduced since the mid-1980s at the southern coast of Daerah Istimewa Yogyakarta (DIY). However, the industry was not well growing in the initial stage. New shrimp development project also promoted in the early 2000s, particularly in Jangkaran Village, Subdistrict of Temon, Kulon Progo District and Poncosari Village, Subdistrict of Srandakan, Bantul District, but many of shrimp farms failed because of shrimp diseases, lack of capital to recover and shrimp farming experiences. Recently, the shrimp culture industry experienced rapid expansion along the coast of the two districts. This study aimed to determine the profile, develop shrimp farming at the southern coast of DIY and identify the technical, social, and economic indicators of sustainable shrimp culture in less favorable areas. To identify sustainability of current shrimp culture, the study developed four indicators consist of technical indicators (6 sub-indicators), economic indicators (9 sub-indicators), social indicators (7 sub-indicators), and environmental indicators (8 sub-indicator). The study was conducted during March to October 2014 by using a combination of literature study and survey at two selected villages: Jangkaran and Poncosari Villages. The total 82 respondents were interviewed; consist of shrimp farmers, coastal communities, community leaders, and local government. The study showed that the rapid growing of shrimp farming were caused by several factors, among others: (1) the existence of technological innovation in shrimp farming in the sandy soil areas, particularly the lower cost in the pond investment and the more easier of

seawater collecting; (2) high price and market opportunities of the commodity; and (3) changes in the physical environment due to the threat of coastal erosion which damage the fisher livelihood, thus demanding adaptation strategies. Shrimp farmer in average managed 2,138 m^2 and implemented intensive to super intensive cultivation technologies, with an average stocking density of 144 shrimp/m^2. Production per year in average reached 25.9 ton/ha and generated revenue of IDR 286.544.232 per year. The total cost of production was estimated at IDR 210.590.175 per year, and generated a net profit of IDR 75.954.057 per year. The perception-based indicator of sustainability showed that the environmental related issues were low in average. Thus, environmental regulation of aquaculture is an important aspect to be considered in promoting sustainable development of shrimp farming at the southern coast of the DIY province.

Keywords: **Shrimp culture; perception; sustainability; coastal; DIY**

INTRODUCTION

The rapid growing of shrimp culture has been providing a wide range of economic benefits, both for the community as well as the country as a source of foreign exchange. However, the rapid and uncontrolled development of the industry also resulted in negative externalities such as the decrease of environmental quality, the emerge of various diseases and loss of mangrove ecosystem, which occurred in many parts of the world such as in the United States, Thailand, Vietnam, Bangladesh and Indonesia (Neiland *et al*., 2001; Bosma & Verdegem, 2011; Samuel-Fitwi, 2012; Hopkins *et al*., 1995; Lebel *et al*., 2002; Barbier & Cox, 2004; Paul & Vogl, 2011). Therefore, sustainable arrangement and practice of the shrimp culture needs to be developed to increase the economic benefits, social, and the business environmental.

The rapid development of the shrimp culture in Daerah Istimewa Yogyakarta (DIY) and many part of Southern coast of Java in the last few years, i.e. by converting less productive land, such as the sandy soil becomes farm for shrimp culture, it needs to be well managed and controlled. Failure in managing these changes is concerned to threaten the sustainability of the business, the coastal ecosystem and communities socio-economic. Even a failure in managing it also potentially impedes efforts in accelerating utilization of potential coastal and marine resources of DIY, as written in the RPJMD (Rencana Pembangunan Jangka Menengah Daerah/the Mid-term Plan of Regional Development) 2013-2017, i.e. encouraging superior new civilization by taking cultural strategy, i.e., turning the paradigm of ‹*among tani*› (agricultural/land-based) to ‹*dagang layar*› (trade/coastal and marine-based economy).

Communities' perceptions and attitudes towards the development of sustainable shrimp culture need to be identified to know the social economic behavior in the development of the business. The attitude in this context is a response that is appropriate or not against an object, person, or event. The response may be based on sufficient information or just emotional in nature against an object and simply refer to personal evaluation against the psychology object (Sadati *et al*., 2010). Sadati *et al*. (2010) further has shown a strong relationship between the farmers' attitudes with their economic behavior. The attitude is also viewed as a predictor variable of the success of an activity including in terms of resource conservation. AhnstrÖm *et al*. (2008) also reports that farmers' attitude receiving various scheme determines the quality of the conservation activities results. A positive attitude will result in success rate and better return from the expense per unit of investment costs input. This research aimed to: (1) know the profiles and the development of the shrimp culture at the southern coast of DIY; (2) identify aspects of technical, social, and economic for the indicator preparation of aquaculture in a sustainable way, and (3) develop the concept and strategy of sustainable development of shrimp culture at the southern coast of DIY.

MATERIALS AND METHODS

This research was conducted in two centers of the shrimp culture in DIY, namely (1) Jangkaran Village, Temon sub-district, Kulon Progo Regency and (2) Poncosari village, Kecamatan Srandakan, Bantul Regency (Figure 1). Both locations have experiences and wide range of dynamics in the shrimp culture. Shrimp culture was carried in the land of the Sultan Ground, Pakualaman Ground or ground of *wedi kenser* (might belong to state).

Figure 1. Study sites in Jangkaran Village and Poncosari Village.

The research was carried out in March to October 2014, by using a combination of qualitative and quantitative research method (mixed method). Data collection techniques used interviews with the guideline questionnaires and in-depth interview. In-depth interview was carried to the key informants that included local leaders at both the informal as well as formal institutions. Respondents consisted of member of shrimp farmer group, coastal communities, community leaders, and local governments. Snowball sampling method was used to select respondents (Somekh & Lewin, 2005). Through this method, the first respondent informed some choices to the second respondent, then the second to the third respondent, and the process was conducted continually until the last respondent. Total of

82 respondents were interviewed. To find out the general conditions of the coastal economy before the introduction of the fisheries business activities (especially aquaculture), data were collected from various secondary sources such as publications of relevant agencies and various available scientific publications. Data then were analyzed using descriptive statistical analysis method.

RESULTS AND DISCUSSION

General condition of the research locations

Geographically, the first research site, Jangkaran Village, is the administrative area of Kulon Progo Regency located in the southernmost part of the Regency. Research area physically borders directly with the Indian Ocean in the south and Purworejo Regency, Central Java province in the west. The second research location was in Poncosari Village, Srandakan sub-district, Bantul Regency (Figure 1).

The coastal area of Jangkaran Village is an area that is very potential for marine capture fisheries, aquaculture, and agricultural activities in general. In the history of fisheries in DIY, the fisher in this village were first trained to be fishers in the early of 1980s. However, capture fisheries did not develop well at the stage of initiation (Suadi, 2002). Coastal aquaculture (shrimp and milkfish commodity) has also been initiated in almost the same year (early 1980s), i.e. by developing aquaculture station for cultivating milkfish and shrimp that is currently known as *Unit Kerja Budidaya Air Payau Congot* (Brackishwater Aquaculture Section at Office of Marine Affair and Fisheries DIY).

Shrimp culture in Jangkaran Village has just developed in the early 2000s, through a series of community empowerment programs carried out by the regional government of Kulon Progo Regency as well as DIY. The development of shrimp culture in the location was very dynamic, with the experience of success and failure in the business management. When tiger prawn culture was initiated through funding assistance program of local government in 2001/2002, the utilization of marginal land in the coastal areas of the village has been thriving. The high price of tiger shrimp attracted groups of people forming groups of shrimp farmers. Nevertheless, business began to recede in 2004-2005 since the shrimp was stricken by disease. However, the business began to bounce back at the end of 2011, i.e. by the introduction of whiteleg shrimp (*Litopenaeus vannamei*).

The second research site was in the southern coast in the westernmost part of Bantul Regency. Poncosari Village consists of 24 hamlets, and most of the people earn their living from the coastal and marine resources. Most of the village land is used for agriculture, and majority was non-irrigated rice field. There are three beaches known as centers for fishing and tourism activities in Poncosari Village, i.e., Pandansimo Beach, Baru Beach, and Kuwaru Beach. The fishery activity that first developed was capture fisheries, which was initiated in 2000. The initiation of this business was done through training programs and assistance. Until recently, the capture fishery business has been surviving, but the fishing fleet decreasing. Along with the development of capture fisheries, tourism activity is also expanding. However, the two are seen to recede since the coast has been stricken by coastal abrasion. High waves continue to erode the coastal area that the shore becomes steeper and the fir trees that become tourists' shelter lost/reduced due to the abrasion.

Shrimp culture has been developed in the early 2000s, along with the operation of PT Indokor (private company) that built the ponds in the sandy soil land. Until the end of 2011, only the ponds of Indokor operate in the location. But nowadays, especially since the middle of 2013, along the beach of Poncosari Village have been full of shrimp ponds. The rapid development of shrimp culture is inseparable from the development of shrimp culture technology in the sandy soil land that is simpler with affordability, such as shrimp culture technology with plastic pond and walls of the asbestos and the taking of water through ground water wells. General description of the study site is shown in Table 1 and shrimp culture business development in DIY is briefly presented in Figure 2.

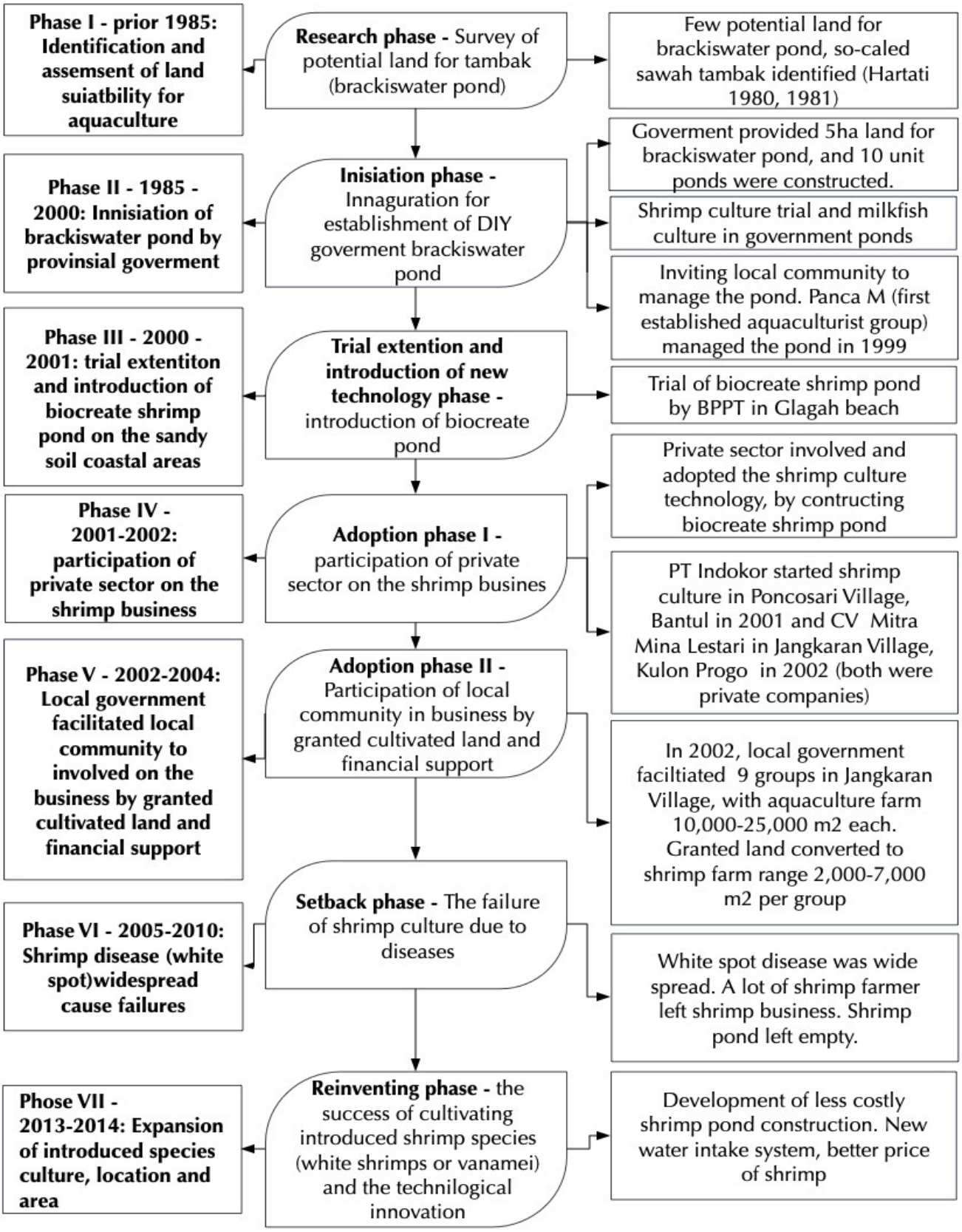

Figure 2. Shrimp culture growth in DIY.

Table 1. General description of the study sites.

Characteristics	Research site 1 (Jangkaran)	Research site 2 (Poncosari)
Administrative location	Jangkaran Village, Subdistrict of Temon, Kulon Progo Regency	Poncosari Village, Subdistrict of Srandakan, Bantul Regency
Aquaculture potency	Brackishwater aquaculture particularly for shrimp, milkfish and silvofishery for crab farming in mangrove ecosystem	Brackishwater aquaculture particularly for shrimp culture
Shrimp culture initiation and development	Shrimp culture was introduced in mid-1980s, but adopted in early 2000. Government inaugurated community development project through shrimp culture in 2001/2002. Tiger prawn was the main cultivated species, but many of farmers group failed due to shrimp diseases, started in 2005. Introduced shrimp species (vanamei) started to be cultivated and rapidly expanded during 2013.	Private sector introduced and developed shrimp culture in 2000, but no farmers adopted due to capital intensive in the business. Cheaper shrimp pond construction and easier seawater intake technic were tried by the community in 2013 and the shrimp cultures were spreaded in the area and surrounds. The high density shrimp culture (intensive) was conducted.
General problems	Shrimp diseases, aquaculture management, and environmental issues.	Shrimp diseases, aquaculture management, and environmental issues.

Technical aspect of shrimp culture

Respondents in this study were 82 people, consisting of 61 farmers and 21 non-farmers. Respondents were generally male with the age range of 30-60 years and most were 41-60 years old (48% of total respondents). Most respondents were High School graduates (46 respondents) and 29 respondents of Elementary or Junior High School graduates while the 7 others (9%) have ever attended higher education. Based on the mean of living, 45 respondents made the aquaculture as the main livelihood. Professions of other respondents were 3 fishermen, 4 retirements, 7 of civil servants, 10 entrepreneurs and 19 farmers. Among these respondents, there were 37 respondents were farmers without a side jobs.

Based on the income level, the majority of respondents had income less than or equal to IDR 2,500,000 per month (68.3%), of which 22% respondents had income of only IDR 500,000 per month. Respondents who had income above IDR 5.000.000 per month were 26 respondents (31.7%), there were respondents who had income of IDR 10.000.000 per month (2.4% of total respondents). Almost all of the respondents who had income above IDR 5.000.000 per month were shrimp farmers. Aquaculture business financially gives a pretty good family income.

Although shrimp farmer groups in general have a better income level compared to other respondents, however they have a fairly diverse self-perception related to the wealth level. A group of farmers who perceive themselves as poor were 13% and the average group reached 61% of total respondents of 61 farmers. The number of respondents included in the group of rich enough reached 23% and the rest perceived themselves as the have.

Respondents started the shrimp culture business at the various time. Farmers who started the business before 2005-2010 were 11 respondents, between 2005-2010 were 5 respondents, and most of them started the business in 2012 or later. Respondents who started the businesses before 2005 were entirely in Jangkaran Village, while respondents in Poncosari Village generally started the business at the beginning of 2013. One respondent in this research was the respondent who managed one of income generating units in Office of Marine Affairs and Fisheries of DIY.

Shrimp culture business in 2001-2010 was still less popular, except in Jangkaran Village. The business has not yet developed enough because the cost of investment was quite expensive and inhabitants in the South coast of DIY have not mastered shrimp culture techniques. Starting in 2013 the shrimp culture business began to be famous and continued to grow. The factor of high price of shrimp became the attractive part of the business. Indeed, the data of FAO Globefish in September 2014 shows the increasing price of shrimp during the period because of EMS (early mortality syndrome) disease in the major producer countries of shrimps such as China and Thailand (that started in 2013), that led to the limited supply of global shrimp (FAO 2014a). It is like a windfall for the shrimp culture businessmen in Indonesia, including farmers at the southern coast of DIY. Another very important factor that encourages the development of shrimp culture was the growing of new technology that was more affordable from financial perspective and easiness of managing the shrimp culture. The expansion of shrimp farm using plastics with asbestos wall, which costs more affordable than the bio-create pond (previously existed) cause the investment to grow faster. The difficulties to take seawater to the pond that has been hampered by a high wave also can be anticipated by using well around the beach, made the limiting factor be managed by shrimp farmers. The physical environmental change, particularly the abrasion at the beach became also an important factor for the farmer to quickly find the alternative income source, one of which through investment on shrimp culture. Thus, the interaction of global factors and dynamics at the local level clearly become the determining factor for the rapid growing of aquaculture activities at the southern coast of DIY. In fact, local governments also continue to develop the infrastructure of the fisheries such as the creation of permanence (concrete) ponds.

The shrimp ponds maintained by the respondents were generally ponds with the wall of asbestos (49.2%) and ponds with the wall of mulch plastic (47.5%) as well as other types of pond such as permanent (concrete) ponds. Respondent in average managed 2 unit of ponds with size of 2.138 m^2 each shrimp farmer. The study shows that 31 respondents (50.8%) said the wide of shrimp ponds that

is managed increases; it showed farmers do expansion (reinvestment) by making a new pond from their income. The business cost is largely derived from bank loans (33 respondents or 54% of farmers), third parties and joint venture, as well as a small portion relying on its own capital (10 respondents or just 16% of farmers). The proximity of the village community with banking showed a social change that occurred with the development of the shrimp culture. The changes are particularly apparent from the courage of the villagers to get financial credit from the bank to support the shrimp production (risk taking).

Shrimp pond at the southern coast of DIY have an average depth of 1-1.5 m, relied on water pumping to fill the pond (water refilling as much as 10-30% per day). The shrimp farmers generally do not control the water quality before it goes into the pond. From all ponds, there were only 6 farmers who have discarded waste processing installations (IPAL), for processing waste before flowing to a river or sea. Nevertheless, shrimp farmers report that soil and water conditions are still in good state. To maintain water quality, 54 farmers (88.5% of respondents) do turn of the pond water 10-30% per day with no treatment either at the inlet and outlet. Related to level of shrimp disease attacked, the data indicated that 30 shrimp farmers rarely get serious diseases, while 13 respondents said that sometimes the shrimp are stricken by serious diseases and 10 farmers said that they often get a serious disease. White feces, white spot and vibrio dominated the shrimp disease in DIY.

The shrimp culture employed intensive culture technology, even with very high density (average of 144 shrimps/m^2). Farmers who used low density, less than or equal to 50 shrimps/m^2 were only 3.3% of total respondents. Farmers generally do stocking with the density of 51-100 shrimps/m^2 (42.5%) and the rest above 100 shrimps/m^2 (9.8% respondents by stocking of 100-150 shrimps/m^2, and 44.3% above 150 shrimps/m^2). A majority of respondents do stocking 2-3 times a year (90.2%) and the rest above 3 times of stocking season per year.

All shrimp farmers used aerator for the pond aeration, with the frequency of use very often. This was done to support the needs of oxygen with the high density of stocking (intensive shrimp culture technology). Survival rate of shrimp was 75.2% with an average harvest size of 86 shrimps/kg. To manage the business, farmers paid attention very seriously; even some farmers had professionals as the manager. Average production per year with unit area of 2.138 m^2 reached 5.54 tons or equivalent to 25.9 tons/ha/year. Table 1 presents the overall profile of farmers and technical aspects of the shrimp culture of the South coast of DIY.

Table 1. Technical profile of shrimp culture in DIY.

No	Criteria	Unit	Details	Respondent number (person)	Percentage of respondent (%)
1.	Type of ponds		Plastics	29	47,5
			Bio-create	1	1,6
			Asbestos wall with plastics	30	49,2
			Concreate	1	1,6
2.	Average pond ownership	m^2		2,138	
3.	Average pond unit	unit		2	
4.	Average pond size	m^2 per unit		1,106	
5.	Fry sources		a. Hatchery in DIY	14	23,0
			b. Hatchery outside DIY	42	68,9
			c. Hatchery in and outside DIY	5	8,2
6.	Stock density	Fry per m^2	a. ≤ 50	2	3,3
			b. 51-100	26	42,6
			c. 101-150	6	9,8
			d. 151-200	18	29,5
			e. >200	9	14,8
7.	Percentage of water replenishing	% per day	a. 5-10% (pump)	7	11,5
			b. 10-20% (pump)	36	59,0
			c. 20-30% (pump)	18	29,5
8.	Water depth	m	a. 0,4 -1	8	13,1
			b. 1 – 1,5	48	78,7
			c. > 1,5	5	8,2
9.	Type of feed and feeding frequency		Natural feed	0	-
			Natural and artificial feed	38	62,3
			Artificial feed and supplement	23	37,7
			Feeding irregularly	1	1,6
			Feeding ad libitum	5	8,2
			Feeding based on careful calculating	55	90,2

No	Criteria	Unit	Details	Respondent number (person)	Percentage of respondent (%)
10.	Fertilizer use		No	17	27,9
			Rare	27	44,3
			Less amount of organic and inorganic fertilizer	11	18,0
			Calculated amount of organic and inorganic fertilizer	6	9,8
11.	Shrimp species		Black tiger	0	-
			Vannamei (white leg shrimp)	61	100,0
			Polyculture	0	-
12.	Cultivation cycle	Cycle per year	a. 1 (one)	0	-
			b. 2 – 3	55	90,2
			c. > 3	6	9,8
13.	Chemical and drug use		a. No	33	54,1
			b. Less amount	13	21,3
			c. Calculated amount	15	24,6
14.	Occurrence of diseases		Rare, not serious	4	6,6
			Rare, serious	30	49,2
			Sometime - often, serious	13	21,3
			Often – very often, serious	10	16,4
			Never	4	6,6
15.	Pond management		Lack of management	0	-
			Well managed by owner and family	59	96,7
			Managed by professional	2	3,3
16.	Survival rate (SR)	%		75,2	
17.	Production	ton/ha/year		25,9	
18.	Harvest size	shrimp per kg		86	
19.	Potential profit class (perception based)		a. Low	7	11,5
			b. Middle	30	49,2
			c. High	24	39,3
20.	Marketing type		a. Trader/collector	42	68,9
			b. Direct to industry	19	31,1
21.	Problems and difficulties		Nature	15	24,6
			Financial	34	55,7
			Transportation	2	3,3
			Tenure	6	9,8
			Skill	10	16,4
			Technology	10	16,4
			Market	1	1,6
			License	13	21,3
			High feed price	5	8,2
			Feed supply	1	1,6
			Diseases	1	1,6

Financial aspect of shrimp culture

Analysis on the financial aspect was done with the aim to analyze whether the shrimp culture in DIY will earn profitable income and be able to restore financing granted by the Bank within a reasonable period. The results of this analysis can be used as input for the financing institutions (to assess the credit application), as well as reference for shrimp farmers in planning the business management.

Investment, operational, and maintenance cost

Investment cost is the fixed cost to do shrimp culture. The investment of shrimp culture included: the construction of ponds, guard houses, construction of the warehouse, wells, pumps, windmills (aerator), harvest net, pails/jerry, scales, diesel, electric and cable network, pipes, nets, place of harvested shrimp, plastics, and drums. The total investment cost was IDR 99.845.563 on the scale of business area of 2.138 m^2 (Table 2).

Table 2. Components of shrimp culture investment cost.

Components	Average cost (IDR)	Percentage (%)	The 5 highest cost rank
Pond construction	66,616,120	66,7	1
Guard facilities	3,226,230	3,2	4
Storage	745,902	0,7	
Wells	3,027,869	3,0	5
Pumps	7,058,361	7,1	3
Paddle wheel	14,542,623	14,6	2
Harvesting net	279,262	0,3	
Bucket	584,607	0,6	
Weight	855,492	0,9	
Diesel	2,219,344	2,2	
Electrical devices	447,541	0,4	
Pipe	65,902	0,1	
Paranet	19,180	0,0	
Harvesting bucket	39,344	0,0	
Plastics	114,754	0,1	
Drum	3,033	0,0	
Subtotal (a)	**99,845,563**	100,0	

Operating cost or variable cost depends on the number of products. Components of operating costs in the shrimp culture included: shrimp fries, feed, dolomite, limestone, zeolite, urea, KCL, NPK, TSP, fertilizer, probiotic, fuel (solar), labor, land lease, electricity, vitamins etc, EM4, molasses, ZA, and the antibiotic. The average operating cost required in the first cycle of the business was IDR 49.961.184 (Table 3).

Table 3. Components of shrimp culture operational cost.

Components	Average cost (IDR)	Percentage (%)	The 5 highest cost rank
Fry	6,968,115	13,9	2
Feed	31,872,680	63,8	1
Dolomite	439,377	0,9	
Lime	117,787	0,2	
Kaptan	133,115	0,3	
Zeolite	148,525	0,3	
Urea	9,139	0,0	
KCL	213	0,0	
NPK	648	0,0	
TSP	82,000	0,2	
Other fertilizer	4,246	0,0	
Probiotic	765,705	1,5	5
Fuel	6,678,836	13,4	3
Worker	2,219,672	4,4	4
Land rents	49,180	0,1	
Electrical	115,574	0,2	
Vitamins	331,257	0,7	
EM4	7,869	0,0	
Others	7,221	0,0	
Subtotal (b)	**49,961,184**	100,0	

Maintenance costs included: treatment of pond, diesel, windmills, plastics, and net (Table 4). The average amount of funding needed for investment and working capital in the shrimp culture at the research site was IDR 167.608.540.

Table 4. Components of shrimp culture maintenance cost

Components	Average cost (IDR)	Percentage (%)	The 5 highest cost rank
Pond	3,620,492	20,3	2
Diesel	2,300,910	12,9	3
Paddle whell	1,802,721	10,1	4
Plastics and net	93,115	0,5	5
Depreciation (10%)	9,984,556	56,1	1
Sub total (c)	**17,801,794**	100,0	

Profit projection

An average of ponds ownership about 2.138 m^2 per shrimp farmers and the farmer can have harvested approximately 1.900 kg/cycle or approximately 5.54 kg/year. In this research, the average price was calculated at IDR 51.769 shrimp/kg (the average price of a variety of sizes of harvested). Based on the number of production and the price, it was known that the total income per cycle was IDR 98.348.609 or equivalent to IDR 286.544.232 per year (an average of 3 cycles of harvests per year). With an estimated total cost of IDR 210.590.175 (total cost after the risk cost of 15% included in the calculation), then it obtained a net profit got by farmers of IDR 75.954.057 per year (Table 5).

Table 5. Components of shrimp culture maintenance cost

No.	Components	Average (IDR)
1	Harvest (kg)	5,535
2	Price/kg	51,769
3	Total revenue (1*2)	286,544,232
4	Total cost (a+b+c+d) (IDR)	210,590,175
	a. Investment cost (IDR)	99,845,563
	b. Operasional cost (IDR)	49,961,184
	c. Maitenance and depreciation (IDR)	17,801,794
	d. Risk (15%) (IDR)*	42,981,635
	Net profit (π = 3 – 4) (IDR)	**75,954,057**

The financial analysis shows that the shrimp culture was profitable. However, this study used fix price of shrimp at average of IDR 51.769/kg. In fact, the shrimp prices actually tend to fluctuate according to the number of demand and offer of the shrimp in the global market, although with the rising trend. FAO Food Outlook-Mei 2014 (FAO, 2014[b]) gave an indication that during 2013, the price of shrimp rose because of limited supplies due to decrease production of shrimp in China, Thailand, and Mexico caused by EMS (early mortality syndrome). In Japan, shrimp prices were even reported rising of more than 30% between 2012 and 2013 (FAO, 2014[b]). However, farmers need to pay attention that if the third parties determine the price, then the business is only seasonal, prone to decline, because the price is too much influenced by the interest rate.

Analysis of shrimp farming sustainability

Sustainability become a very prominent issue in the management of shrimp culture in various regions of the world. The issue is important because various experiences of failure in managing the shrimp culture, especially at the North coast of Java, for the case of Indonesia. To know the sustainability indicators of shrimp culture in DIY, shrimp farmer perception analysis on the issues has been conducted. The indicators were compiled with references to the parameters of white shrimp production with intensive technologies (SNI 01-7246-2006), the assessment of aquaculture development sustainability (Samuel-Fitwi *et al*., 2012), principles and practice of sustainable aquaculture (Bosma & Verdegen 2011), and international standard of responsible shrimp culture (FAO/NACA/WB/WWF/UNEP, 2006).

Based on perception data, there were four group of indicators being developed i.e. technical indicators (**Technical 1-6**), Economic indicators (**Economic 1-9**), Social indicators (**Social 1-7**), and Environmental indicators (**Environmental 1-8**) as presented in Table 6. Each of the indicators has 6-9 sub-indicators, and thus the total number of sub-indicators was 30 Perception-based indicators. Respondents were requested to give an agreement or disagreement on the statement, with the lowest value of 1 (one) and the highest of 7 (seven). A value of 1 (one) shows that respondents strongly disagree with the statement, while the value of 7 (seven) shows that respondents are strongly agree. The higher the value thus indicates the higher level of respondents' approval or vice versa on the statement (Table 6).

Table 6. Perception-based indicator components for shrimp culture in DIY.

A. Technical Indicators

1. Shrimp farming is easy to do because the technology is available and can be accessed by anyone (**Technical 1**)
2. Availability of production factors (fry, feed, fertilizer, fuel, etc.), easiness and affordable price (**Technical 2**)
3. Fry used are certified juveniles (**Technical 3**)
4. Farmers can harvest a variety of sizes to suit the market demand (**Technical 4**)
5. The risk of failure is low (including shrimp is not susceptible to disease) (**Technical 5**)
6. Any farmer managing the cultivation residual or waste (**Technical 6**)

B. Economic Indicators

1. Shrimp culture can improve fishery household incomes (**Economics 1**)
2. Worker revenue on average higher than other business (**Economics 2**)
3. High opportunity as regional income (PAD) and trigger for other economic activities to grow (**Economics 3**)
4. Ability to create jobs (new shrimp farmer keeps popping) (**Economics 4**)
5. The price of shrimp products is competitive and profitable (**Economic 5**)
6. No problems related to availability of labor (**Economic 6**)
7. Access to the market is more easier (**Economy 7**)
8. Farmers invest for the repair and improvement of business units (**Economic 8**)
9. Ability to pay by installments and pay off debts on time or according to the agreement (**Economic 9**)

C. Social Indicators

1. The quality of life of fish farmers continues to improve (an improvement of nutrition and family nutrition and education of children) (**Social 1**)
2. Shrimp farming poses no potential of social conflict (**Social 2**)
3. Access to cultivated land is easy and not problematic (**Social 3**)
4. Aquaculturist became a member of shrimp farming association and is involved actively in the association (board, meetings, dues, etc.). (**Social 4**)
5. Shrimp farmers easily adopt new technologies (**Social 5**)
6. Legislation and local regulations to reduce negative externalities (adverse effects) is available and followed (permits etc.) (**Social 6**)
7. Expect children to become shrimp farmers in the future (**Social 7**)

D. Environmental Indicators

1. The coastal ecosystem (mangroves, caswarina tree, etc.) well maintained, although there is shrimp farming **(Environment 1**)
2. There are no significant environmental disruption (ex. the intrusion of seawater does not occurred) (**Environment 2**)
3. Fish farming using recirculation system (**Environment 3**)
4. The cultivation has been equipped with a waste water management unit (**Environment 4**)
5. Shrimps farmers adopted guidelines or code of conduct on the responsible shrimp farming (**Environment 5**)
6. No need to use antibiotics and chemicals to improve results (**Environment 6**)
7. Shrimp pond is not easy and no potential disease (**Environment 7**)
8. Location ponds mostly not violate commensurate beach and river (**Environment 8**)

Figure 3 shows an overview of the respondents' responses related to 30 sub-indicators of sustainability of shrimp farming on the southern coast of DIY. Figure 3 also shows the detail of responses based on respondent groups, i.e. shrimp farmers in Jangkaran Village and Poncosari Village and non-shrimp farmers from the two villages. Figure 4 further presents the aggregate value of the entire indicators based on the average value of indicators of technical, social, economic and environmental.

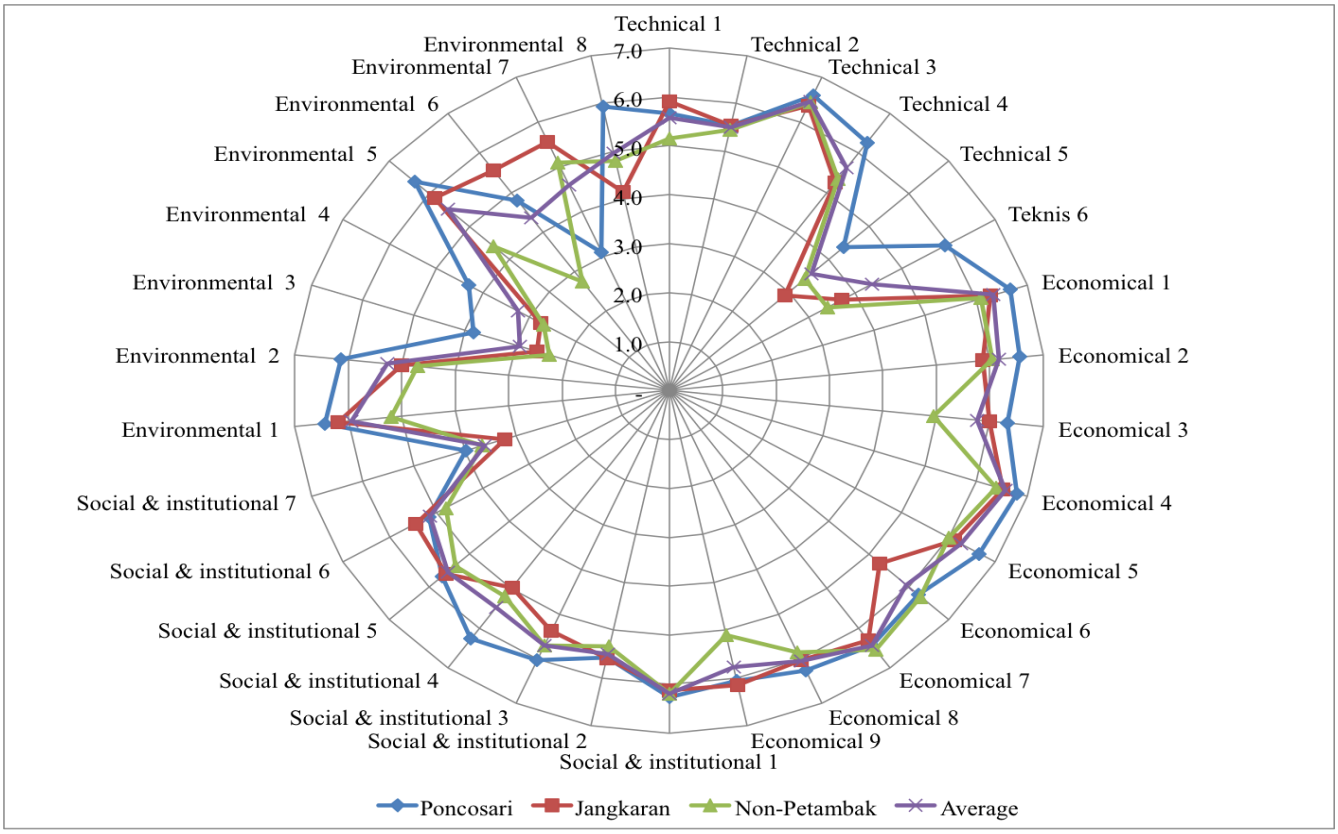

Figure 3. Respondent Perception-based indicator of shrimp culture sustainability in DIY.

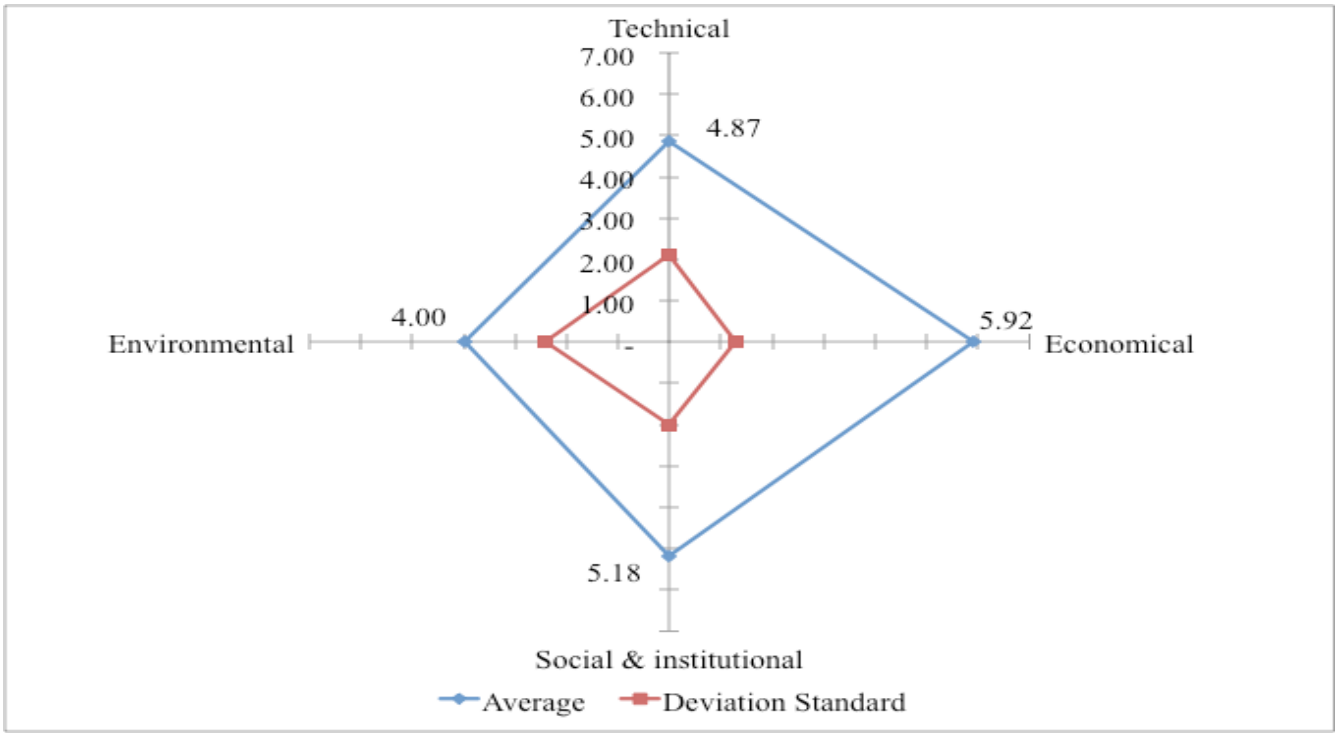

Figure 4. Sustainability indicator of shrimp culture in DIY.

Based on the data presented in Figure 3 and Figure 4, the study shows that the entire economic indicators had a high value or a high level of agreement on each statement of a group of farmers and non-farmers in both the Poncosari and Srandakan. The average index of perception of respondents related to the sustainability economically achieved the value of 5.92 (scale of 1-7). These results indicate that the shrimp culture was able to improve the fish farmer income (**Economic 1**), encourage growing investment in fisheries (**Economic 8**), able to pay in installment and pay off the debt on time or according to agreement (**Economic 9**), provide work opportunity (**Economic 4**) with a higher income of workers (**Economic 2**), and had a chance to contribute regional income (PAD) as well as being a catalyst for other economic development (**Economic 3**).

The second indicator with a high average value was the social indicator, i.e., with a value of 5.18. This indicator had data distribution that was not too wide on each sub-indicator being asked. Ponds according to respondents were able to improve the quality of farmers' life (there is nutrition improvement in the family and children education) (**Social 1**), did not pose the potential of and/or social conflict occurrence (**Social 2**), provided a space for socializing, i.e. by becoming a member of the farmer association and active in the activities of the association (board, meetings, dues, etc.) (**Social 4**). One indicator, however, had the lowest value on social indicator, with the perception index ranged from 3.2-3.65 that was associated with the respondents' expectation to lead children as future farmers (**Social 7**). This data shows that the respondents did not expect their children to become farmers in the future, but respondents expected their children to work out of the farming. It also gives an overview that although the shrimp farming was economically profitable, however it socially has not been able to give a pride for the family and society in the present and in the future.

Based on technical aspect, the shrimp culture had a sustainability indicator with the value of 4.87. This business technically had a potential to be sustainable since shrimp culture was easy to do for the available technology and could be accessed by anyone (perception index of 5,79) (**Technical 1**), the availability of fries, feed, fertilizer, fuel, etc. were easy and the price was affordable (Index 5.53) (**Technical 2**), using certified fries (Index 6.48) (**Technical 3**), and farmers could harvest a variety of size based on the market demand (index 5.74) (**Technical 4**). However, technically, this business was seen to have a high risk of failure, one of them when the disease strikes (the average of perception index related to business statement had only a small risk of 3.61 and the lowest was in Jangkaran with the index 2.9) (**Technical 5**). Another index that was pretty low of the technical indicator was related to waste management (**Technical 6**). Respondents had perception index of 4.79 related to statements of each farmer carried out waste management in the current shrimp culture. This index was primarily very low in farmers' and non-farmers' perception in Jangkaran. Waste management problems that most of them unavailable need to be anticipated by farmers.

The lowest indicators of sustainability in shrimp culture was the environmental indicator, with the perception index of sustainability of 4.0 and high standard deviation, i.e. of 2.43. Related to the waste water management issues, farmers had not conducted such management yet. Farmers also generally did not perform the recirculation of the water (index 3.19) (**Environmental 3**), and the respondents were also not equipped their pond with waste water management unit (index 3.5) (**Environmental 4**). Nevertheless, the respondents justified that the practice of cultivating shrimp was adopting the guidelines on responsible shrimp culture (**Environmental 5**), not damaging ecosystems (mangroves and other trees) (**Environmental 1**), not making changes on the environment (e.g. the intrusion of seawater does not occur/has not occurred) (**Environmental 2**), and not using antibiotics and chemicals to improve the product outcomes (**Environmental 6**).

Based on the sustainability indicator, the management framework of more environmentally friendly and sustainable development of pond aquaculture needs to be developed at the southern coast of DIY. Environmental issues using the four indicators show the average lower values than other indicators. With the failure experience of the tiger prawn culture by farmers in Jangkaran, particularly due to the environmental issues, the setting up of environmental sound shirmp culture became an important aspect. The zoning plan that has been established through provincial regulation such as zoning plan of the coastal areas and small islands of DIY in 2011-2030, followed by drafting documents of coastal management need to be enforced to avoid violations on the use of spaces in the coastal areas.

CONCLUSION

The shrimp culture at the southern coast of DIY was initiated in the mid-1980s in Jangkaran Village, Kulonprogo regency and in the early of 2000s in Poncosari village, Bantul Regency, yet expanded rapidly since 2013 both in the Jangkaran and Poncosari as well as along the coast in the two regencies.

The rapid development of shrimp culture were related to three important factors: (1) the emergence of technological innovations in shrimp aquaculture on the sand-soil land, i.e. (a) with growing of asbestos wall farms that is more affordable than the previous culture technology and (b) the innovation of the easier sea-water retrieval system using the absorption wells; (2) an open market opportunities and high shrimp prices during the research period; and (3) the physical environmental changes due to the high waves and abrasion demanding coastal communities adaptation strategies.

The average ownership of farms was 2.138 m^2 and farmers applied intensive culture technology, with an average stocking density of 144 shrimps/m^2. The average production per year reached 25.9 tons/ha and with total value of IDR 286.544.232 per year. The total cost of production was estimated at IDR 210.590.175 per year, and a net profit of IDR 75.954.057 per year.

The Perception-based analysis of shrimp culture

sustainability with the four group of indicators, scale 1-7, the study indicates the lowest to highest indicators as follows: (a) environmental indicators (with 8 sub-indicators), (b) technical indicators (with 6 sub-indicators), (c) social indicators (with 7 sub-indicators), and (d) economic indicators (with 9 sub-indicators). Therefore, the study shows that the economic benefit of the shrimp culture will be challenged by the environmental issues for its sustainability. Waste water management is one of important environmental issues.

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