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ADOPTION LEVEL OF GOOD AQUACULTURE PRACTICES IN BRACKISH WATER POND AQUACULTURE IN PINRANG REGENCY, SOUTH SULAWESI PROVINCE

TINGKAT ADOPSI CARA BUDIDAYA IKAN YANG BAIK DI BUDIDAYA TAMBAK, KABUPATEN PINRANG, PROVINSI SULAWESI SELATAN

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ABSTRACT

Pinrang Regency is a center of brackish water pond aquaculture production in South Sulawesi Province in which some of brackish water pond farmers in this regency have adopted Good Aquaculture Practices (GAqP). A study was conducted to determine GAqP adoption level, to identify GAqP aspects required to be improved, and to determine the category of GAqP adoption level as the first step to maximize the GAqP adoption level in the brackish water ponds. Primary data were obtained from 76 respondents consisted of pond farmers who already have adopted and or obtained GAqP certificates. On the basis of the adoption level, the adoption level classification is carried out into three categories, namely low adopters, medium adopters, and high adopters. The results showed that the highest GAqP adoption levels in brackish water ponds were in food security (89.41%) and technical aspects (78.57%). The lowest GAqP adoption levels were in management (8.71%) and environmental aspects (0%). It was also reported that the GAqP adoption level in brackish water ponds varied from 40.58 to 67.01% with an average of 42.86% and was categorized as moderate adopters. Based on this study, management and environmental aspects were found to be the aspects that need serious attention to increase the GAqP adoption level in the brackish water ponds.

Keywords: adoption, brackish water pond, GAqP, Pinrang Regency.

ABSTRAK

Kabupaten Pinrang merupakan sentra produksi budidaya tambak di Provinsi Sulawesi Selatan dan sebagian pembudidaya tambaknya telah mengadopsi Cara Budidaya Ikan yang Baik (CBIB). Penelitian bertujuan untuk mengetahui tingkat adopsi CBIB untuk dapat mengidentifikasi aspek CBIB yang perlu ditingkatkan dan menentukan kategori tingkat adopsi CBIB sebagai langkah awal untuk dapat memaksimalkan tingkat adopsi CBIB di tambak Kabupaten Pinrang. Data primer diperoleh dari 76 responden yang merupakan populasi pembudidaya tambak yang telah mengadopsi dan atau memiliki sertifikat CBIB. Atas dasar tingkat adopsi dilakukan klasifikasi tingkat adopsi atas tiga kategori, yaitu pengadopsi rendah, pengadopsi sedang, dan pengadopsi tinggi. Hasil penelitian menunjukkan bahwa tingkat adopsi CBIB di tambak Kabupaten Pinrang yang tinggi didapatkan pada aspek keamanan pangan (89,41%) dan aspek teknis (78,57%) dan yang rendah pada aspek manajemen (8,71%) dan aspek lingkungan (0%). Dilaporkan juga bahwa tingkat adopsi CBIB bervariasi dari 40,58 sampai 67,01% dengan rata-rata 42,86% dan dikategorikan sebagai pengadopsi sedang. Aspek manajemen dan aspek lingkungan akan menjadi aspek yang perlu mendapatkan perhatian serius untuk meningkatkan tingkat adopsi CBIB di tambak Kabupaten Pinrang.

Kata kunci: adopsi, tambak, CBIB, Kabupaten Pinrang.

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INTRODUCTION

Increase in quality of aquaculture product is more addressed to provide food safety assurance, from raw materials to aquaculture product that is contaminant-free to fulfill the market requirement. Good Aquaculture Practices (GAqP) is the adoption of practices to maintain or raise shrimp/fish to finally harvest the output in a controlled environment to guarantee food security from aquaculture by considering sanitation, feed, fish medicine, chemical and biological products, also the balance of ecosystem and environment as stated in Kepmen KP No. KEP.02/MEN/2007 (KKP, 2007a). This program was established to encourage aquaculturists to adopt GAqP since adopting GAqP reflects a real action made by pond farmers to increase product quality and improve aquaculture sustainability.

GAqP is a program encouraged by the government that is the Directorate General of Aquaculture (DGA) of the Ministry of Marine Affairs and Fisheries (MMAF) to ensure the quality and safety of aquaculture products. GAqP in Indonesia was established in 2004 with an initial concept that focused on the land requirements for shrimp culture. Later, this concept was developed by GAqP in 2007 with a focus on food safety. Moreover, related to the process of ensuring the quality and safety of aquaculture products, the government the concept was followed up through Permen KP No. PER.01/MEN/2007 (KKP, 2007b), as amended by Permen KP No. PER.04/MEN/2008 (KKP, 2008), and further revised by Permen KP No. PER.19/MEN/2010 (KKP, 2010). In 2012, GAqP was synergized with FAO Guidelines and ASEAN Good Aquaculture Practices for Shrimp Farming Standard to ensure the national quality system to be dynamically competitive in regional, national, and international markets. In 2015, DGA started the Preparation for Guideline of Ecosystem Approach to Aquaculture (EAA) which necessarily meet three principles, namely the principle of ecosystem sustainability, improvement of community welfare, and integration, hence facilitating both principles will result in harmony. A problem often faced by pond farmers in the adoption of GAqP is the lack of awareness and commitment of pond farmers concerning the importance of GAqP implementation considering the effort to increase quality assurance and safety of aquaculture products by also taken into account ecosystem balance and environment. Coordination among sectors within the scope of government frequently deals with technical problems in the adoption of GAqP program due to lack of communication.

Pinrang Regency is one of the aquaculture production centers, particularly for brackish water pond aquaculture in South Sulawesi. The largest brackish water pond in South Sulawesi is located in Pinrang Regency which covers an area of 15,026 or 13.85% of the total brackish water pond area in South Sulawesi (DKP, 2020). As one of the regencies with the largest brackish water pond industry in South Sulawesi, many programs have been applied in this regency, among others is GAqP that has been implemented since 2007. Several fish farmer groups (*pokdakan*, *kelompok pembudidaya ikan*) have adopted or applied GAqP, and even obtaining the GAqP certificate. However, the adoption has not yet been optimally done due to many problems. As reported by Hishamunda *et al*. (2014) and Kusumawati and Bush (2015), the adoption of policy and governance in aquaculture by producers could lead to problems since it requires investment in time, effort, and money, thus many

producers rejected it. As mentioned by Rogers (1995), four main elements that affect the spread of new ideas: innovation, communication channel, time, and social system. Therefore, to achieve a sustainable brackish water pond in addition to support the program initiated by the elected Governor of South Sulawesi in 2018, that is Restoring the Glory of Tiger Shrimp in South Sulawesi and increasing the quality and quantity of production, it is necessary to conduct a study on GAqP adoption level in brackish water ponds in Pinrang Regency. This study aimed to determine the adoption level of GAqP, allowing the identification of GAqP aspects that need to be improved also to determine the category of GAqP adoption level as the first step to maximize the adoption level of GAqP in brackish water ponds in Pinrang Regency.

RESEARCH METHODS

Place and Time of Study

The study was carried out in brackish water pond clusters of SalopokkoE and CempaE Fish Farmer Groups in Wae Tuwoe Village and Pottotau Fish Farmer Group in Lanrisang Urban Village, Lanrisang Subdistrict and Rawa Subur Lapolo Balena Fish Farmer Group in Patobong Village, Mattiro Sompe Subdistrict, Pinrang Regency, South Sulawesi Province, Indonesia in March, September, and October 2019. Focus Group Discussion on the implementation of GAqP participated by stakeholders related to brackish water ponds in Pinrang Regency, Fisheries and Marine Sevices of South Sulawesi Province, and Research Centre for Marine and Fisheries Socio-Economic was done in the capital city of Pinrang Regency, i.e., Pinrang in July 2019.

Data Collection

Descriptive research was applied in this study with a research instrument or data collection tool in the form of a questionnaire. In this descriptive study, the survey method was conducted in primary data collection through interviews and structured observation to obtain detailed information about the object assessed. Data collection to determine GAqP adoption level was done through the cencus method to all respondents that have already adopted or obtained GAqP certificate. A population of 76 respondents was selected in this study. Information required were 53 principles and 18 requirements of GAqP as stated in the Regulation DJPB No. 65/PER-DJPB/2015 (DJPB, 2015b).

Interview and structured observation were applied to collect information of GAqP adoption for requirements of location; water supply; layout and design; sanitation of facilities and equipment; pond preparation; water management; fry; use of chemicals, biological materials, and fish medicine; harvest; waste disposal; recording; corrective action; training; and personal hygiene were obtained from respondents of pond farmers. Information of GAqP adoption particularly concerning the use of ice and water, postharvest handling, and transportation was obtained from interviews and structured observations on respondents working as shrimp collectors in Lanrisang Urban Village (Lanrisang Subdistrict) and Pallameang Urban Village (Mattiro Sompe Subdistrict).

Data Analysis

The data collected were further tabulated, read, examined, and pre-analyzed by performing data reduction, data categorization, data validation, and finally data interpretation (Moleong, 2010). Respondents who have adopted GAqP principles should answer “yes”, and otherwise “no”. The answer “yes” was given a score of 1 and “no” was given a score of 0. All answers with a score of 1 were summed up to obtain the total number of principles adopted by pond farmers. The adoption level of GAqP by pond farmers was calculated by adjusting the formula developed by Farid *et al*. (2015).

$$\text{Adoption level} = \frac{\text{Number of principles adopted by pond farmers}}{\text{Total of principles to be adopted}} \times 100\% \quad (1)$$

The calculation of the average GAqP adoption level was in accordance with GAqP aspects and each fish farmer group. Therefore, adoption level was divided into three categories following Prasad and Jain (2018), the namely low adopter (adoption level of 0−33.33%); moderate adopter (adoption level of 33.34−66.66%), and high adopter (adoption level of 66.67−100.00%).

RESULTS AND DISCUSSION

Adoption Level of GAqP Aspects

Adoption is the process of receiving new things (innovation) offered by others. The main purpose of diffusion of innovation is the adoption of an innovation, namely ideas, knowledge, and technology, both by individuals or certain social groups (Rogers, 1995). The adoption of GAqP in fish farmer groups in Pinrang Regency has started in 2007. This way, the adoption of GAqP in Pinrang Regency is considered fast, only took three years after the establishment of GAqP in Indonesia in the year 2004. As a comparison, GAqP, which started in 2004 and until 2020, out of 6 million fish farmers in Indonesia, only 8,000 fish farmers (0.13%) were certified to implement GAqP (KKP, 2020). According to Rogers (1995) and de Oca Munguia *et al*. (2021), the rate of adoption is influenced by factors: the nature of the innovation, the nature of its target, the way of decision making, the communication channels used, the state of the extension agent, and the variety of information sources. However, three fish farmer groups in Lanrisang Subdistrict, namely SalopokkoE, CempaE, and Pottotau started to adopt GAqP in 2017, 2015, and 2014, respectively and respectively obtained certificate in 2018, 2018, and 2015. The fish farmer group of Rawa Subur Lapolo Balena in Mattiro Sompe Subdistrict started to adopt GAqP in 2012 and obtained a certificate in 2014. The adoption level of GAqP by each fish farmer group is presented in Table 1.

According to the Regulation of DJPB No. 65/PER-DJPB/2015 (DJPB, 2015b), there are 18 requirements of GAqP which is grouped into four aspects of GAqP adoption, namely the aspects of technical, management, food safety, and environmental described in the following section.

Table 1. Adoption Level of Good Aquaculture Practices by Four Fish Farmer Groups in Brackish Water Pond Aquaculture in Pinrang Regency, South Sulawesi Province, Indonesia

No.	Aspects / Requirements	Adoption Level (%)				
		SalopokkoE n = 16	CempaE n = 14	Pottotau n = 12	Rawa Subur Lapolo Balena n = 34	Average
1	Technical					
	a Location	100.00	100.00	100.00	100.00	100.00
	b Water supply	100.00	100.00	100.00	100.00	100.00
	c Layout and design	28.13	28.57	29.17	34.56	30.11
	d Sanitation of facilities and equipment	50.00	50.00	50.00	50.00	50.00
	e Pond preparation	100.00	100.00	100.00	100.00	100.00
	f Water management	28.13	42.86	4.17	4.41	19.89
	g Fry	100.00	100.00	100.00	100.00	100.00
	h Use of ice and water	100.00	100.00	100.00	100.00	100.00
	i Harvest	100.00	100.00	100.00	100.00	100.00
	j Postharvest handling	75.00	75.00	75.00	75.00	75.00
	k Transportation	100.00	100.00	100.00	100.00	100.00
	l Corrective action	0.00	0.00	50.00	50.00	25.00
	m Training	100.00	100.00	100.00	100.00	100.00
	n Personal hygiene	100.00	100.00	100.00	100.00	100.00
	Average	77.23	78.32	79.17	79.57	78.57
2	Management					
	a Recording	9.38	8.16	8.33	8.97	8.71
3	Food Safety					
	a Feed	100.00	95.24	100.00	100.00	98.81
	b Use of chemicals, biological materials, and fish medicine during culture	80.00	80.00	80.00	80.00	80.00
	Average	90.00	87.62	90.00	90.00	89.41
4	Environmental					
	a Waste disposal	0.00	0.00	0.00	0.00	0.00
Average		44.15	43.53	44.38	44.64	44.18

(Source: Primary Data Analysis, 2020)

From Table 1 it can be explained in the following section.

1. Aspect of Technical

Two requirements of GAqP included in the technical aspect are location and water supply. In general, both components are included in land suitability for brackish water pond aquaculture. Hence, this finding is in accordance with the initial concept of GAqP which focuses on the land requirements for shrimp culture as previously mentioned. Results of the study showed a perfect GAqP adoption level of 100% in four fish farmer groups (Table 1). Based on the result of a study conducted by Mustafa *et al*. (2008) which included factors of topography and hydrology, soil condition, water quality, and climate, the ponds of the four fish farmer groups were considered suitable for brackish water ponds, both in the rainy season and dry season.

Three principles were found to be incompletely adopted by the four fish farmer groups in the context of layout and design of brackish water ponds, namely: the design and layout of brackish water pond were not able to prevent cross-contamination; other facilities potentially contaminated aquaculture products, and ponds were not facilitated with the wastewater treatment plant. One

principle of pond layout and design requirement adopted by the four fish farmer groups is that they used the ponds only for the brackish water ponds purpose.

Brackish water ponds of the four fish farmer groups which were located in Pinrang Regency were not yet met the hygiene and sanitation requirement. Animals such as cattle and goats were found grazing in the pond dyke. However, fuels and other materials were no longer stored around the pond since pond farmers kept them in their houses. This way, materials are securely stored and will not contaminate the pond. Other facilities and equipment were made from materials that are safe for aquaculture products, thus preventing product contamination.

Pond preparation conducted by the four fish farmer groups in Pinrang Regency was not optimally done even though this activity was basically performed with the aim to prepare the brackish water ponds themself. On average, the status of brackish water ponds used by the four fish farmer groups was in contract. The contract was normally started in September or October, hence pond preparation was done during this period. Also, it was observed that pond farmers were no longer use inorganic pesticides to eradicate pests since they only used organic pesticides, namely saponin. The study carried out in 2005 by Mustafa and Ratnawati (2007) showed that pond farmers in Pinrang Regency included those in Lanrisang and Mattiro Sompe Subdistricts, still used inorganic pesticides that contained Endosulfan, Metidation, and Sipermetrin during pond preparation and Deltamethrin during culture. All inorganic pesticides are potentially toxic to all sorts of life and some are even classified as probable human carcinogens, neutrotoxics, and endocrine system disruptors (Malhat *et al*., 2018; Ajiboye *et al*., 2020). The government has prohibited the use of pesticide containing those active compounds in brackish water ponds for their high toxicity, their characteristics that are difficult to be degraded might accumulate in pond soil and have a high potential to be accumulated in the tissue of the organism.

Besides using pesticides to eradicate pests during pond preparation, pond farmers in Pinrang Regency also used fertilizer, both organic and inorganic fertilizer, and lime. Fertilizer and lime are chemical products mostly used in Asian ponds (Phillips, 2000; Mishra *et al*., 2017), including brackish water ponds in Indonesia (Mustafa *et al*., 2010), and brackish water ponds in South Sulawesi (Mustafa *et al*., 2009). The use of fertilizer and lime in brackish water ponds is expected to have no negative impact on environment. So far, the environmental problems due to the use of fertilizer and lime have not yet been found in Asia (Phillips, 2000; Hossain *et al*., 2013) and in the world (Ajiboye *et al*., 2020).

There are two principles of water management requirement assessed in this study, namely brackish water ponds have water reservoir and pond farmers conduct regular monitoring of water source quality to ensure the health and sanitation of shrimp/fish cultured. It was found that only 1 pond farmer from the Fish Farmer Group of Rawa Subur Lapolo Balena had a reservoir for clean water. In terms of other principles, many ponds were remained unmonitored for their water source quality. Water quality should be regularly monitored to maintain the health and sanitation of shrimp/fish besides ensuring aquaculture product is safe to consume. Pond farmers also did not conduct general monitoring of water quality in brackish water ponds, however, this activity was

performed by other parties, yet they did not inform the result to pond farmers. The adoption level of GAqP for water management requirements was categorized as low in a range of 4.17−42.86% with a average of 19.89% (Table 1).

The brackish water pond aquaculture culture system applied by the four fish farmer groups was polyculture of tiger shrimp (*Penaeus monodon*) and milkfish (*Chanos chanos*). Shrimp fry was obtained from the hatcheries located in Suppa Subdistrict, Pinrang Regency and Mallusetasi Subdistrict, Barru Regency which has adopted the Good Hatchery Practices, thus resulted in an adoption level of 100%. Shrimp fry was separated in rearing brackish water ponds before being stocked in the grow-out pond to enhance their vitality besides preparing for immediate harvest and sale due to disease attacks.

The requirement for the use of ice and water; harvest; postharvest handling; and transportation performed by the four fish farmer groups obtained a high level of adoption with similar value. This situation was possible since the adoption of four requirements was done by shrimp collectors in Lanrisang and Mattiro Sompe Subdistricts that have basically adopted the Standard Operational Procedure (SOP) required by the shrimp market in Japan, the European Union, and the United States of America for postharvest handling of brackish water ponds. Partial harvest was conducted by pond farmers to be immediately transported to collectors in two subdistricts. Later, these collectors carried out product handling according to the SOP by using water and ice hygienically. Transporting aquaculture products was also done by collectors in the subdistricts to be further delivered to larger collectors in the capital city of Pinrang Regency in Pinrang.

Pond farmers were observed to have not performed any corrective actions in preventing and controlling food safety. To say, the wastewater treatment plant was not applied by pond farmers, pond waste possibly contaminated the product produced. Furthermore, animals roamed freely in the pond areas and might contaminate the products produced from brackish water ponds. Sanction in the form of payment amounted to IDR 500,000.00/cattle was applied, yet this effort was proven to be ineffective since cattle were still found in pond dyke and no action was taken.

Availability of human resources, includes high-quality pond farmers, is the main capital to be the business player in brackish water ponds. Hence, the capability of pond farmers should be developed through regular training, seminar, workshop, and dissemination along with the technological advance that is proven to benefit pond farmers, not only in terms of production quantity but also in terms of production quality. Finding of Kamaruddin and Baharuddin (2015) and Samah and Kamaruddin (2015) indicated that pond farmers with more experience in aquaculture were found to have a higher level of technical knowledge, and have participated in training related to aquaculture, have the potential to increase the adoption level of GAqP in Kedah, Malaysia. Respondents in this study commonly have attended various pieces of training, seminars, workshops, and/or dissemination programs related to brackish water ponds including GAqP, therefore the principle of training obtained adoption level of a 100%.

2. Aspect of Management

One of the institutions assisted by the government and provided for the main player and fishery business players according to Kepmen KP No. KEP.14/MEN/2012 (KKP, 2012) is a fish farmer group, which is an organized group consists of pond farmers. Therefore, the four fish farmer groups in Pinrang Regency have their organizational structure and management since fish farmer groups have similar goals, interests, and motives, particularly in fishery business; similar tradition, domicile, business location, economic status, and language; informal status; inter-dependence between individuals; independent and participatory; controlled by regulations/norms mutually agreed; and have organized administration. Research findings showed that solid and close groups will adopt innovation *via* their group (Rogers, 1995; Hofstra *et al*., 2020). However, data processing which included the recording of type and origin of feed; the use of chemical materials, biological materials, and fish medicine; record-keeping for data of water quality according to the requirement; and record-keeping for data of disease incidence that might have an impact on food safety of aquaculture product were not completely done. Similarly, Ayuningtyas *et al*. (2018) confirmed that one of the problems faced in the adoption of GAqP in East Bolaang Mongondow Regency, North Sulawesi Province was the absence of recording in pond farming business activity development, such as fish hatching/nursery, grow-out, harvest, handling, and distribution of the product. The weak recording system is the major factor causing the loss or broken chain of fishery product traceability since the applicable system, particularly in the small business units and the public, has not supported the implementation of good traceability system (Dwiyitno, 2009). Pond farmers should conduct document recording that ensures traceability of shrimp/fish products. Shrimp exporting countries have also required traceability data of imported shrimp, the role of recording is therefore necessary. In terms of the management aspect, the level of GAqP adoption in brackish water ponds in Pinrang Regency varied between 8.16−9.38% with an average of 8.71%.

3. Aspect of Food Safety

The aspect of food safety in GAqP includes a requirement for feed and the use of chemical, biological materials, and fish medicine during culture. In the assessment of six principles of feed requirement, GAqP adoption has been completely adopted. A total of 13 out of 76 pond farmers used commercial feed or self-made feed in Pinrang Regency. It was observed that most pond farmers applied traditional technology, and only a small portion adopted traditional plus technology, hence they did not use commercial feed. The type of commercial feed used by pond farmers was the recommended type; artificial feed was well-stored; artificial feed was used before the expiration date; the artificial date was not mixed with feed additives; artificial feed was given appropriate to the recommended dosage and frequency; and artificial feed used was equipped with information about composition, expiration date, dosage, and frequency of feeding. It was found that pond farmers used artificial feed, yet they self-made the feed using local ingredients as observed in the Fish Farmer Group of Pottotau. The use of self-made artificial feed has fulfilled the requirement in GAqP since

pond farmers were able to explain the formula, the process of feed production, and the result of proximate analysis of feed from the accredited laboratory.

The four fish farmer groups in Pinrang Regency properly used the chemical materials, biological materials, and fish medicine according to the GAqP requirement. Cruz-Lacierda *et al*. (2008), Makori *et al*. (2017), Hasan and Banerjee (2020) and Zhang *et al*. (2020) reported that the use of chemical and biological products in aquaculture is aimed at increasing natural productivity, maintaining the optimal physical-chemical water parameter for the growth of cultured organisms, and preventing as well as treatment for a disease problem. Chemical problems used during culture in the ponds were only in the form of fertilizer and lime to improve water quality. Biological materials used during shrimp/fish culture were small-sized crustaceans, identified as Phronima Suppa (*Phronima* sp) by Fattah *et al*. (2015, 2017). One of the fish medicine applied during culture was RICA probiotic that is produced by the Research Institute of Coastal Aquaculture and Fisheries Extension. There is only one principle out of five requirement principles assessed, namely testing to detect residual of chemical materials and fish medicine, with the result of below the threshold if compared to ponds that did not adopt GAqP, hence, the four fish farmer groups achieved GAqP adoption level of 80% in term of a requirement for feed and the use of chemical materials, biological materials, and fish medicine.

4. Aspect of Environment

There is one requirement in the environmental aspect, that is waste disposal requirement that only has one principle, namely the principle of waste treatment by applying hygiene and sanitation practices to prevent contamination. Unfortunately, out of all respondents selected from four fish farmer groups in Pinrang Regency, not even one pond farmer performed wastewater treatment plant before pond water is discharged, resulted in a 0% adoption level of GAqP in terms of the environmental aspect. Several factors contributed to the absence of wastewater treatment plant activity in the ponds, for example, farmers applied traditional technology that does not require a wastewater treatment plant. Another factor is that most pond farmers only rent the pond, thus they only focused on doing activities in the grow-out ponds to produce shrimp/fish. As observed in South Lampung Regency, Lampung Province, whiteleg shrimp (*Litopenaeus vannamei*) farmers thought that sacrificing brackish water ponds for wastewater treatment plants will only put them at a disadvantage (Kuku, 2017).

Category of GAqP Adoption Level

The analysis of GAqP adoption level according to four aspects of GAqP showed that GAqP adoption level in brackish water ponds in Pinrang Regency was high in the aspects of food safety (89.41%) and technical (78.57%) and low in the aspects of management (8.71%) and environment (0%) (Table 1). Analysis result of 53 principles of GAqP indicated that GAqP adoption level in brackish water ponds in Pinrang Regency varied between 40.58 and 67.01% in an average of 42.86%. Referred to the category developed by Prasad and Jain (2018), the adoption level of GAqP in Pinrang Regency was categorized as a moderate adopter (adoption level of 33.34−66.66%), which was conducted by 75 of total 76 pond farmers or 98.68% (Table 2).

Table 2. Adoption Level Categories of Good Aquaculture Practices in Brackish Water Pond Aquaculture Owned by Four Fish Farmer Groups in Pinrang Regency, South Sulawesi Province, Indonesia

Category of Adoption Level*	SalopokkoE n = 16		CempaE n = 14		Pottotau n = 12		Rawa Subur Lapolo Balena n = 34		Total n = 76	
	Pond Farmer	%	Pond Farmer	%	Pond Farmer	%	Pond Farmer	%	Pond Farmer	%
Low adopter (adoption level 0−33.33%)	0	0	0	0	0	0	0	0	0	0
Moderate adopter (adoption level 33.34−66.66%)	16	100.00	14	100.00	11	91.67	34	100.00	75	98.68
High adopter (adoption level 66.67−100.00%)	0	0	0	0	1	8.33	0	0	1	1.32
Total	16	100.00	14	100.00	12	100.00	34	100.00	76	100.00

(Source: Primary Data Analysis, 2020)
Note: * = Prasad & Jain (2018)

As seen in Table 2, no pond farmers were included in the low adopter category (adoption level of lower than 33.33%) and there was only 1 pond farmer or 1.32% belonged to the high adopter category (adoption level of higher than 66.67%) in brackish water ponds in Pinrang Regency. The adoption level of 45% was relatively similar to the result of a study conducted by Ayuningtyas *et al*. (2018) on GAqP adoption in freshwater pond aquaculture in East Bolaang Mongondow Regency. Study of GAqP adoption in semi-intensive whiteleg shrimp culture in Galur Subdistrict, Kulon Progo Regency and Srandakan Subdistrict, Bantul Regency, Special Region of Yogyakarta resulted in an adoption level of 62.24% related to the assessment of 21 GAqP principles (Nugroho *et al*., 2016). Hence, GAqP adoption level in Pinrang Regency was lower than the finding of Nugroho *et al*. (2016). This result might be caused by the low adoption in the aspect of management and environment besides several principles in the technical aspects, such as design and layout, water management, and corrective action in brackish water ponds in Pinrang Regency.

This GAqP adoption has positively affected pond farmers, particularly for enhancing their competitiveness in the global market besides increasing local market absorption despite its less-maximal result. The achievement of GAqP adoption level in Pinrang Regency is not separated from the effort of pond farmers, support and assistance from many parties, such as central government, the provincial government, local government, academician, researchers, fisheries extension, engineer, shrimp exporter, the institution that provides information of weather and climate, independent conservation organization, organization that focuses on the development disaster management and advocates, and other stakeholders. To maximize this GAqP adoption level, real action related to the knowledge increase of pond farmers is needed to apply. Steps that motivate pond farmers to participate in training, seminar, and workshop, and/or other dissemination related to pond farming are therefore necessarily applied besides increasing the number of brackish water ponds training locations to improve the knowledge of pond farmers that eventually will enhance the quantity and quality of production. Similarly, Nugroho *et al*. (2016) found that factors influencing GAqP

adoption in the grow-out activity of whiteleg shrimp were communication and dissemination about the technical aspect of shrimp grow-out by the employer of feed and probiotic company. Innovation is possible to be adopted by a person if it is communicated or conveyed to other people (Rogers, 1995; Appel *et al*., 2019). Apart from increasing the knowledge of pond farmers regarding their role as producers, knowledge about GAqP in technical shrimp grow-out could also be conveyed to consumers to attract their attention to purchase aquaculture products produced by pond farmers who have adopted GAqP. In order to encourage more pond farmers to adopt GAqP, the government or other stakeholders could initiate to provide incentive, subsidy, or set a higher price for shrimp/fish produced by pond farmers that have adopted GAqP since production cost spent by pond farmers that have completely adopted GAqP will be higher compared to that expended by those who do not adopt GAqP.

The adoption level of GAqP in brackish water ponds of Fish Farmer Groups of SalopokkoE, CempaE, Pottotau, and Rawa Subur Lapolo Balena was relatively similar with an average ranged of 43.53−44.64% (Table 1), indicating that pond farmers in Pinrang Regency averagely adopted 43.53−44.64% of 53 principles of GAqP in brackish water ponds. This situation showed a relative similarity among pond farmers in adopting 53 principles of GAqP in brackish water ponds. Out of the four aspects assessed, the aspects of management and environment were observed to be the aspects that need serious attention to increase the adoption level of GAqP in brackish water ponds in Pinrang Regency. It seems that GAqP adoption is only relevant or possibly applied in ponds with advanced technology (semi-intensive, intensive, and super-intensive) since pond farmers are more committed to the environmental aspect, such as pond wastewater treatment plant and management aspect like recording the use and storage of chemical, biological materials, fish medicine, feed, and fertilizer, also putting on record the water quality and disease incidence that might adversely affect food safety of aquaculture product. However, brackish water pond farmers in Indonesia mostly apply low technology in performing pond farming technologies (traditional and traditional plus) with limited financial capital. It is known that the category of GAqP assessment is divided into three categories, namely A, B, and C, in which A means excellent, B means good, and C indicates fair adoption of GAqP, thus pond farming that applies traditional technology as observed in Pinrang Regency was included in the fair category (category C), that is the minimum standard required to maintain the quality standard of product harvested. This way, an innovative act of many stakeholders should be made to bridge the achievement gap of GAqP adoption. The adoption of GAqP is important since it could facilitate a more effective and efficient process of shrimp/fish culture besides reducing failure risk, increasing customer trust, allowing export opportunity, and being environmentally-friendly.

In terms of environmental aspect, pond wastewater treatment plant should be put into concern for its function as the standard of production success while reflecting aquaculture as an activity that has responsibility for environmental sustainability. Despite the fact that most pond farmers still applied traditional technology, the accumulative impact of waste produced from aquaculture activity should be considered. Treating the waste from the traditional pond is done in a channel to have functioned as “storage” which further triggers the sedimentation of the remaining material, hence

preventing it to be directly disposed of to the sea. Moreover, the wastewater treatment plant is also carried out by culturing fish or seaweed that will decrease the accumulation of pond waste. Another effort is applied by reducing the cost to build a wastewater treatment pond that is each pond group in an area should build a collective wastewater treatment pond, thus only treated water entering the river or sea. However, pond channels or rivers in Pinrang Regency were observed to have poor conditions where the river mouth is always clogged, thus wastewater treatment within the channels will have quite a serious problem.

In the management aspect, monitoring and recording all activities are necessarily applied to trace back shrimp/fish products in addition to overcome problems that might occur and to be used as a reference for the next production cycle. A similar format of recording related to grow-out culture, harvest, handling, and product distribution is preferable. It is necessary to design the concept of a recorded document that is simple yet fulfilling the concept of traceability. The recording should be done in each stage of culture, starting from the process of pre-production, production, to harvest and postharvest handling, including the corrective action and verification. The recording should also be performed on equipment, brackish water ponds, water management, fry, feed, chemical materials, biological materials, and fish medicine used.

According to the 53 GAqP principles as stated in the Regulation of DJPB No. 65/PER-DJPB/2015 (DJPB, 2015b) in the assessment of GAqP adoption in pond farming that applied both traditional and traditional plus technology in Pinrang Regency, there is no principle related to the labor use, opening of employment opportunity, development of the coastal area, and the condition of the local community around brackish water ponds area as a consequence of the existence of pond, also the conflict of land use including water and other natural resources. Therefore, the aspect of socio-econimic should also be considered aside from the aspects of technical, management, food safety, and the environment in the adoption of GAqP. This socio-econimic aspect is of higher concern in brackish water ponds that applies more-advanced technology, i.e. semi-intensive, intensive, and super-intensive system. As previously reported, in term of socio-econimic aspect, the existence of intensive shrimp ponds resulted in the absorption of employment from inside and outside the region while increasing the income and changing the structure of employment in Kwanyar Subdistrict, Bangkalan Regency, East Java Province (Huda, 2018), contaminating agricultural farm and area normally used by fisherman for their daily activity, thus reducing the income of people in Andulang Village, Gapura Subdistrict, Sumenep Regency, East Java Province (Hidayatillah, 2017).

Considering that GAqP adoption level in di Pinrang Regency belonged to the group of moderate adopters in an average of 42.86%, hence other stakeholders related to brackish water ponds within the regency should be more significantly participate in order to increase the adoption level of GAqP. An increase in GAqP adoption level is expected to result in quality and safety assurance according to the applicable national and international standards besides an increasing the quantity of brackish water ponds production.

CONCLUSION AND SUGGESTION

Conclusion

The results of this study on the implementation of 53 principles of GAqP that were incorporated into 18 requirements and subsequently grouped in 4 aspects, namely technical, management, food safety, and environmental in brackish water pond aquaculture located in Lanrisang and Mattiro Sompe Subdistricts, Pinrang Regency, Indonesia indicated a high level of GAqP adoption in food security (89.41%) and technical aspects (78.57%) as well as low GAqP adoption level in the management (8.71%) and environmental aspects (0%). It was also found that the level of GAqP adoption by pond farmers in Pinrang Regency varied from 40.58 to 67.01% with an average of 42.86% and was categorized as moderate adopters.

Suggestion

The aspects of management and environment should be taken into consideration to further increase the GAqP adoption level in brackish water pond aquaculture in Pinrang Regency, South Sulawesi Province, Indonesia. Moreover, socio-economic aspect is necessarily included in the assessment of GAqP for aquaculture in general and brackish water pond aquaculture in particular.

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