Research article

Potency and Barrier of the Small-Scale Aquaculture Development in Reclaimed Tidal Lowlands, South Sumatera, Indonesia

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Received 8 January 2019 Accepted 31 May 2019 (*Corresponding Author)

Abstract The small-scale aquaculture holds an essential role in the provision of nutrition, increasing the income and welfare of the community in developing countries. Through the transmigration program, which has been undertaken in tidal lowland by the Indonesian government, small-scale fish farming is a feasible prospect that should be considered. This research aimed to study the characteristics, the strength, and barriers of current aquaculture systems in the tidal lowlands area. Data were collected through survey interview to 60 farmers who have earthen ponds. Soil and water quality analysis have been done in two villages of Banyuasin Regency, South Sumatera, Indonesia. The strengths, weaknesses, opportunities, and threats (SWOT) analysis showed that aquaculture could be an alternative income besides agricultural activities (paddy and corn farming). The available of earthen ponds sized 16-300 m^2, and the water canal could be functioned as media farming and water source. Farmers have a decent expectation of fish culture, mainly due to the high demand for fish. The weakness comes from water and soil quality besides the less availability of adequate feed and fry. The presence of pyrite in the soil as a character of tidal lowlands caused low pH (<4). Thus, it should be managed appropriately. Social conditions, technology, and information, as well as government supports, are great opportunities for improving small-scale aquaculture. However, some threats such as limited capital, a suitable price, and management practices have to be evaluated to optimize sustainable fish production.

Keywords small-scale aquaculture, SWOT analysis, reclaimed tidal lowlands, pond management

INTRODUCTION

The increasing of a human population in the world has been predicted to reach about 9 billion in 2050, which will impact the demand for food consumption. Therefore, aquaculture has essential roles. Six percent of the total intake of human protein comes from the fish. Fish protein was even consumed in developing countries by 30% of all animal protein intake (NACA, 2015). Therefore, aquaculture production should be more than 90 million-$year^{-1}$ by 2030 (FAO, 2014). De Silva (2012) revealed at least more than 50% of the total production of aquaculture in 2006 should be reached by 2020.

The small-scale aquaculture is an important issue. This activity contributes almost half of the total inland fish production worldwide (FAO, 2014). The small fisheries farm could increase the food intake (Kawarazuka, 2010), and a minimum of 90% of the people involved in this regime worked on the small scale of practices (Mohanty et al., 2010).

Indonesia was one of the top 25 producers, and a central group of farm species in the world

has been playing a part in providing food security through the primary production, income generation in rural areas, and procreating the significant export (KKP, 2018). These indicate that fisheries product is essential. However, this condition must remarkably be considered since the overfishing and aquaculture development has been facing severe problems related to the technology and management practices adaptation. Furthermore, the competition of natural resources requirements such as water and land use, as well as the presence of the fieldworker, could be a serious issue.

Mostly, freshwater aquaculture in Indonesia has been developed in Java and Sumatera Island. However, since the increasing of the human population impacted the land and water use in Java, fish culture likely moved to Sumatera, a location with a lower community (Edwards, 2010). The Indonesian government, through the transmigration program, has reclaimed the new area in lowlands. Primarily tidal swamps as new settlements, to support the growth of food production and food self-sufficiency program by the lowlands intensification program. This program has given more benefits, mainly in the case of distribution of population, an increase in agricultural production, economy, and public prosperity (Susanto et al., 2014).

South Sumatera is one of the provinces in Indonesia which has tidal lowlands. It spreads into five districts; Ogan Komering Ilir, Banyuasin, Musi Banyuasin, Ogan Ilir, and Muara Enim. District of Banyuasin is the second largest tidal lowland area where agricultural production has reached more than 4 million tons. ha^{-1} (BPS, 2018). Although the increase in output has been impacting farmer's income and profitability, the potency of reclaimed tidal lowlands is still un-optimally exerted. Most farmers have approximately 0.25 ha land for housing, with minimal one earthen pond that had been built accidentally (Susanto et al., 2015). Some farmers were using the pond for small-scale aquaculture, while others emptied the pond or used as the water source for daily activity. However, there were limited pieces of information about how the existing small fish farming activities conducted.

OBJECTIVE

This study aimed to identify the characteristic, current status, the barrier, and challenges of small-scale aquaculture to improve the potency of reclaimed tidal lowlands for sustainable fish farming.

METHODOLOGY

The study of potency and barrier of the small-scale aquaculture development in reclaimed tidal lowlands had been taken in two locations. They were in Mulyasari and Bangunsari Villages in Tanjung Lago Sub District of Banyuasin Regency as the representative of the farming area of small-scale fish activity.

Survey location and interview have been conducted to 60 farmers who have an earthen pond. Purposive sampling was chosen as a sampling technique. In this part, data collection consisting of the closed questioner and a structured interview - the questions related to the farmer background or demographic information, fish culture activity, particularly on soil and water management, and how the government or other participators involved. Water and soil pH was measured using a portable pH meter. Total alkalinity and hardness were measured by using a protocol in Clesceri et al. (1998). A glass electrode was inserted into a soil mixture and distilled water (1:1) to measure soil pH Soil (Thunjai et al., 2004). A particle-size analysis was calculated by using a simplified hydrometer method described by Weber and Gokel (1977). The last, using SWOT analysis to analyze the data to find the strength, weaknesses, opportunities, and treats (Rimmer et al., 2013).

RESULTS AND DISCUSSION

Bangunsari Village has an area of 21.10 km^2 while Mulyasari around 18.83 km^2. Most of these areas were lowland, with the altitude ranges 10-20 meters above the sea level. The climate of those two locations was tropical, with high rainfall of about 1000-2000 mm-year-1 and temperature

around 26-32^{0}C (BPS, 2018). The distance between the village was about 12 km. Generally, both areas could be accessed through either land or river (canal) routes using small boats. Canals have been built for water management and as border an area of a village to another place (zoning). The channel also was functioned as a water source and the embankment for the road. Both of Bangunsari and Mulyasari have village shaft roads along about 4 km made by cement, and some parts were soil road. Those soil roads condition were hardly passed during the rainy season, especially in Bangunsari. Mostly the area of Bangunsari and Mulyasari were used for agricultural land, which has been producing paddy and corn (Zea mays) with the growing production year by year. Many unutilized waste products of paddy and corn were found, as shown in Fig. 1.

(a) (b) (c) (d)

Fig. 1 Water canal (a), paddy field (b) and corn product (c), and unused product of paddy and corn (d)

The Status and Potency of the Small-scale Fish Farming

The significant part area of Tanjung Lago District included Bangunsari and Mulyasari were located in reclaimed tidal lowland, which was impacted by tidal from the main river. More than 40% of the whole regions have been used for agriculture farming, mainly paddy and corn. Aquaculture was a side activity. The farmers used the earthen pond surrounding their house yard to rear the fish (Fig. 2).

(a)

(b)

Fig. 2 Condition of the ponds in Bangunsari (a) and Mulyasari (b)

The earthen ponds used in both areas were categorized as a small scale, which has a varied size (16-300 m^2) with the depth range 0.5-1.0 m. The water source came from the rain and water canal. Although fish farming has been conducted for more than ten years ago, most of the fish were cultured just for family consumption and the local market. Commonly, the fry of fish was spread in the small number (less than 6000 fish) from the local seller in Palembang city and the river or canal. During the culture, pellet, and *Lemna* sp. were used as feed for fish. The commercial feed was usually used with no information about its nutrient content. Farmers just selected the low price or based on the shop recommendation and information from other farmers. There was much various information about how long the fish farm. However, it could be concluded approximately more than six to 12 months, and sometimes it depends on the need or occasion.

Every member of each family has a role in fish culture, especially the woman, who participate more in this activity. Generally, the wife of the farmers spent most of the time at home to take care of the children and do household activities, included handling the fish culture. The woman contribution indicates one of the successful initiatives under which small-scale aquaculture (Bhujel, 2012).

The Barrier of Small-scale Aquaculture

During the field survey, the information revealed un well-management of fish culture. The poor soil and water quality of earthen pond were the factors besides less feed management, and capital impacted the success of aquaculture in both Bangunsari and Mulyasari. The earthen pond in both places has different water pH and soil pH. However, mostly, the pH condition was very acid. Ponds had low water alkalinity and hardness, although some ponds had a high value of alkalinity and hardness (Table 1). The content of pyrite could be seen by yellow color on the soil through the picture, which indicates the acidity in those areas (White et al., 1995).

Table 1 Current conditions, soil and water qualities, and some management practices of earthen ponds in Bangunsari and Mulyasari

Criteria and condition	Bangunsari	Mulyasari
Pond construction	• The pond embankment was parallel to the land • unavailable Inlet or outlet • The ponds were quite shady because of many plants planted in the yard	• The pond embankment was parallel to the land • Inlet or outlet was unavailable • The ponds were quite shady because of many plants planted in the yard
Water quality	• pH 5.3-7.0 • Alkalinity 18.67-44.00 mg/L $CaCO_3$ • Hardness 21.51-60.92 mg/L $CaCO_3$	• pH 3.9-6.8 • Alkalinity 18.67-83.33 mg/L $CaCO_3$ • Hardness 13.76-72.68 mg/L $CaCO_3$
Soil quality	• Texture: sandy clay loam • pH 3.30-6.17 • Contain of pyrite	• Texture: sandy clay loam • pH 3.50-5.86 • Contain of pyrite
	 	 
Pond management used • Liming • Fertilizer	Mostly used to be practiced Some ponds	Never Some ponds

Based on the SWOT analysis (Table 2), there was a weakness of small-scale fish farming activity in both two villages, such as less knowledge and information about fish farming management practices and also empowerment for the farmer. The majority, the farmers, were around 30-50 years old and elementary graduated. The farmers were not focused yet on aquaculture. They did fish farming as a hobby or followed their neighbors. Some of those farmers have joined the training and workshop, which were held by the local government and university. However, those activities have not regularly practiced. Thus, the information and knowledge were not optimally beneficial due to no empowerment and control.

Table 2 SWOT Analysis

Strengths	Weakness
• Existence of farmer who has earthen pond • Good support from community, especially woman • Accessibility of earthen ponds, public infrastructure; electricity, road and water canals • Availability of local market and the high of fish consumption • Abundant of agricultural waste product	• Low educating and knowledge • Less of training and management practices • Severe of pond soil and water quality • No maintenance system • High cost and variable quality of feeds • High production costs • Less of research and empowerment from university and government
Opportunities	**Threats**
• Farmer training and extension Increasing employment and incomes • National policy and support for fish farming development • Regulation of Banyuasin Regency No. 24 year 2012 about protection of Sustainable Agriculture Land • Increasing market demand • Increase the use of local ingredients in feeds • Promotion of fish product	• Erratic weather condition impacting the water quantity and quality • Increasing cost of production • No-communication/connection • No-budget for maintenance

Severe soil and water quality were also significant problems in the case of fish culture in reclaimed tidal lowland. The earthen pond has low productivity due to acid soil and water quality, especially in Mulyasary Village, where the high content of pyrite impacted the low alkalinity and pH (Boyd, 1995). The threats came from the issue of climate change that might affect the aquaculture activity. The changing of the weather caused the culture period to be unpredictable. Water quality was the main factor impacted in this case. There was no budget and maintenance, and also a connection between the community, government, and university resulted in the low productivity of aquaculture.

Fig. 3 Documentation of survey and interview process

CONCLUSION

The aquaculture in both Bangunsari and Mulyasari Villages was a small scale that has an excellent potency to be developed. The unique area, the reclaimed tidal lowland, needs excellent management and empowerment. It involves not only the farmers or community, but also the concern of government, academia, and multi-party are also essential. The obstacle comes from improper management of fish culture practices, including poor soil and water quality. Even though the small scale is suitable in those areas to increase the resilience of rural livelihoods, if the private

sector is attracted to collaborate, this project can be explored to be commercial aquaculture that is beneficial for many people.

ACKNOWLEDGEMENTS

This paper was a part of the Dissertation of Mirna Fitrani, under supervised by Assistant Prof. Dr. Idsariya Wudtisin and Assistant Prof. Dr. Methee Kawnern. The authors would like to thank the Indonesian Endowment Fund for Education Ministry of Finance (LPDP-Budi) for the research fund, and all participation from the farmers. Further, the sincere appreciation and gratitude to the late Prof. Dr. Robiyanto Hendro Susanto, as well as his Team in Pusdatarawa (Rodo, Yenni, Eny, Ica, Eko, Abdi, Faisal, and Pak Een) for all help and support which have given.

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