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IDENTIFICATION OF RISKS OF TIGER SHRIMP FARMING USING FAILURE MODE AND EFFECT ANALYSIS (FMEA) IN BELAWAN SICANANG VILLAGE

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Abstract

Black Tiger Shrimp breeding is has been done as the hereditary of the farm shrimp Belawan Sicanang urban village which has no uncertainty. The aims of the research to identify the sources of black tiger shrimp breeding and recommend the alternative strategy to overcome the problems. The method which used in the research is survey method with descriptive and Failure Mode and Effect Analysis (FMEA) methods. The result of the research shows that risk source of black tiger shrimp breeding are disease, high rainfall, the quality of seeds, quality of water, pest attack, the broke embankment, the selling price decreased, the land rent increased, the fertilizer price increased, the demand decreased, the saponin price increased, the fish seed increased and the dolomite price increased. The alternative strategy to overcome the risk is the application the Best Management Practice (BMP) dan konsep biosecurity principles. Upper drainage system, frying time, insertion / replacement of water in ponds, use of filters in water intake pipes, certified fry hatcheries, catching pests and repairing embankments.

Keywords: Black Tiger Shrimp, FMEA, Risk

1. Introduction

The aquaculture subsector contributes to national development performance. The volume of aquaculture production, in the last five years (2013-2017) was recorded to grow by an average of 5.11% where in 2017 the volume of aquaculture production reached 16.16 million tons (Kementerian Kelautan dan Perikanan, 2018). The commodities of the fishery products are shrimp, crabs, tuna, pearls, seaweed and other processed fish products.

Coastal areas have brackish water and are suitable for shrimp, fish and other cultivation. Belawan Sicanang Village is a coastal area in Medan Belawan District, Medan City. The majority of the people of Belawang Sicanang Village work as fishermen or pond farmers. Pond farmers in Belawan Sicanang Village have been cultivating tiger shrimp since decades ago. Tiger shrimp have a high attraction to be cultivated because of the selling price, demand for shrimp both at home and abroad and the nutritional content of shrimp.

Pond farmers cultivate tiger shrimp with an extensive/traditional system that is still dependent on the surrounding nature. Community-managed agriculture has risks or uncertainties that cause negative impacts. Many obstacles were found such as a decrease in seawater quality due to community activities around the sea, the activities of industrial companies, waste from the Waterfall Landfill, ship traffic passing through the waters and natural factors that change in a certain time. The decline in the environmental quality of aquaculture waters will trigger disease attacks on shrimp in the production process and will result in a decrease in production yield. The obstacles that exist in shrimp pond cultivation have not made farmers stop farming and until now they are still surviving. To prevent future failures, a risk management strategy is needed.

Failure Mode and Effect Analysis (FMEA) is a method to analyze the risk of failure with frequent rating values (Suryaningrat et al., 2019). FMEA is an approach to predict failure, its impact and causes (Basori & Supriyadi, 2017). The FMEA method uses the

Risk Priority Number (RPN) as the basis for determining failure (Haq et al., 2021). Structured procedures to identify and prevent failures (Dudek-Burlikowska, 2011). Some of the studies related to the topic of risk identification of cultivation with the FMEA method are (Syamsiyah et al., 2019) identifying mango cultivation, (Astaningrum & Djuwendah, 2017) identifying cut chrysanthemum cultivation. Based on the description above, the problems in this study include things that cause failure in tiger shrimp cultivation. This study aims to identify the sources of risk in tiger shrimp cultivation and recommend efforts to overcome the risks faced

2. Methods

The research was conducted in Belawan Sicanang Village, Medan Belawan District, Medan City. The research was carried out in January – July 2020. The pupolation in this study is all farmers who cultivate tiger shrimp. The total population in this study is 166 farmers. The sampling method in this study is simple random sampling. The number of samples used was 30 farmers.

The data collection technique in this study is a direct interview method using questionnaire aids and observation/observation. The type of data used is primary data obtained directly by tiger shrimp farmers including the chairman of the joint farmer group, the chairman of the farmer group and secondary data obtained from several related agencies, such as the Fisheries Service, the Central Statistics Agency and other sources.

The data processing in this study uses the Failure Mode and Effect Analysis (FMEA) method. The stages carried out are (a) Recording / identifying all possibilities that are the cause of a failure and then knowing the effects of the failure it causes. Identification is seen from potential risks that will and have occurred (Fahmi, 2011). In this study, it is categorized into three elements, namely production risk, price risk and income risk. (b) Risk assessment or measurement used to calculate the identification results. Measurement with FMEA is the Risk Priority Number (RPN) or priority risk points (Utami et al., 2017). The variables used are: severity (S) which is the impact that occurs if an error (failure) occurs, occurrenceance (O) which is the probability or probability or frequency of the error and detection (D) the possibility to detect an error will occur or before the impact of the error occurs. (c) Measurement of risk sources by calculating the risk priority level or Risk Priority Number (RPN) and Risk Score Value (RSV) of each risk source. According to (Chin et al., 2009) the formula for Risk Priority Number and Risk Score Value is as follows: Risk Priority Number (RPN) = Occurrence x severity x Detection and Risk Score Value (RSV) = Occurrence x severity. (d) The results of the Risk Priority Number (RPN) and Risk Score Value (RSV) were validated by asking why and repeated several times until the root cause of the problem was found to be the same as in the field. The RPN and RSV values are sorted from largest to smallest using a pareto chart, then which risk profile is prioritized to be addressed immediately. (e) Formulate efforts to address priority sources of risk.

3. Results and Discussion

3.1 Identification of Risk Sources of Windu Shrimp Farming

The risk is identified from the cause of the crop failure that has occurred. In this study, the types of risk sources are categorized into three, namely production risk sources,

prices and income. The results of the study showed 13 sources of risk in tiger shrimp farming as shown in Table 1.

Table 1. Source of risk of windu shrimp pond farming

Types of Risk	Source of Risk	Effects of Failure
Production	High Rainfall	Heavy rain reduces appetite
		Ph Water Death in Shrimp
	Water Quality	lowers the immune system of shrimp, shrimp are more susceptible to diseases
	Pest Attacks	Impairs the growth and respiration of shrimp
	Disease	Crop Failure, Slow Growth
	Breakage of the Embankment	Harvest failure, Shrimp out of the pond go with the current
	Fry Quality	low shrimp life rate
Price	Shrimp prices decline	Shrimp cannot be sold to factories, income is reduced
	Demand for shrimp declines	Tiger Shrimp Prices Decrease, Income Decreases
Income	Land Rent Increases	Reduced income, Reduced land used for shrimp farming
	The price of fry increased	Lack of fry used, not in accordance with the capacity of the pond
	Fertilizer Prices Increase	Reduction of Fertilizer Use, natural feed reduced
	Saponin Prices Increase	Unable to eradicate carriers and predators in ponds
	Dolomite Prices Increase	The use of dolomite is reduced and results in reduced alkanity and hardness

The production risk faced by farmers is fluctuations in the number of harvests caused by the death and loss of shrimp in the production process so that the target cannot be achieved.

In several months of 2019, the rainfall in Medan City was more than 300 mm and included in the high category, namely April, July, September and October (BPS, 2019). High rainfall can cause shrimp farmers to be susceptible to various diseases and cause death, rainwater can reduce salinity, reduce appetite and potentially cause pond erosion (Supono, 2017).

Pests that attack tiger shrimp ponds are wild fish such as payus (Elops hawaensis), moons (Megalops cyprinoides), snakes (Cerberus rhynchops), monitor lizards (Varanus salvator) and others and birds such as egrets (Egretta intermedia), blekok (Ardeola ralloides) and pecuk ulo (Anhinga rufa melnogaster). Parrots can enter the water and eat shrimp cultivated by farmers.

Diseases that attack shrimp are caused by viruses, bacteria. diseases that attack the tiger are White Spot Syndrome Virus (WSSV), taura syndrome virus (TSV), or infectious myonecrosis virus (IMNV). One of the main causes of widespread disease is the degradation of the pond environment. Diseases will arise if there is an interaction between poor environmental conditions, the presence of pathogens, and the condition of weak fish (Supono, 2017). If one shrimp has been affected by the disease, other shrimp will also be affected. This disease is transmitted to other shrimp so that shrimp in one pond can die en masse. Shrimp affected by the disease will swim to the surface of the pond and on the shrimp's body there are white and reddish bins.

Tiger shrimp farmers take advantage of the flow of river water from the Belawan River and the Terjun River. On the banks of the waterfall there is the Silver Hamparan Waterfall Final Settlement Site (TPA) and a factory. Some factory waste is dumped into the river. During rain, a lot of garbage from the landfill flows into the river so that the river water smells and is greasy. The water can affect the life of tiger shrimp cultivated by

farmers. This is supported in the research of (Effendi, 2016) and (Akbar & Irawan, 2023) that poor water quality will interfere with shrimp growth and lower the shrimp immune system so that the mortality rate increases and will cause shrimp to be more susceptible to disease.

High tides will result in flash floods. When a flash flood occurs, most of the farmers' embankments burst or leak. Ponds are close to each other. If the embankment of the pond near the paluh breaks, the pond next to it is influential and may be able to break as well. The embankment burst causing the shrimp cultivated by farmers to disappear with the current. This is in line with the research of (Azmi et al., 2018) and (Nawari et al., 2023) that most farmers experience crop failure due to embankment damage due to high tides.

The tiger shrimp fry used are not certified. Farmers get fry from Aceh Province. The quality of fry used by farmers has decreased since the 2014 tsunami because many tiger shrimp hatcheries have been damaged and many shrimp broodstock have died. The quality of the fry affects the life rate of the shrimp. Currently, many farmers are experiencing a decrease in production/failure because the life rate of shrimp is low and there are farmers who cultivate shrimp but the shrimp do not develop even though they are 3 months old.

The price of shrimp varies depending on the size of the shrimp. The higher the size of the shrimp, the higher the price. If the quality of the shrimp obtained by farmers is low, it can result in shrimp not being sold to the factory or the price becoming cheaper, which affects the income of shrimp farmers. During the Covid-19 pandemic, the selling price of shrimp decreased. The price decrease is around Rp. 5,000 – Rp. 10,000 per kilogram per shrimp size. The selling price of shrimp at the factory is higher than the price at the agent. The price difference at the factory and at the agent is around Rp. 5,000 – Rp. 10,000 per kilogram. Farmers cannot sell shrimp to the factory if the shrimp yield is less than 30 kg.

Tiger shrimp is the government's mainstay export commodity to increase the country's foreign exchange. During the Covid-19 pandemic, there were limitations in the delivery of export goods in destination countries. This limitation has resulted in a decrease in the demand for tiger shrimp in factories. The declining demand has resulted in a decrease in the price of tiger shrimp.

Farmers rent most of their pond land. Rental fee set per year. The cost of renting ponds affects the income generated by farmers, because the revenue from selling shrimp crops will be reduced by land rental costs. The land rental fee that must be paid by farmers per planting season is Rp. 856,209 per farmer and the average rental cost per hectare is Rp. 694,212.

Fry are the main capital in farming. The price of fry varies depending on the quality. The price of fry is around Rp. 40 – 50/head. If the farmer's income in the previous planting season is high, the farmer will use a lot of fry, but if the farmer's income is low, the fry used are few. Farmers use 10,000 – 20,000 fry/hectare.

Fertilizers are used to fertilize the soil, adding nutrients so that the production of natural feed for shrimp can be increased. These natural feeds are such as plankton, moss or algae (Hidayat Suryanto Suwoyo, H.S Fahrur et al., 2016). The need for urea fertilizer in 1 hectare is 150 – 200 kg/hectare. The price of urea fertilizer is Rp. 5,000 – Rp. 8,000/kg.

Because most farmers do not use feed, farmers use a lot of urea fertilizer. Fertilizer prices affect farmers' income. Fertilizers used such as urea fertilizer, TSP or compost.

Saponins are one of the anti-pest drugs. Saponins not only kill unwanted fish pests, but can also stimulate skin turnover in shrimp farming. The price of Saponin ranges from Rp. 8,000 – 11,000/kg. If farmers have sufficient capital, farmers will use these saponins, otherwise they will partially reduce the amount of saponins used or not use them.

Most farmers in Belawan Sicanang Village use dolomite. The price of dolomite ranges from Rp. 5,000 – Rp. 10,000 / kg. If the previous crop is successful or the results obtained can cover the initial capital, the farmer will use dolomite again. If farmers lack capital, farmers do not use it.

3.2 Measuring the Source of Risk

The identified sources of production, price and income risk will be measured by calculating the Risk Priority Number and Risk Score Value of each risk source. The results of the value measurement in each risk source are seen in Table 1 and the pareto graph of the Risk Priority Number and the Risk Score Value are seen in Figures 1 and 2, respectively.

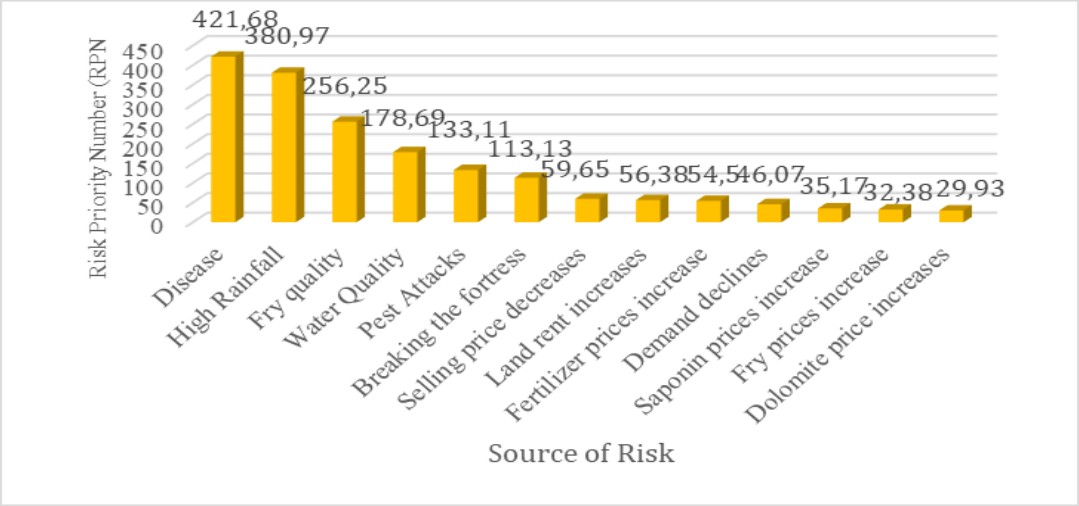

Figure 1. Pareto graph based on Risk Priority Number (RPN)

The level of risk priority value or Risk Priority Number (RPN) and risk score value or Risk Score Value (RSV) can be seen in the pareto chart in Figure 1 and 2. Pareto charts provide planning guidance that is responsive to which risks are prioritized in handling them (Carbone & Tippett, 2004). The five risk sources of having the highest RPN and RSV are disease, high rainfall, fry quality, water quality and pest infestation. Most of the uncertainty in tiger shrimp farming is caused by natural factors. The highest risk detected will be the main concern for tiger shrimp cultivation so a risk strategy is needed to achieve the targeted production amount.

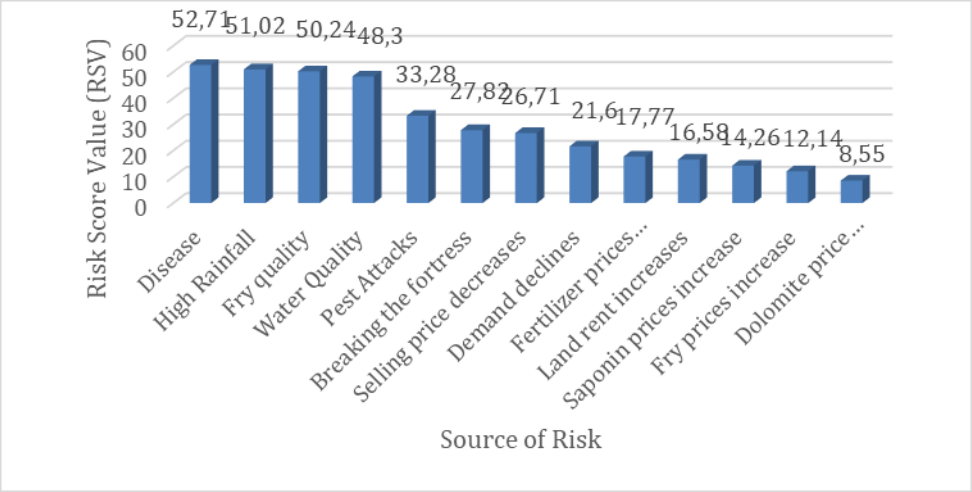

Figure 2. Pareto graph based on Risk Score Value (RSV)

3.3 Recommendations for Efforts to Handle Windu Shrimp Farming Risks

Recommended efforts to overcome the sources of risk in tiger shrimp ponds in Belawan Sicanang Village are as follows:

1. Application of Best Management Practice (BMP) principles and biosecurity concepts, the principle of Best Management Practice (BMP) is based on the application of environmentally friendly cultivation. Water supply is free of infectious pests and harmful heavy metals, the pond can hold water and maintain the desired depth (no seepage). The application of the BMP method can reduce crop failure in tiger shrimp cultivation. The recommended strategy is the same as the research of (Arief et al., 2015) and (Syaichudin et al., 2011). The concept of biosecurity (safety from contamination). Shrimp ponds apply to quarantine installations. This concept has become an international rule in the shrimp production process but in Belawan Sicanang Village, this concept has not been implemented.
2. Top Exhaust System, during times of high rainfall, efforts are made so as not to pose a big risk by making a top exhaust system. The rainwater that falls does not directly mix with the water in the pond. Before mixing, a water drain was made on the pond embankment. The drain is made above the normal water level in the pond. Thus, rainwater that has passed the normal limit will come out through the sewer.
3. Fry stocking time, farmers stock fry in the dry season, do not scatter in the rainy season. In the rainy season with high rainfall, shrimp fry will be prone to death because the shrimp fry's immune system is not strong.
4. Water intake/change in ponds, an alternative effort to overcome the poor quality of water outside the pond is that farmers do not put new water into the pond if the water outside is not good. Research by (Febrina et al., 2016) suggests the same thing. Water intake after land cultivation and left for 15 days before stocking fry. Do not add water if the shrimp are not yet 2 months old. Shrimp that are approximately 2 months old are still susceptible to diseases caused by the introduction of new water. If the shrimp are more than 2 months old, they can put in new water because with that age the shrimp's immune system is already strong.

5. Use of Filters in Water Inlet Pipes, the water inlet pipe is installed with filtration to prevent the entry of pests, bacteria and viruses from outside the pond. Installation of filters to avoid pest attacks such as wild fish in tiger shrimp farming.
6. Certified fry hatchery, tiger shrimp hatchery in North Sumatra Province does not exist yet, but vannamei shrimp hatchery is in Serdang Berdagai Regency. Farmers hope that the government will create a tiger shrimp hatchery so that farmers are not too far away to get tiger shrimp fry. The distance of the fry travel from Aceh Province to Medan City affects the quality of the fry because the distance of the trip can make shrimp stressed, in addition to the influence of mileage, environmental conditions in Medan City are different in Aceh Province so that the life of tiger shrimp will be different.
7. Pest capture, countermeasures in pest eradication are by mechanical and chemical means (Herlina Nonny, 2004). Eradication by mechanical means is by searching, catching and killing the pest. Like hunting a peckingbird. To avoid cranes, a thread like kite thread is installed on top of the shrimp pond so that the birds cannot reach the surface of the water. Chemical eradication is with the help of vegetable poisons or pesticides that are recommended.
8. Embankment Repair, embankment maintenance is carried out every month with human labor. An alternative effort suggested is to repair the embankment with the help of machinery. Embankments with heavy equipment will be sturdier and more durable. In addition, to overcome the loss of shrimp during flooding, nets are installed around the pond so that shrimp do not move to other ponds or drift.

4. Conclusion

The results of the analysis showed that the risk identification based on the FMEA method was disease, high rainfall, fry quality, water quality, pest infestation, embankment breakage, selling price decreased, land rent increased, fertilizer price increased, demand decreased, saponin price increased, fry price increased and dolomite price increased. Recommendations for efforts to handle risks faced by farmers are the application of Best Management Practice (BMP) principles and the concept of biosecurity, top disposal system, fry stocking time, water intake/change, use of filters in water inlet pipes, certified fry hatchery, pest capture and embankment repair. The recommendations given are based on the results of literature and discussions with government extension agencies. Extension workers are committed to helping farmers starting from knowledge and goods. The next research is expected to look at the risks that occur from the land processing process to post-harvest by applying the five why analysis, risk matrix and Fault Tree Analysis (FTA) methods.

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