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Risk Management of Polyculture Production the Milkfish (*Chanos chanos*) and the Vaname Shrimp (*Litopenaeus vannamei*) in Bulukumba Regency

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ABSTRACT

The research discusses management strategies for addressing production risks in the polyculture cultivation of milkfish and vaname shrimp in Bulukumba Regency. Effective management is necessary to minimize these risks and optimize profits for business operators. Production risk management is carried out using Value at Risk (VaR) analysis, based on observations and meetings with business operators and fisheries services. This approach helps identify and address sources of production risk in the polyculture of milkfish and vaname shrimp. The findings show that both the probability and impact of risk sources are higher for vaname shrimp than for milkfish. Feed is the largest source of risk for milkfish, while disease poses the greatest risk for vaname shrimp. Conversely, feed is a minor risk factor for vaname shrimp, and disease is a smaller concern for milkfish. Risk mitigation strategies include: (1) carefully monitoring the dosage of saponin poison used to eradicate pests; (2) ensuring the correct dosage and application of urea fertilizer, TSP, and feed; (3) controlling water quality; and (4) selecting high-quality seeds.

INTRODUCTION

Bulukumba Regency is a rich district, and fishery resources have important economic and strategic value. Pond cultivation is an example of the wealth of Bulukumba Regency. According to the **Ministry of Maritime Affairs and Fisheries (2023)**, Bulukumba Regency has a pond cultivation area of 3,794.6 ha, consisting of 3,593.7 ha of traditional ponds and 200.9 ha of intensive ponds. The results of traditional plus and intensive pond aquaculture production in Bulukumba Regency in 2017–2021 were in the range of 6,254.9 - 7,318.1 tons **(BPS Bulukumba Regency, 2021)**, which can be seen in Fig. (1).

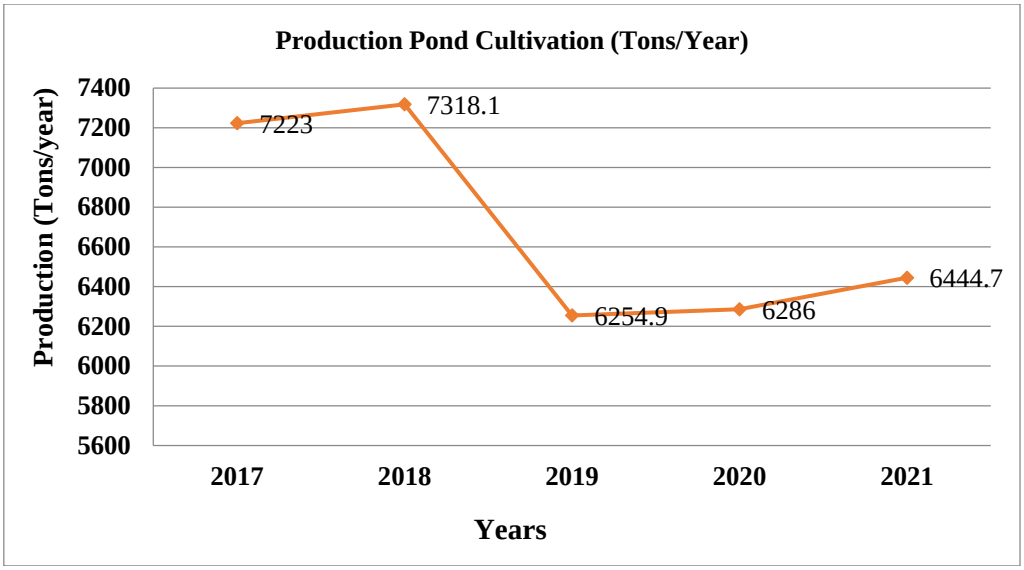

Fig 1. Total aquaculture production in Bulukumba Regency

The data in Fig. (1) shows that total production from traditional and intensive pond cultivation in Bulukumba Regency fluctuated between 2017 and 2021. Overall, the production of milkfish and vaname shrimp is relatively low, with milkfish production being lower than that of vaname shrimp, as indicated in Fig. (2) **(South Sulawesi Maritime Affairs and Fisheries Service, 2022)**.

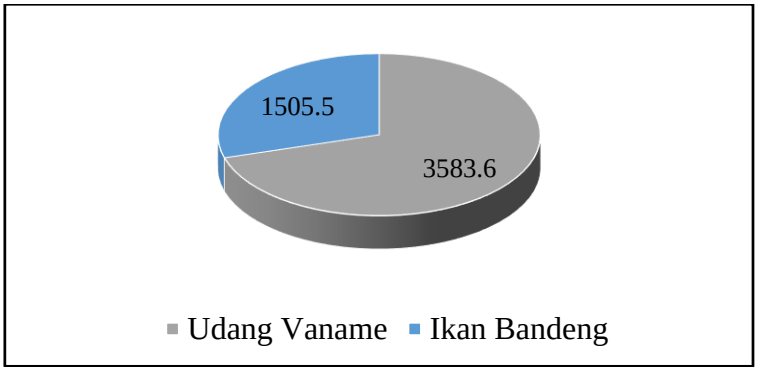

Fig. 2 Milkfish and vaname fish production (Tons) in Bulukumba Regency

This is influenced by the condition of traditional plus ponds in Bulukumba Regency, which experiences a decrease in land productivity. Milkfish production can increase the income of pond farmers. Based on the results of research regarding the nitrate content in ponds, it is in the range of 0.001–0.016mg/ l from the normal range of 0.9–3.5mg/ l for cultivated land **(Nasrul *et al.*, 2018)**. Unfulfilled nutritional intake during cultivation can cause decreased productivity. In general, the shrimp commodity has its own challenges that are felt to be hampering the increase in national shrimp production, including the lack of infrastructure in production areas, such as the use of processing technology and comprehensive utilization of pond areas. Another challenge is related to the price of raw materials, both for the seeds and

feed used. The need for regulations and trade systems related to raw material prices or selling prices is also needed by business actors **(Luneto & Kaslam, 2022)**.

There has been a shift in additional commodities in polyculture cultivation. According to the Department of Maritime Affairs and Fisheries, cultivation commodities in Bulukumba Regency experienced a shift in commodities from tiger prawn cultivation in the 2000s to cultivating milkfish and vaname shrimp, which was caused by disease attacks. However, vaname shrimp in Bulukumba Regency have also been infected with White Spot Syndrome Virus (WSSV) without showing clinical symptoms when the vaname shrimp are two months old, which is characterized by stunted growth. WSSV disease is a group of pathogens that often infect vaname shrimp. WSSV is a very virulent viral disease that can attack the various types of shrimp **(Lilisuriani, 2020)**.

The recent decline in pond farmers' intensity in cultivating shrimp has been caused by various problems, such as a decline in environmental quality caused by pests and diseases, errors in applying technology, and difficulties in obtaining quality seeds **(Dahlia *et al*., 2021)**. In addition, according to **Mira *et al*. (2022)**, the openness of pond farmers to innovation can be seen from the technology used. Moreover, pond farmers in Bulukumba Regency are cultivating milkfish as a solution to dealing with the decline in vaname shrimp income. Whereas, milkfish is a commodity that has comparative and strategic advantages because its rearing and hatching technology has been mastered by pond farmers, and its living requirements do not require high suitability criteria because it is tolerant of changes in environmental quality **(Nasrul *et al*., 2018)**.

The business of polyculture pond cultivation of milkfish (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) will not be free from risks that can cause major losses for business actors. The most threatening risks in the polyculture business of milkfish and vaname shrimp in Bulukumba Regency are environmental factors such as pests, disease, and water quality. Things like this are certainly difficult to control. These challenges can be addressed by identifying and analyzing risks in the polyculture pond cultivation of milkfish and vaname shrimp. Key risks include production issues such as disease outbreaks, predation, and damage to equipment and the environment **(McIntosh, 2008)**.

Looking at the fisheries potential in the polyculture pond cultivation sector of milkfish (*Chanos chanos*) and vaname shrimp *(Litopenaeus vannamei*) in large traditional plus ponds, the development of pond cultivation businesses, and the existing problems, it was necessary to carry out an analysis regarding risk management of milkfish polyculture cultivation production (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) in Bulukumba Regency.

MATERIALS AND METHODS

This research was conducted for 2 months (October-December 2023) in Bulukumba Regency. The method used to determine the possibility of risk occurring was the standard value method or VaR. The steps for calculating the probability of risk occurrence are as follows **(Kountur, 2006)**:

1. Count average incident risky

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i}{\mathbf{n}}$$

Where:
X : Average value of risk events
Xi : Value per cycle of risk events
n : Amount of data

2. Count mark standard deviation from incident risk

$$S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}}$$

Where:
S : Standard deviation of risk events
Xi : Value per cycle of risk events
X : Mark average from incident risky
n : Amount of data

3. Count Z-score

$$Z = \frac{X_i - \bar{X}}{S}$$

Where:
Z : Z-score value of incident risky
X : The risk limit is considered to be within normal levels
X : Average value incident risky
S : Standard deviation from the incident noise

4. Mark probability and impact of occurrence risk production

The value of the probability and impact of production risks was carried out using the method Value at Risk (VaR) to measure the largest loss that could happen in a certain time span that is predicted with a certain level of confidence. VaR was calculated using the formula of **Kountur (2006)** as follows:

$$VaR = \bar{X} + Z\left(\frac{S}{\sqrt{n}}\right)$$

Where :
VaR : Impact loss caused by incident risky
X : Average value loss consequence risk event
Z : Mark z from table distribution normal with alpha, which determined
S : Standard deviation of losses due to risk events
n : Lots of it risk event

5. Risk map and risk management

A risk map is a description of the risk position on a map from two axes: the vertical axis describes probability and the horizontal axis describes impact. Risk maps can be seen in Fig. (3).

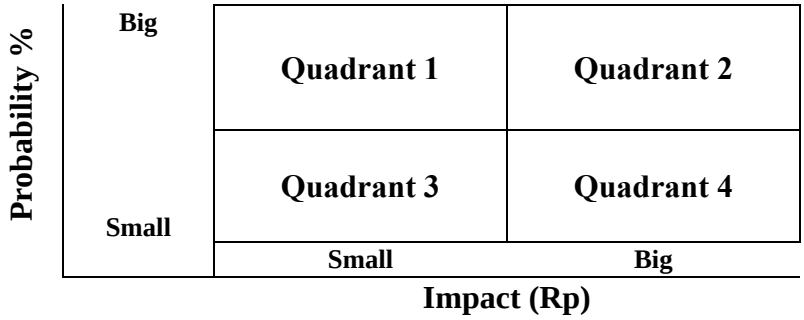

Fig. (3). Risk Map

The probability and impact of the risk occurring in Fig. (3) can be divided into two parts: most likely and least likely. According to **Kountur (2008)**, probability consists of the following dimensions. First, whichstate level possibility something risk happen. The higher probability risk happens, the more need to get attention. Conversely, if the lower the possibility of a risk occurring, the lower the attention that is given. The second dimension is impact, which is the level of emergency or cost that happens if the risk concerned truly becomes reality. The higher the impact of a risk, the more necessary it is that attention is special. On the contrary, the lower the impact of a particular risk, the less attention it requires.

According to **Kountur (2006)**, based on a risk map, appropriate risk management methods can be identified. There are two primary strategies for handling risk:

a. **Risk avoidance (Preventive)**: This strategy aims to prevent risks before they occur and includes the following methods:
   1. Establishing or improving systems,
   2. Developing human resources,
   3. Installing or upgrading physical facilities.

b. **Risk mitigation**: This strategy is designed to minimize or reduce the impact of risks when they occur. Mitigation strategies aim to address risks in such a way that those in quadrant 2 (high probability, low impact) shift to quadrant 1 (low probability, low impact), and those in quadrant 4 (high probability, high impact) shift to quadrant 3 (low probability, high impact).

RESULTS

According to **Ismanto (2016**), the advantage of VaR analysis is that this method focuses on downside risk, does not depend on assumptions about the distribution of returns, and can be applied to all traded financial products such as the polyculture cultivation business. The figures obtained from measurements using this method are the result of a comprehensive calculation of the risks of the products as a whole. VaR analysis includes identification of risk sources, probability of risk sources, impact of risk sources, risk mapping, and handling strategies in the

polyculture business of milkfish (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) in Bulukumba Regency

1. Identifying sources of risk

Identification of sources of risk was carried out by interviewing and analyzing the sources of risk that could occur in traditional polyculture pond cultivation in Bulukumba Regency. Identification of risk sources was obtained from interviews with 117 polyculture pond farmers of milkfish (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) in traditional plus ponds and using a questionnaire. In polyculture cultivation businesses at the research location, the risks affecting production are primarily due to pests, diseases, feed quality, and water quality. The following is an explanation of the sources of risk at the research location:

1.1 Pets

Pests that often attack polyculture ponds in Bulukumba Regency are snails, tilapia fish, and small crabs. These three types of pests are included in the category of destroyers and competitors of milkfish and vaname shrimp. Destructive pests, in this case small crabs, can cause pond embankments to leak, while competing pests, namely tilapia fish and snails, compete with cultivated commodities in terms of food, oxygen, and space.

Based on the results of observations and interviews conducted at the research location, it was found that snail pests, tilapia fish, and small crabs caused an average death of milkfish of 1,500/ha and an average death of white shrimp of 4,000/Ha. Pond farmers treat pests by administering 40-60kg/ ha of saponin poison, and they also use 400-500 grams/ha of besnoite poison.

1.2 Disease

A disease that often attacks polyculture ponds in Bulukumba Regency, namely White Spot Syndrome Virus (WSSV), causes mass death of vaname shrimp (*Litopenaeus vannamei*) for 2-7 days through contaminated water. Based on the results obtained at the research location, it was found that the disease is more likely to attack vaname shrimp than milkfish because milkfish are relatively resistant to the disease, which causes the average death of tiger prawns and vaname shrimp to reach 70%. Moreover, the average mortality of name shrimp is 28,000–35,000 individuals/ha, and the average mortality of milkfish is 180-240 individuals/ha.

1.3 Feed

Based on research results, the feed provided to the polyculture business in Bulukumba Regency consists of two types of feed: natural phytoplakton feed, which comes from the fertilization process (urea fertilizer and TSP), and packaged feed, such as Ruby feed. At the research location, polyculture pond farmers initially apply 1-2 sacks (50-100kg/ ha) of urea and TSP fertilizers, with follow-up fertilization consisting of 10% of the initial amount every 2 weeks after 2 months.

1.4 Water quality

Based on the results of observations and interviews conducted at the research location, it was found that water quality in the polyculture cultivation was maintained by periodically controlling the water and weather conditions, where water changes at the research location were usually performed 2–5 times for one production, depending on pond water conditions. The average mortality of vaname shrimp is 2,000–2,500 individuals/ha, and the average mortality of milkfish is 360-480 individuals/ha.

2. Risk source probability analysis

Calculation of the probability of risk sources was carried out by identifying the number of deaths of milkfish and vaname shrimp caused by each risk source. Subsequently, calculations were carried out regarding the average value and standard deviation of risk events (pests, diseases, feed and water quality). Afterward, normal limits were determined for each risk source, and the z-score value is depicted in **Table (1).**

Table 1. Probability of risk sources for the polyculture business of milkfish (*Chanos chanos)* and vaname shrimp (*Litopenaeus vannamei)* in Bulukumba Regency

No	Sources of Risk	Probability (%)	
		Milkfish	**Vaname Shrimp**
1.	**Pest**	34.46	16.35
2.	**Disease**	2.44	47.61
3.	**Feed**	48.80	6.43
4.	**Water quality**	9.34	33.00

Primary data after processing

Based on the table above, the probability of the biggest risk source for milkfish is feed, with a probability of 48.80%. For vaname shrimp, the greatest risk source is disease, with a probability of 47.61%. The smallest risk source probability for milkfish is disease, at 2.44%, while for vaname shrimp, the smallest risk source is feed, at 6.43%.

3. Risk source impact analysis

The impact of risk sources on the polyculture cultivation of milkfish (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) in Bulukumba Regency was analyzed using the Value at Risk (VaR) method. This method evaluates the potential losses from each risk source in rupiah over a one-year period. According to interviews with pond farmers at the research location, the average price of milkfish is Rp. 5,000.00 per head, while the average price of vaname shrimp is Rp. 450.00 per head, as depicted in Table (2).

Table 2. Impact of risk sources in the polyculture business of milkfish (*Chanos chanos)* and vaname shrimp (*Litopenaeus vannamei)* in Bulukumba Regency

No	Sources of Risk	Risk impact (Rp)	
		Milkfish	Vaname shrimp
1.	Pest	11,183,022.20	4,010,508.76
2.	Disease	1,597,574.60	28,073,561.33
3.	Feed	15,975,746.00	2,005,254.38
4.	Water quality	3,195,149.20	6,015,763.14

Primary data after processing

Based on the table above, the impact biggest source of risk for milkfish is the source of feed risk of IDR 15,975,746.00, while the impact of the biggest source of risk is for vaname shrimp namely the source of disease risk of IDR 28,073,561.33. The smallest impact from a risk source for milkfish is disease, with a financial impact of IDR 1,597,574.60. For vaname shrimp, the smallest impact is from feed risk, amounting to IDR 2,005,254.38.

Risk mapping and management strategy

Risk mapping was conducted by estimating the position of risk sources on a risk map based on probability calculations and the impact of these sources on polyculture cultivation. In this process, the risk status is determined by calculating the product of the probability and impact of each risk source. This risk status helps rank the risk sources from most to least risky, as illustrated in Table (3).

Table 3. Risk status of polyculture business for milkfish (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) in Bulukumba Regency

No.	Sources of risk	Probability (%)	Impact (Rp)	Risk status	Priority
Milkfish					
1.	**Pest**	34.46	11,183,022.20	3,853,669.45	2
2.	**Disease**	2.44	1,597,574.60	38,980.82	4
3.	**Feed**	48.80	15,975,746.00	7,796,164.05	1
4.	**Water quality**	9.34	3,195,149.20	298,426.94	3
	Average	**23.76**	**7,987,873**		
Vaname Shrimp					
1.	**Pest**	16.35	4,010,508.76	655,718.18	3
2.	**Disease**	47.61	28,073,561.33	13,365,822.55	1
3.	**Feed**	6.43	2,005,254.38	128,937.86	4
4.	**Water quality**	33.00	6,015,763.14	1,985,201.84	2
	Average	**25.85**	**10,026,272**		

Primary data after processing

Based on Table (3), the highest risk status for milkfish is from feed, with a value of IDR 7,796,164.05, making it the top priority. For vaname shrimp, the highest risk status is from disease, at IDR 13,365,822.55, establishing it as the top priority. The lowest risk status for milkfish is from disease, with a value of IDR 38,980.82, making it the lowest priority. For vaname shrimp, the smallest risk status is from feed, amounting to IDR 128,937.86, also making it the lowest priority.

The next step is to create a risk map for each commodity in the polyculture business of milkfish (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) in Bulukumba Regency. This involves determining the boundary between probability and impact by calculating the midpoint for each. The middle boundary for the probability of milkfish is 23.76%, while for vaname shrimp it is 25.85%. The middle limit for the risk impact is IDR 7,987,873 for milkfish and IDR 10,026,272 for vaname shrimp, as shown in Fig. (4).

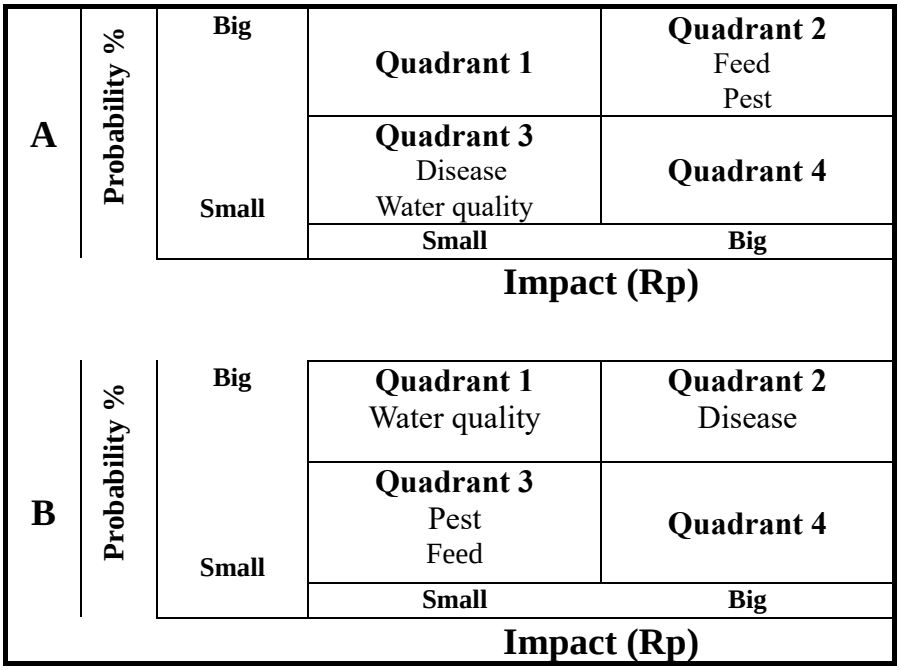

Fig. 4. Risk mapping (a) Milkfish, (b) Vaname shrimp

Based on Fig. (4) of the risk mapping (a) above, the risk sources for milkfish (*Chanos chanos*) are located in quadrants 2 and 3. In Quadrant 2, which represents high probability and high impact, the primary risk sources are feed and pests. In Quadrant 3, indicating high probability but low impact, the sources of risk are disease and water quality.

In Fig. (4) of the risk mapping (b) above, the risk sources for vaname shrimp (*Litopenaeus vannamei*) are found in quadrants 1, 2, and 3. Quadrant 1, which signifies high probability but low impact, is associated with water quality risks. Quadrant 2, representing both high probability and high impact, is linked to disease risks. In Quadrant 3, indicating high probability and low impact, the risk sources are pests and feed.

DISCUSSION

The research indicates that in the polyculture business of milkfish (*Chanos chanos*) and vaname shrimp (*Litopenaeus vannamei*) in Bulukumba Regency, several issues need addressing:

1. **Pest Management**: Pests are treated with saponin poison, but farmers apply only 40-60 kg/ha instead of the recommended dose of 150-200 kg/ha. According to **Lilis and Adawiyah (2021)**, saponin, derived from tea seed cake, is effective in killing wild fish

like tilapia at this higher dose. Saponin is 50 times more toxic to fish than to shrimp, so it primarily targets pests affecting milkfish but has minimal impact on vaname shrimp. Farmers should also adhere to proper timing for saponin application, either during pond preparation by spreading it directly or soaking it for 6-8 hours. Another method includes using besnoite poison to eradicate snail pests.

2. **Disease Management**: Farmers do not address disease risks, making disease a high priority for vaname shrimp. WSSV (White Spot Syndrome Virus) is a common issue at the research location. Farmers are advised to buy certified fry and perform strict selection to avoid disease introduction. Additionally, using immunostimulants to boost shrimp immunity can help prevent disease **(Darmawan, 2021)**.
3. **Feeding Practices**: Farmers at the research location do not follow recommended feeding methods or dosages. They provide artificial feed only when the commodity is two months old or before harvest, relying on natural food from phytoplankton. They apply urea and TSP fertilizers during pond preparation and maintenance but not at the recommended dosages. The recommended dosage is 150-200 kg of urea and 75-100 kg of TSP/ha for initial fertilization **(Amin & Wikanta, 1989)**, with supplementary fertilization of 10% of the initial dose every 1-2 weeks **(Gunarto *et al.*, 2006)**. Inadequate feeding practices pose a significant risk for milkfish, while the risk for vaname shrimp is lower due to the dominance of disease factors.
4. **Water Quality**: The water quality at the research location is suitable for milkfish but poses a high risk for vaname shrimp due to WSSV transmission through water. Farmers should monitor water flow from rivers or other ponds and conduct daily water quality checks. **Supono (2018)** recommends monitoring water quality in the morning (5:00-6:00) and afternoon (12:00-14:00) to assess critical conditions, as morning is the lowest point for dissolved oxygen and high pH, while daytime is peak phytoplankton photosynthesis. Regular water changes should be performed if water quality deteriorates.

These findings highlight the need for improved pest control measures, disease management, feeding practices, and water quality monitoring to enhance the polyculture cultivation of milkfish and vaname shrimp.

CONCLUSION

The impact of risk sources on the vaname shrimp commodity is much higher than that on milkfish. The biggest source of risk for milkfish is feed, whereas the biggest source of risk of vaname shrimp is disease. The smallest source of risk for milkfish is disease, whereas the lowest source of risk of vaname shrimp is feed. Handling sources of risk is carried out by: (1) Paying attention to the dosage of saponin poison in eradicating pests; (2) paying attention to the appropriate dosage and method of administerig urea fertilizer, TSP, and feed; (3) controlling water quality; and (4) performing seed selection.

REFERENCES

Amin, M. and **Wikanta**, **(1989).** Preliminary experiment on supplementary fertilization in rearing tiger prawns (*Penaeus monodon*) in ponds. Research Report. Coastal Cultivation Research Institute. Maros.

BPS Bulukumba Regency (2021). Bulukumba Regency in Figures Bulukumba Regency in Figures 2021. Bulukumba.

Dahlia; Hartinah; Muslimin; Darmawan and **Rusli, A. (2021).** Management conditions of tiger prawn ponds in Pangkajene and Islands Regency. *Agrocomplex*.. **21**(1): 8–17.

Darmawan, M. (2021). Effectiveness of protection of Vaname shrimp (*Litopenaeus vannamei*) against white spot syndrome virus (WSSV) infection with supplementation with sodium alginate *Sargassu*m sp. from Lampung waters and combination with vitamin C. Thesis. Lampung University.

Gunarto; Tangko A.M.; Tampangalo, B. R. and **Muliani, (2006**). Cultivating tiger prawns (*Penaeus monodon*) in ponds with the addition of probiotics. *Journal of Aquaculture Research.*, **1**(3): 303 - 313

Ismanto, H. **(2016).** Value at risk analysis in forming an optimal portfolio (empirical study of shares included in Lq45). *The 3rd University Research Colloquium*: 243-255

Kountur, R. **(2006).** *Management Risk.* Jakarta: Abdi Tandur.

Kountur, R. (**2008).** *Easy to Understand Company Risk Management*. Jakarta: PPM.

Lilis and **Adawiyah, R**. **(2021).** The effect of using different doses of saponin on pest control in Vannamei shrimp (*Litopenaeus vannamei*) ponds in panjang district, Arwana. *Scientific Journal of the Aquatic Studies Program*, **3**(1): 24-27.

Lilisuriani, (2020). Virus disease attacks on shrimp in ponds without showing clinical symptoms. *Journal of Fisheries Science*., **9**(1): 25–32.

Luneto, R. and **Kaslam**, **(2022).** Competitive advantage of pinrang tiger prawns in international trade. *In RIR*., **4**(1): 1–20.

McIntosh, D. (2008). Aquaculture Risk Management. NRAC. No. 107

Ministry of Maritime Affairs and Fisheries. (2023*).* ***Cultivated Land Area in Bulukumba Regency, South Sulawesi*. CTF. Bulukumba.

Mira; Sujarwo, P.A.; Triyanti, R.; Shafitri, N. and Zulham, A. **(2022).** Comparative Analysis of Vaname shrimp farming businesses with traditional, Semi-intensive and intensive techniques in coastal areas., **17**(1): 51– 62.

Nasrul; Syarif, H. and **Maddatuang**. **(2018).** Evaluation of the suitability of milkfish pond land in Salemba Village, Ujung Loe District, Bulukumba Regency. *Journal of Environmental Science*., **1**(1): 14–20.

South Sulawesi Province Maritime and Fisheries Service (2021). *South Sulawesi Maritime Affairs and Fisheries Annual Report 2021*. Bulukumba.

Supono (2018). *Water Quality Management for Shrimp Cultivation*. Lampung: Aura.