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RISK MANAGEMENT OF SEAWEED CULTIVATION BUSINESS

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ABSTRAK

Produksi rumput laut di Kecamatan Bluto mengalami fluktuasi dari waktu ke waktu. Hal tersebut menunjukkan adanya risiko produksi dan berdampak pada pendapatan petani. Tujuan dari penelitian ini adalah mengetahui faktor apa saja yang menyebabkan terjadinya risiko produksi rumput laut dan mengetahui strategi yang dilakukan dalam mengurangi risiko produksi rumput laut di Kecamatan Bluto, Kabupaten Sumenep. Data primer dikumpulkan dari 50 orang petani yang dipilih melalui sensus. Data dianalsisis menggunakan *Failure Mode of Effect Analysis* (FMEA) dan analisis deskriptif untuk melihat strategi *ex ante, interactive,* dan *ex-post*. Hasil analisis menunjukkan bahwa faktor penyebab risiko produksi rumput laut di atas nilai kritis adalah cuaca, kondisi gelombang, dan hama penyakit. Faktor penyebab risiko di bawah nilai kritis adalah kualitas air, kondisi rakit apung, kualitas bibit, dan lingkungan yang tercemar. Strategi penanganan risiko yang dilakukan adalah melakukan pengecekan dan pengontrolan pada alat serta bibit yang akan digunakan, dan melakukan percepatan masa panen saat cuaca tidak mendukung
Kata Kunci: *risiko produksi, manajemen risiko, rumput laut*

ABSTRACT

Seaweed production in Bluto District has fluctuated from time to time. This indicates a production risk and has an impact on farmers' income. The purpose of this research is to find out factors causing the risk of seaweed production and to find out the strategies used to reduce the risk of seaweed production in Bluto District, Sumenep Regency. Primary data were collected from 50 farmers who were selected by the census. Data were analyzed using Failure Mode of Effect Analysis (FMEA) and descriptive analysis to see ex-ante, interactive, and ex-post strategies. The results of the analysis showed that the risk factors for seaweed production above the critical value were weather, wave conditions, and pests and diseases. The risk factors below the critical value were water quality, floating raft conditions, seedling quality, and polluted environment. The risk management strategy carried out was to check and control the tools and seeds to be used, and to accelerate the harvest period when the weather was not supportive.

Keywords: *production risk, risk management, seaweed*

INTRODUCTION

Seaweed is a commodity that has high economic value (Salim and Ernawati, 2015) that can be cultivated using simple technology and relatively small capital (Santoso dan Nugraha, 2008) but has quite a high level of risk of seaweed production (Jufri *et al.*, 2018). According to (Kasim *et al.*, 2017), the high risk of seaweed production is related to natural/environmental conditions including some factors such as weather, water currents, pest and disease attacks, and extreme sea waves.

One of the seaweed-producing areas in Indonesia is Madura Island. Because of its geography, which is surrounded by straits and oceans, this island is one of the most major seaweed production hubs with the potential to become an export commodity. Sumenep Regency that is located in Madura Island has the largest seaweed production compared to other districts in East Java Province. Among several seaweed-producing subdistricts in Sumenep Regency is Bluto District.

The production of seaweed in the Bluto District varies year by year, with a coefficient of variation of up to 24%. Variations in production are frequently related to risk, and riskier scenarios tend to have more fluctuation in production, putting farmers at risk to meet financial goals (income) (Crane *et al.*, 2013). Specifically, Hanafi (2014) defined that risk is an unfavorable incident or a potential outcome that differs from what is expected.

According to Hasan *et al.*(2017), risk cannot be eradicated but can be minimized by risk management. Rustam (2017) defined risk management as a series of methodologies and procedures utilized to identify, measure, monitor, and control risks emerging from any business activities aiming to increase company value.

According to Kahan (2013), farmers should understand risks and possess risk management skills to anticipate problems well and reduce the consequences of those risks. Several previous studies examined the risks of seaweed cultivation, but they focus on the level of production risk (Sulistyo and Wahyuni, 2020), farmer behavior in overcoming risks (Kasim *et al.,* 2017; Susanti *et al.,* 2018), the risk effect on the behavior of farmer households in allocating inputs (Jufr *et al.*, 2018), and risk management strategies of processing industry-level (Sarinah and Djatna, 2015). Therefore, research examining the sources of production risk and strategies for dealing with it has not been conducted yet.

This study aims to: (1) find out the factors causing the risk of seaweed production in Bluto District, Sumenep Regency (2) find out the strategies used in dealing with production risk in seaweed cultivation business in Bluto District, Sumenep Regency.

RESEARCH METHOD

The research site of Bluto District, Sumenep Regency was determined purposively with the consideration that the district is one of the centers for seaweed production in Sumenep Regency and has fluctuations in its production. The study was conducted from September to October 2020. The research population was seaweed farmers who had their own rafts with the assumption that they had the freedom to make decisions, particularly in determining strategies to overcome risks. All members of the population become respondents so that the sampling technique employs a census with a total of 50 farmers.

The first objective of the study was analyzed using Failure Mode and Effect Analysis (FMEA). The FMEA model was employed to determine the major causes of the risk of seaweed cultivation production which was then used to provide recommendations for proper actions to fix the damage caused by the emerging risks. According to Irawan *et al.* (2017), FMEA is a structured procedure to identify and prevent as many failures as possible.

The failure identification procedure was performed by ranking each cause of failure based on the severity, occurrence, and detection rates (Carlson, 2014). Severity rate is a rating number related to the most serious effect of a certain failure cause based on criteria of a severity scale. The occurrence rate is the number of disturbances that can lead to failure in the production process. Detection rate is the capability to understand the causes of risks that can occur and is influenced by production control (Surya *et al.,* 2017). The FMEA method of risk assessment scale can be seen in the following table :

Calculation of the value of the Risk Priority Number (RPN) and the value of the Risk Score Value (RSV) was performed using the following formula:

RPN = occurrence scores (Occ) x severity scores (Sev) x detection scores (Det)

RSV = occurrence scores (Occ) x severity scores (Sev)

The Risk Priority Number (RPN) was measured to find out priorities and rank failures in the production process. The Risk Severity Number (RSV) was employed to find out the highest value of failure in a production process. It is essential to understand the RSV and RPN values to minimize the potential for risks and take preventive actions before these risks take place.

Table 1. Severity Rating Scale

Ranking	Impact criteria
9 – 10	The cause of failure has an impact on production failure > 20%
7 – 8	The cause of failure has an impact on production failure at 10%–20%
5 – 6	The cause of failure has an impact on production failure at 5% - 10%
3 – 4	The cause of failure has an impact on production failure < 5%
1 – 2	The cause of failure has an insignificant impact on production failure

Source: Carbone and Tippett, 2004

Table 2. Occurrence Rating Scale

Possible Failure	Criteria: Occurrence of Cause	Ranking
Very high	>1 of 10	10
	1 of 20	9
High	1 of 50	8
	1 of 100	7
Moderate	1 of 200	6
	1 of 500	5
	1 of 1.000	4
Low	1 of 2.000	3
	1 of 10.000	2
Very low	<1 of 100.000	1

Source: Carlson, 2014

Tabel 3. Detection Rating Scale

Ranking	Criteria
10	Causes of the failure are not detected
9	The probability of the causes of the failure being detected is small
6 – 8	The probability of the causes of the failure being detected is easy enough
2 – 5	The probability of the causes of the failure being detected is high
1	The probability of the causes of the failure are almost certain to be detected

Source: Carbone and Tippett, 2004

The value of the RPN demonstrates the seriousness of the issue and the high probability of failure. The higher the RPN value, the higher the potential for failure to take place. Risk is classified as critical if the RSV and RPN values are critical. The critical value of RPN is achieved by measuring the total RPN/number of risk causes, while the critical value of RSV is achieved by measuring the total RSV/number of risk causes. The RPN and RSV values divide a diagram into four parts as follows:

Figure 1 presents (1) The upper right area is the category area of the dominant priority risk. If the risk takes place in this area, it will threaten the accomplishment of the objectives of a business, (2) The upper left area is an area with a risk category that takes place on a regular basis. If the risk occurs in this area, the accomplishment of objectives of a business and targets is not too disturbed, (3) The lower left area is an area with low RPN and RSV values. If the risk takes place in this area, the risk tends to be less significant to consider so that the company does not need to allocate resources to overcome the risk, (4) The lower right area is a risk area that is quite rare, but if it emerges, the company will not be able to accomplish its objectives.

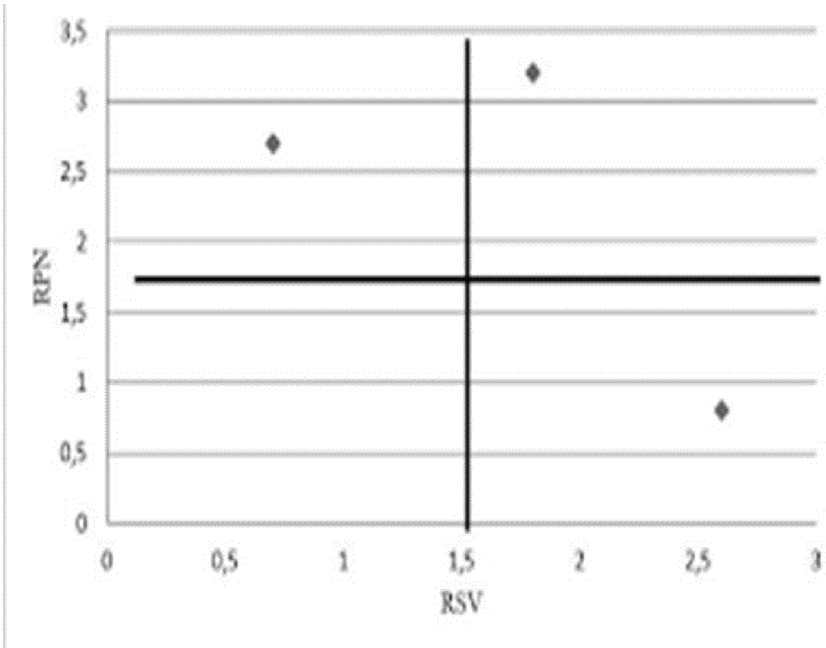

Figure 1. Scatter Chart
Source: Kusno et al. (2017)

The second objective of the study was analyzed descriptively on the ex-ante, interactive, and ex-post strategies. (1) ex-ante strategy is performed by seaweed farmers prior to the occurrence of the risk with the aim of preventing the occurrence of the risk, (2) interactive strategy is performed by seaweed farmers when the risk occurs in order to reduce the risk cause, (3) ex-post strategy is performed by seaweed farmers after the risk occurs aiming at reducing the risk in the next production period.

RESULTS AND DISCUSSION

Characteristics of Seaweed Farmers

The majority of seaweed farmers in Bluto District are male with a male-to-female ratio of 82 percent. It is because seaweed cultivation activities need a large amount of energy so that there are more male respondents than female ones. The characteristics of seaweed farmers based on age were classified into three groups, including the age range of 21-40 years, 41-60 years, and 61-80 years. The majority of farmers or 66% of them are between the ages of 41 and 60.

The education level of seaweed farmers in Bluto District consists of those who do not go to school, graduate from elementary school, graduate from junior high school, and graduate from senior high school. Farmers who completed education in elementary school were the most common in Bluto District. The experience in the seaweed cultivation business is possessed by farmers who cultivate seaweed with a unit size of a year. Most of the seaweed farmers in Bluto District or 40% of them have experience in seaweed cultivation for 21-30 years. It is because many seaweed farmers have been carrying out seaweed cultivation since they were young. This experience affected crop yields, in which the more experience a farmer has, the fewer errors will happen.

Seaweed farmers in Bluto District have various family dependents depending on the number of family members. The majority of farmers have family dependents of three to four people with a percentage of 74%. The number of family dependents has an impact on the cultivation process, in which the higher the number of family dependents, the higher the number of farmers carrying out cultivation activities to increase family income. Raft or commonly called *ancak* is a tool owned by seaweed farmers in carrying out seaweed cultivation. Most farmers or 70% of them own one to ten rafts. Because the cost of making rafts is relatively expensive, farmers only make rafts according to their capital capabilities.

Factors Causing Highest to Lowest Risk in Seaweed Cultivation Business in Bluto District

Many risk factors occur in seaweed cultivation where the causes of risk and their assessment by respondents are shown in Table 4 below:

Table 4 shows that weather, wave conditions, and pests and diseases become the major risk factors as they have RPN value ≥ RPN critical value (301.95). These results are in line with those of the study Santoso dan Nugraha (2008) where seaweed harvest failure is often due to the effect of big waves that destroy cultivation media and biota, as well as anomalies and climates of extremely high rainfall or long summers that affect the emergence of disease (ice-ice) or seaweed rot.

The weather becomes the highest risk factor with the RPN value of 791.48 ≥ the critical value of 301.95. A high RPN value for weather means that the weather becomes the cause of failure in the seaweed cultivation process.

Table 4. Assessment of the Risk Causes in Seaweed Cultivation Business in Bluto District, Sumenep Regency

Risk Causes	**Sev**	**Occ**	**Det**	**RPN**	**RSV**
Polluted environment	3.52	3.62	2.52	32.11	12.74
Seed Quality	5.54	4.68	4.58	118.74	25.93
Weather	9.06	8.86	9.86	791.48	80.27
Big waves	8.00	7.52	7.50	451.2	60.16
Seawater quality	7.54	6.22	5.18	242.94	46.89
Floating raft condition	4.62	3.34	4.52	69.75	15.43
Pest and Disease	8.02	7.84	6.48	407.44	62.88
Total				**2113.66**	**304.31**
Critical Value				**301.95**	**43.48**

Source: Primary data processed, 2020.

It is due to the highly dependent cultivation process on weather conditions including wind speed. The wind speed determines the current conditions. Therefore, currents that are too strong can break seaweed, while currents that are too weak can disrupt seaweed growth.

Wave conditions become the second risk cause. The result of the calculation of the RPN value from this factor was 451.2 ≥ 301.95. Wave conditions remarkably affect seaweed growth conditions. The waves that are too big cause the rafts and seaweed to break. However, the wave that is too low causes pests and diseases to stick to the plants. Regular monitoring of the raft is important to avoid further damage.

The third risk factor is pests and diseases. The RPN value obtained was 407.44 ≥ 301.95. The disease that often attacks seaweed is commonly called *ice-ice*. According to Santoso and Nugraha (2008), ice-ice is a malignant disease in seaweed that can be a source of failure for seaweed cultivation in Indonesia.

Other risk factors including polluted environment, seed quality, seawater quality, and floating raft conditions are not classified as the highest-rated risks. It is shown that the RPN value of these four factors does not exceed the critical value (≤ 301.95). According to the arguments of Nur *et al.* (2016) in their research results, the seeds are sown and the water quality including temperature, salinity, and turbidity of the water has an effect on the growth of seaweed. Of all the risk factors for seaweed cultivation, the lowest RPN value obtained was the polluted environment of 32.11. A polluted environment is the lowest risk factor, and even if there is damage, it will not have a significant impact on seaweed cultivation failure.

Table 4 also reveals that the factors causing the highest failure included weather, wave conditions, and pests and diseases indicated by the RPN value. These three risk factors were also the highest causes of failure as seen from the RSV values. All of these three factors had higher RSV values when compared to the critical RSV value (43,48). The RSV value of these three factors includes the weather of 80.27, the wave quality of 60.16, and the pests and disease of 62.88.

Other risk factors like seed quality, seawater quality, polluted environment, and floating raft conditions had RSV values lower than the critical RSV value. Risnawati *et al.*

(2018) in their study revealed that fine seawater quality, space, and the light become elements supporting seaweed growth. Besides, environmental conditions and seed quality also affect seaweed production. A polluted environment is a risk factor with the lowest RSV score of 12.74 ≤ 43.48. Based on the figures in Table 8, a scatter diagram can be established to inform the position of the risk-causing category seen from the RPN and RSV values.

Figure 2 shows that the factors of weather, wave conditions, and pests and diseases become the highest risk factors as they are located in the upper right area. All of these three factors are considered a source of high production risk because of their destructive nature to the cultivation media, marine biota, and the seaweed itself (Santoso dan Nugraha, 2008; Mudeng *et al.*, 2015). The upper right area is the primary priority risk category area. If these risk factors are not addressed immediately, seaweed farmers would face failure in their cultivation business.

Seed quality, polluted environment, and floating raft conditions are located in the lower-left area. The risks occurring in this area do not require much attention as the occurrence and severity are small.

The factor of seawater quality becomes a risk factor occupying the lower right area. This area has a risk category that is quite rare, but if this risk happens, the farmers can experience a crop failure. Changes in water quality because of low salinity, temperature, water movement, and turbidity (that can affect light intensity) cause stress on seaweed, making it easier to be infected by pathogens or susceptible to disease (Hurtado and Agbyani, 2000; Fitrian, 2015).

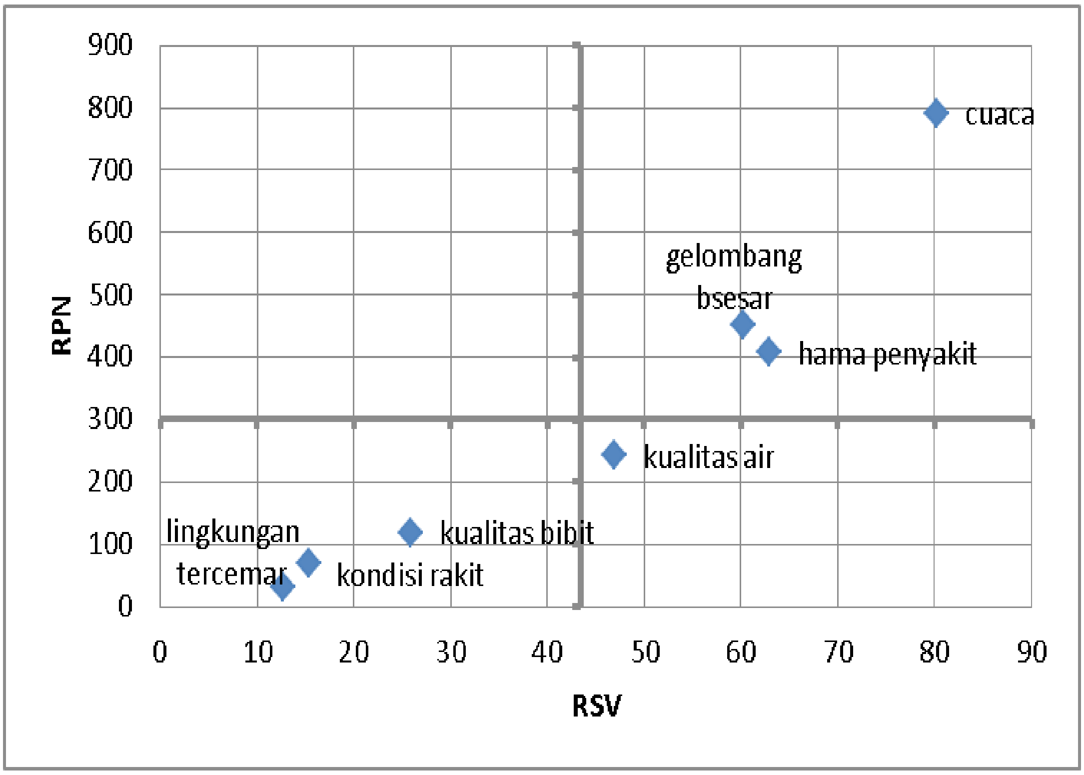

Figure 2. Scatter Diagram of the Risk Causes in Seaweed Cultivation
Source: Primary data processed, 2020.

Strategies Implemented by Seaweed Farmers to Reduce the Risk of Failure

Risks cannot be eliminated but they can be reduced. Reducing, minimizing, or decreasing risks in seaweed cultivation needs handling from seaweed farmers. It is in accordance with risk management as stated by Pramana (2011) that one type of risk management is by minimizing it. Three strategies in risk reduction include ex-ante strategy (before the risk occurs), interactive strategy (when the risk is occurring), and ex-post strategy (when the risk has occurred) (Windani *et al.*,2016).

Strategies carried out before the risks occur

Wind and wave conditions become factors that will affect both physical damages to cultivation facilities and the seaweed (Mudeng *et al.*, 2015). The strategy taken by seaweed farmers prior to the risk of damage occurred was to plant the seaweed when the wind conditions were not too strong or too low and the waves were not too big or too small (these conditions commonly occur at the peak of the rainy season in December-February). Generally, most farmers only cultivate seaweed during the rainy season (October-March), while a few farmers cultivate it throughout the year and some of them also cultivate it in the dry season (April-September). In December-February, however, they will increase the number of rafts.

The selection of the best time to cultivate the seaweed affects the quantity and quality of production. The results of a study conducted by Asni (2015) revealed that the season affects production in which production in the dry season is not higher than that in the rainy season. It is because, during the rainy season, there are changes in water quality. Besides, the availability of nutrients that originate from the flow of rainwater in the sea is higher.

According to Sunaryat (2004), Actually other strategies can be implemented to avoid strong winds and big waves, which is choosing a protected location. However, seaweed farmers in Bluto District cannot do this strategy. The location that is considered protected is commonly in the waters of the bay or open water protected by a barrier or island in front of it.

Some coastal areas in Bluto District have been experiencing pollution because of the waste of several tofu factories and households. Therefore, the farmers' strategy to avoid the risk of product failure is choosing a location that is far from the factory location in order for the cultivated seaweed to be uncontaminated with the waste. It is in accordance with the research results of Abdullah (2011) that the location of seaweed cultivation needs to be in waters that are free from pollution, both from industrial and household waste.

Another strategy prior to cultivating is to check the tools to be utilized. This strategy is performed to determine whether the tool used is in good condition or not. Examining the seeds is also important to perform to determine whether the seeds to be planted are in proper condition. Therefore, when the tools or materials are not in proper condition, these tools can be repaired so that good quality materials can be obtained immediately. It is in line with the results of the study conducted by Abdullah (2011) which stated that the selection of seeds is a crucial aspect that should be carried out because the better the seeds used, the better the growth of the seeds. The seeds used by the seaweed farmers in Bluto District are Eucheuma Cottonii. This type of seaweed tends to grow slowly during the ice-ice season and extreme weather.

Strategies carried out when the risks occur

Seaweed cultivation business has the probability of risks taking place during cultivation activities. The highest risk factors include weather, wave conditions, and pests and diseases. Weather is a natural condition that cannot be predicted. Farmers have not performed the handling of risks related to weather yet to reduce the occurrence of this risk. Cultivation activities that are carried out in the rainy season, wave, and wind conditions are relatively stable compared to the dry season. Farmers can keep planting when the waves and wind are strong during the dry season, although the number of seeds on the rafts utilized is reduced and accelerates the harvest period. It has an impact on the low quality of the seaweed harvest. This condition is in accordance with the results of the study conducted by Marseno *et al.*. (2010) that early harvesting results in lower carrageenan content and gel strength. The results of a study carried out by Lewerissa (2005) revealed that the older the seaweed harvest, the higher the yield.

The next risk factors include pest and disease attacks. Plants should not be left exposed to pests as they might spread to other plants. Farmers handle pests and diseases in a simple way, which is by cleaning mud, dirt, and moss attached to prevent further pest and disease attacks and replanting plants that have been damaged. According to the results of a study conducted by Maryunus (2018), there is an effective strategy to handle diseases, particularly ice-ice, and simultaneously can maintain production sustainability, which is by carrying out limited manipulation of the environment during extreme seasons.

The floating raft conditions also need to be considered during cultivation activities because when damaged rope or bamboo can be replaced immediately. Furthermore, farmers also make repairs to ballast stakes when damage occurs.

Seawater quality is the last risk factor in this category. Stable seawater quality can affect the growth of seaweed. It is in accordance with the argument of Kurniawan *et al.* (2018) that good water quality is a crucial factor to support the growth of seaweed. Seawater that is too warm commonly occurs in the dry season might cause seaweed to become stunted and yellowed which then leads to the occurrence of ice-ice disease, resulting in low quality of the harvest. It is in line with a study conducted by Radiarta *et al.* (2013) that a prolonged summer can increase seawater temperatures, leading to the decay of cultivated seaweed and the occurrence of disease (ice-ice). When this risk occurs, the farmers move their rafts to an area with seawater that is not too warm. They also examine the seaweed to minimize damage.

Strategies carried out after the risks occur

The strategy employed by farmers when the ex-ante and interactive strategies do not work is utilizing a strategy carried out after the risks occur (ex-post strategy). Reducing risks with the ex-post strategy performed by seaweed farmers is by selling the assets they have such as livestock and jewelry. Furthermore, seaweed farmers also borrow capital from families or collectors. The loan is utilized for further capital in doing the next cultivation businesses. Seaweed farmers keep planting the seaweed because most of them depend on their income from farming. This is in accordance with the results of the study conducted by Hasan *et al.*

(2017) that if crop failure still occurs although they have implemented ex-ante and interactive strategies, then farmers perform ex-post strategies by selling assets and seeking loans for capital from financial institutions or relatives that will be used for the next planting season.

CONCLUSION AND SUGGESTION

Based on the research results that have been described, it can be concluded that the highest risk factors (above the critical value) in seaweed cultivation in Bluto District, Sumenep Regency include weather, wave conditions, and pests and diseases, while the causative factors (below the critical value) include water quality, floating raft conditions, seed quality, and polluted environment. The strategies carried out by farmers to reduce risk include (a) ex-ante strategy by determining the research site and time of planting, examining the tools, and the seed condition to be used, (b) interactive strategy by cleaning and repairing equipment that has damage, (c) ex-post strategy by looking for loans used as a capital for the next growing season.

Based on the results of the study that has been carried out, several suggestions can be provided, including, the edge of the planting area of the raft should be installed with nets to minimize pest attacks on plants. Meanwhile, to overcome the ice-ice disease attack, planting breaks can be performed or the seed can be replaced with the disease-resistant. As for weather conditions, such as the strong wind, it can be handled by minimizing the number of rafts or the use of seeds with other species that are more resistant to extreme weather. Similar treatment (reducing rafts and replacing seeds) can also be implemented in high wave conditions. Furthermore, farmers should check the plants regularly so that damage can be immediately addressed.

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