RJOAS: Russian Journal of Agricultural and Socio-Economic Sciences
ISSN 2226-1184 (Online) | Issue 8(140), August 2023

UDC 639

RISK ANALYSIS OF CATFISH CULTIVATION PRODUCTION IN KEDIRI REGENCY, INDONESIA

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ABSTRACT
Cultivators who manage catfish farming businesses must consider the possibility of low production yields caused by both external and internal variables. The risks that catfish farmers confront may be to blame for the low output. The aims of this study were to determine the source of production risk and the level of risk correlated with catfish production. The method of determining the area of study is carried out intentionally (purposively). This research method is a descriptive and analytical method. The snowball sampling approach was used with a sample of 40 respondents. The data used is a combination of sources both primary and secondary. The analysis used includes variance, standard deviation, coefficient of variation, and risk level based on the risk map. Pests and diseases, weather and climate, the quality of catfish seeds, water quality, cannibalism, and human resources or cultivators who carried out the catfish cultivation process are all factors of production risk in Kediri Regency. The level of risk of catfish production is high, based on the variance value of 21.03, standard deviation of 4.59, and coefficient of variation of 1.61, while the production risk map reveals that the production risk faced by farmers is in the yellow zone, therefore it is included in the high-risk category.

KEY WORDS
Coefficient of variation, production risk, risk map, sources of risk.

The fishing sub-sector will be the second largest contributor to the agricultural, forestry, and fishery sectors in 2021, accounting for 8.04 percent of the total [1]. The fisheries industry in Kediri Regency is divided into two sub-sectors: 1) inland public water fisheries, which includes reservoirs, rivers, swamps, and other puddles; and 2) freshwater aquaculture, which includes ponds, minapadi, pond rice fields, floating net cages, and ornamental fish.

Fish ponds are a land-use alternative that is supported by easy accessibility to fresh water as a method of survival for fish. Catfish (*Clarias sp*) is one of the fishing commodities grown in ponds. Catfish is one of the fishery commodities whose development is in demand by cultivators in Kediri Regency. According to [1], the development of freshwater consumption fish production, particularly catfish, in Kediri Regency from 2017 to 2021 consistently improves and ranks first. Catfish farming is one of the freshwater aquaculture enterprises that some individuals engage in Kediri Regency since it provides a possibility to earn a significant enough profit. According to [2], risk is an uncertainty that produces losses or deviates from intended aims.

Both internal and external factors can lead to low production results, which cannot be avoided by engaging in catfish farming. Production risk is caused by internal factors that cultivators can control, such as the management of production inputs and water quality, and external factors that farmers cannot control, such as the weather or climate, pests, and diseases. According to the research results of [3] the use of production inputs in the form of feed has a substantial effect on production risk. The high percentage of deaths, low productivity, limited capital, small profits, and the high use of production costs all contribute to production risk in aquaculture [4].

Catfish cultivators in the Kediri Regency should consider the production risk they face when conducting their cultivation business. If the risk of loss is extremely high, then it must be avoided, but if it is low, then it must be pursued. However, the cultivator does not clearly

observe the sources of risk that cause production risk, the magnitude of production risk, nor does he have information that can be used as a deciding factor for his cultivation business. This study aimed to identify the source of production risk and the level of risk associated with catfish production.

LITERATURE REVIEW

Risk is the likelihood of a business occurrence resulting in losses [5 [6] [7]. Fisheries is one of the industries with a high level of risk. Farmers' daily actions as business people are always dealing with irrational change in terms of products, prices, and income, among other things. Sources of production risk in the fishing business are generally caused by several factors such as the use of inputs, pests and diseases, changes in temperature, and human error from the workforce.

According to [8], risks that often occur in agriculture and can reduce farmers' income levels are: (1) Production risk; (2) Price or market (sales) risk; (3) Risk Institutions (institutional); (4) Financial risk; (5) Human risk.

Risk assessment is based on measuring the variance (deviation) of an asset's return. The variance, standard deviation, and coefficient of variation are used to calculate risk [9] [10] [11] [12]. These three sizes are related to one another, with the variance value functioning as a determinant of the others. The standard deviation is the square root of the variance, whereas the coefficient variation is the standard deviation divided by the expected return value of a commercial activity. The obtained return can take the form of revenue, production, or price.

METHODS OF RESEARCH

This research was conducted in Kediri Regency from June 2022 to August 2022. The sample selection method used snowball sampling, which was based on information from one farmer to the next as many as 40 people.

This research utilizes both descriptive and quantitative methods of analysis. According to [13], the purpose of descriptive method is to describe significant current events. This quantitative analysis employs quantitative methods in data analysis, with the objective of testing hypotheses by examining specific populations or samples [14].

Risk analysis will be used to test the first hypothesis regarding the sources of production risk catfish farmers face. Descriptive analysis can be used to examine the sources of risk in catfish farming. The second hypothesis test concerned the production risk faced by catfish cultivators in Kediri Regency. A risk analysis was conducted using the variance, standard deviation, and coefficient of variation based on the level of productivity, and a risk map was used to analyze the results.

As said by [15], the risk measurement includes the variance value, the standard deviation, and the coefficient of variation. The variance is the measure of the difference between the squares of the expected return and the actual return (production), multiplied by the probability. Analysis of variance can be formulated mathematically as follows [16]:

$$\sigma_i^2 = \sum_{j=1}^{m} Pij\ (Rij - Ri)^2 \qquad (1)$$

Where: P_{ij} = Probability, R_{ij} = Expected return, R_i = Return (production), σ_i^2 = Variance.

As mentioned by [17], standart deviation and variance are closely related as measures of the variation in a data set. The standard deviation equals the square of the variance, and conversely. Based on this statement the standard deviation can be formulated mathematically as follows:

$$\sigma_i = \sqrt{\sigma_i^2} \quad (2)$$

Where: σ_i^2 = Variance, σi = Standard deviation.

According to [18], the coefficient variation is calculated by dividing the standard deviation by the mean. Based on this statement the coefficient of variation can be formulated:

$$CV = \frac{\sigma i}{\mu} \quad (3)$$

Where: σi = Standard deviation, μ = Average production (unit/ha).

The coefficient variation is calculated using the following criteria: if the CV value is < 0.5, the production has a low risk, if the CV value is > 0.5, the production has a high risk.

The production risk map can be known if the level of risk is known in advance. The risk level is obtained by multiplying the likelihood value with the risk consequence value. The risk level can be formulated as follows [19]:

$$Level\ of\ Risk\ (R) = Likelihood\ (L) \times Consequence\ (Q) \quad (4)$$

Where: L = Value of Likelihood (Levels of probability); Q = Value of Consequence (Levels of Impacts); R = Level of Risk (Risk Rating).

The following step is to initiate the evaluation of catfish production, which is derived from the calculation of the probability value using the level of probability and probability of occurrence of risk with a score range of 1-5 (Table 1), as well as the value of the consequences obtained by considering the possible impacts with a value range of 1 to 5 (Table 2).

Table 1 – Risk Assessment of Likelihood of Catfish Production

Score	Description	Likelihood
1	Rare	It might occur only in unusual circumstances
2	Unlikely	It may occur under specific conditions and at a particular time
3	Possible	It may occur at some point or under specific conditions
4	Likely	Possible in numerous conditions
5	Almost certain	Can occur in numerous situations

Source: [20].

Table 2 – Risk Assessment of Consequence of Catfish Production

Score	Description	Risk Consequence
1	Insignificant	Very minor loss with negligible effect on business objectives
2	Minor	Low Losses, minimal influence on business objectives
3	Moderate	Moderate loss, substantial influence on business goals
4	Major	Significant loss and effect on business objectives
5	Catastrophic	Huge loss, enormous effect on business objectives

Source: [20]

The final step entails mapping the risk of ornamental fish production derived from the likelihood assessment, risk consequence assessment, and evaluation of the risk of catfish production (Table 3).

Table 3 – Criteria for Evaluating the Production Risk of Catfish

Risk Level	Risk Category	Risk Acceptability	Risk Assessment Priorities
1-4	Low	Acceptable	This level of risk is tolerable with monitoring
5-9	Medium	Tolerable	This level of risk is acceptable with regular monitoring for any changes in probability or consequence levels
10-16	High	Unacceptable	This type of risk is unacceptable. Immediate development and implementation of treatment strategies aimed at lowering the risk level is required
17-25	Extreme	Intolerable	The impact of this risk occurring would be so severe that the related activity would need to cease immediately. Extreme risks need immediate mitigation strategies to be implemented

Source: [20]

RESULTS AND DISCUSSION

Changes in the weather can cause alterations in water temperature and pH, as well as a variety of diseases. During the dry season, the productivity of catfish farming is affected by weather conditions. In addition, abrupt weather changes will cause catfish to experience stress and quickly perish.

Based on the field, the average air temperature in the rearing pond is between 26.7ºC and 32ºC, and the average pH is between 6.7 and 7.7. As said by [21], catfish cultivation requires an air temperature between 20ºC and 30ºC and a pH between 5.5 and 7.5. The weather and climate also affect the quality of pond water, which in turn causes the emergence of various disease-causing agents. Extreme temperature fluctuations from day to night result in numerous fish deaths. The fish's appetite decreases in cold pond water, and catfish become more lethargic and unproductive. This is consistent with the results of [22] research which indicates that prolonged exposure to low temperatures causes fish to lose their appetite, making them susceptible to disease and weakened. Changes in weather and climate also cause changes in air quality, which are closely related to the onset of disease, which is caused by temperature changes that have an effect on stress-prone fish [23]; [24]; and [25].

4.1.2 Quality of Fish Seed. The success of catfish farming depends on the utilization of high-quality seeds. Several factors determine seed quality, including rapid growth, a high survival rate (SR), uniform size, and disease resistance. Utilizing high-quality seeds will increase production yield, which will have a positive effect on acceptance. In the business of catfish farming, seeds are not produced for use in their own operations. The catfish breeding business obtains its seeds from the UPR (Unit Pembenihan Rakyat) and the UPT Catfish Hatchery in Kediri and the surrounding area.

According to field data, seed quality causes the most catfish mortality of all potential risk factors. Because catfish seeds are susceptible to disease and easily stressed, they account for the vast majority of catfish deaths. As per [21] high-quality seeds are essential for successful expansion. It has been demonstrated that the use of superior seeds increases catfish species' productivity and profits [26]; [27].

Water is a crucial component that must be considered when catfish are being farmed. If the water is of great quality, fish will have a voracious appetite, resulting in rapid growth of catfish. The productivity of catfish farming will also be affected by water quality.

Due to the limits of water quality measurement tools, the expansion pond's water quality is less controlled in accordance with excellent water standards, based on field data. In addition, water for expansion is frequently mixed with direct precipitation that has not been deposited, rendering the pond water substandard and causing catfish placed in the pond to experience stress and die. Additionally, catfish excrement and uneaten food were discovered in the pond, lowering the water quality. In addition, water changes are irregular because growers believe that if the pond water does not change color, it is still in good condition, therefore they simply replace the water infrequently within a single production cycle. As said by [21] the primary element affecting the survival of catfish is the presence of water. According to Tania [28], the water as a living medium for aquatic biota must be tailored to ideal circumstances for the sustained biota. [29], report that the best temperature for the growth of catfish (*Clarias sp.)* is 25-30°C, and the optimal pH for the cultivation of catfish (*Clarias sp*.) is 7-8.5. Catfish *(Clarias sp.)* may have a diminished appetite if the pH level is 9.

Catfish mortality is caused not only by parasites and diseases, but also by their cannibalistic nature. This is due to the fact that catfish are cannibals. According to [30], cannibalism is the nature of preying on individuals of the same sexe and is typically practiced by larger fish against smaller fish. Several factors contribute to cannibalism, including high stocking density, non-uniform seed size, and shortage of food.

Observations and interviews indicate that inconsistent fish size and a lack of food trigger cannibalism. Catfish of the same age might vary in body size due to both natural and intentional/negligent reasons. Natural factors are impacted by hereditary qualities, health and stamina, chance and aggressiveness in the pursuit of food. In the meantime, the

intentional/negligent factor is caused by cultivators who do not sort the size of the farmed fish. According to [31] catfish are typically sorted every three weeks based on their condition; if the size is not uniform, sorting might be accelerated.

Cannibalism can also be triggered by a lack of food. Due to excessive feed prices and their own neglect, farmers suffer from a lack of feed. The high cost of feed will have an impact on the dosage and frequency of feedings, as cultivator will cut the dosage and frequency to reduce production expenses. In addition to the price of feed, the lack of feed is also caused by cultivator's carelessness, which results in feeding delays. Feeding delays can be caused by overworked farmers and a lack of feed stock. As said by [32] unplanned feeding led to a rise in catfish cannibalism. [33] stated that in the catfish farming system, late feeding of fish will lead to cannibalism in a pond, resulting in a fish population decrease. According to [34], the high survival rate is due to the fact that the feed given is adequately utilized and the fish's nutritional needs are addressed, hence reducing their cannibalistic tendencies.

Pests and diseases present risks to every method of catfish production. Pests and diseases are direct causes of mortality in catfish. Pests and diseases will attack catfish and lead to their demise if the fish lack a robust immune system, disease resistance, and a supporting culture environment.

According to interview data, the most common pests in catfish farming are birds, bats, and frogs. Catfish are usually affected by white spot illness, jaundice, and flatulence. White spot illness is initially characterized by the presence of red spots, which eventually burst and bleed, causing the spots to become white. In addition to white blotches, the catfish's whiskers looked fractured and injured. According to [35], *Ichthyophthirius multifiliis* is a parasite that causes white spot illness. This parasite was identified from the caudal fin of fish based on its horseshoe-shaped macronucleus and cilia. Fish infected with this sort of parasite will be covered in white dots.

Catfish get jaundice due to poor water quality or carrion consumption. Yellowing of the catfish's body and yellowing of its internal organs (liver, intestines, bile, stomach wall) are indicative of jaundice. The catfish also becomes weak and inactive, and its internal organs (liver, intestines, bile, and stomach wall) are yellow. The epidermis, internal organs, and other tissues of an African catfish with jaundice are yellow [36].

The symptoms of bloated stomach disease in catfish consist of the stomach being enlarged. This illness is not communicable and is brought on by overfeeding. The feed that is consumed by a catfish will expand in the catfish's stomach. When this occurs, the stomach of the catfish swells and even causes the small intestine to rupture, causing the stomach fluid to enter the abdominal cavity and causing infection until the catfish dies.

Aquaculture activities necessitate highly-skilled human resources, cultivation techniques mastery, and the ability to overcome any challenge that may arise. Basic errors in catfish farming include forgetting or being late to feed the fish, not being cautious when harvesting, and not controlling each pond carefully. Future catfish extinction may result from these elementary errors. The most common errors made by catfish farmers include tardiness and forgetting to feed the fish when they are engaged in other activities, because they cultivate the fish themselves without the assistance of personnel.

Assessment of the risk level associated with catfish production in the area of study, as shown in Table 4.

Table 4 – Result of Assessment of Risk Level of Catfish Production

Measurement	Value
Expected Value	2,84
Variance	21,03
Standard Deviation	4,59
Variance Coefficient	1,61

It can be seen from the table above that the coefficient of variation is greater than 0.5 (1.61 > 0.5), indicating that catfish producers face a high production risk. Some other

research results on the risk of cattle cow business production [37]; risk of fish farming production [38]; and production risk of catfish (*Pangasius hypophthalmus*) farming business [39] conclude that if the coefficient variation value is greater than 0.5, the business has a high risk level.

The level of risk can be used to determine the risk map of catfish farming production in Kediri Regency. The results of the risk likelihood assessment of catfish production (Table 5) and the risk assessment of the consequences of catfish production are presented (Table 6).

Table 5 – Value Likelihood of Catfish Production Risk (L)

Production	Likelihood Value		
	L Weather/Climate	L Diseases	L Pests
Low	2	2	1
High	4	4	2

Table 5 indicates that weather/climate and disease factors are unlikely to constitute a threat to farmers with low production levels, whereas pests do not offer a threat to production or may occur only under exceptional circumstances. Weather/climate and disease factors are more likely to represent a threat to farmers with high production levels, whereas pest factors are less likely to pose a threat or may only do so under certain conditions or at certain periods.

Table 6 – Value Consequences of Catfish Production Risk (Q)

Production	Consequence Value		
	Q Weather/Climate	Q Diseases	Q Pests
Low	2	2	1
High	4	4	2

Based on Table 6, it can be shown that weather/climate and disease factors result in modest losses for farmers with low production levels, whereas pest attack factors result in very low losses. In cultivators with high production levels, weather/climate and disease variables have a high loss rate, while pest attack causes have a moderate loss rate.

The likelihood value (L) and the consequence value (Q) will be used to determine the level of risk associated with catfish farming.

Table 7 – Risk Level of Catfish Production

Production	Risk Level (R)		
	R Weather/Climate	R Diseases	R Pests
Low	6	6	2
High	16	12	4

Table 7 illustrates that weather/climate factors and disease attacks place farmers with low production levels at intermediate risk for catfish production, whereas pest attack factors place farmers at low risk. Weather/climate conditions and disease attacks place farmers with high production levels at danger; while pest attacks place cultivators with low output levels at risk. The results of the average risk level for catfish production are displayed in Table 8 below.

Table 8 – Rating of the Average Risk Level for Catfish Production

Measurement	Score	Description	Explanation
Likelihood (L)	3,25	Moderate Probability	Cultivators have the possibility of risk occurring in certain times and conditions.
Consequence (Q)	3,13	Moderate Loss	Cultivators experience moderate losses and a significant impact on their cultivation business objectives.
Risk Level (R)	10,16	High Risk	Cultivators must emphasize their roles and responsibilities in dealing with production risks.

The risk likelihood value (L) for the average catfish production is 3.25, while the risk consequence value (Q) is 3.13, as shown in Table 8. This number suggests that the catfish farming business may encounter production risk at some point or under certain conditions, with the farmer experiencing a moderate level of production loss and a substantial effect on the cultivation firm's purpose. The threat to catfish production posed by unfavorable conditions such as bad weather/climate conditions and disease outbreaks. The production risk (R) score for catfish farming is 10.16, indicating a high level of risk for catfish producers. According to research [20]; [3] when the risk value of agricultural output reaches 10 to 16, the risk faced by farmers is high. The production risk map can be used to describe the risk of catfish production in the study region based on assessment results (Figure 1).

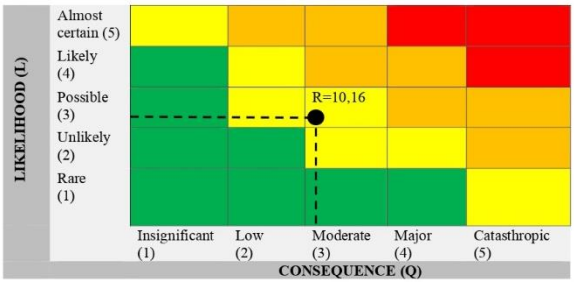

Figure 1 – Risk Level of Catfish Production Based on Risk Map

Based on the research results, it is necessary to implement preventative and mitigation techniques to manage these risks. Cultivator can implement preventative measures by attempting to produce their own catfish seeds so that the quality of their catfish can be tailored to their needs, regularly inspecting the condition of pond water and catfish, removing and separating sick and dead catfish as early as possible, sorting and shoveling carefully, and not throwing catfish roughly. The mitigation strategy that can be applied is that cultivators can participate in a fishery insurance program for small cultivators in order to provide guaranteed protection for the risks experienced by cultivators in the catfish farming business.

CONCLUSION

The level of production risk of catfish farming based on the variance value of 21.03, standard deviation of 4.59, and coefficient variation of 1.61, it can be concluded that the risk of catfish farming business faced by cultivators is high. Based on the production risk map, it can be concluded that the risks faced by cultivators are included in the high-risk category and are in the yellow zone which indicates a high level of risk.

Priority in mitigating catfish farming business risks for high-production cultivators is given to weather/climate conditions and disease outbreaks. Regularly inspect the condition of pond water and catfish, and immediately remove and separate sick and dead catfish.

ACKNOWLEDGMENTS

We would like to thank the Rector of the University of Brawijaya and the Institution of Research and Community Services of Brawijaya University (LPPM-UB) for providing financial support through the 2022 Beginner Research Grant (HPP) program, as well as all parties who participated in this research directly or indirectly.

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