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RISK MITIGATION IN THE FOOD CORN SUPPLY CHAIN: A CASE STUDY IN KEDIRI REGENCY

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Abstract. Kediri Regency is one of the corn production centers in East Java. UD. XYZ is an MSME from Kediri Regency that produces processed food products from corn, namely marning. Operational activities and supply chain at UD. XYZ causes risk events. This study aims to identify, analyze, evaluate, and mitigate risks at each food corn supply chain tier. The research sample was determined using convenience and snowball sampling. The risks at the farmer level are 15 risks. The risks at the collector trader and MSME levels are seven risks and 11 risks. The vulnerability risk event matrix at the farmer tier shows extremely vulnerable (F 1.10 and F 1.12), highly vulnerable (F 1.4, F 1.5, and F 1.14), and moderate vulnerability (F 1.3, F 1.13, and F 1.15). The vulnerability risk event matrix at the collector trader tier shows low vulnerability at risks CT 2.1, CT 2.2, CT 2.3, CT 2.4, and CT 2.5. The vulnerability risk event matrix at the MSME tier shows highly vulnerable (C 4.1, C 4.2, C 4.10, and C 4.11), moderate vulnerability (C 4.7), and low vulnerability (C 4.6). Risk mitigation is carried out for risk events that are extremely vulnerable, highly vulnerable, moderately vulnerable, and low vulnerability.

Keywords: agricultural supply chain, food corn, supply chain risk management

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INTRODUCTION

Corn is an important food crop (Dabija et al., 2021). The benefits of corn are as animal feed and food ingredients (Zhang et al., 2021). Supply chain activities in corn plants from the farmer to the consumer tier cause risk events that need to be anticipated. East Java is Indonesia's largest corn production center, with production in 2022 reaching 6,608,822 tons (Pusdatin, 2023). Kediri Regency is one of the corn production centers in East Java. Corn kernel production in Kediri Regency in 2022 reached 348,055 tons (BPS, 2023). Some locations in Kediri Regency can plant corn one to three times a year. UD. XYZ is a micro, small, and medium enterprise (MSME) from Kediri Regency that produces

processed food products from corn, namely corn marning. Marning is a snack made from fried corn kernels. Marning products are produced from raw materials of quality corn. Operational activities and supply chains at UD. XYZ causes risk events. Each risk event requires appropriate risk mitigation.

Supply chain is a comprehensive approach that covers the entire process from production to delivery to the end user (Akram et al., 2024; Cong et al., 2024). The supply chain connects suppliers, industries, and consumers (Rebelo et al., 2022). Producing and delivering products is part of the supply chain (MacCarthy et al., 2022). Supply chains require coordination with organizational partners (Ramos et al., 2022). Agricultural supply chain (ASC) activities are planting agricultural products in marketing (Kafi et al., 2025; Routroy & Behera, 2017). Agriculture as a food source requires proper ASC management (Chu & Pham, 2024; Ray, 2021).

Risk is uncertainty that harms an organization. The causes of risk are natural and human factors. Important components of risk management are identification, analysis, evaluation, mitigation, and risk monitoring (Senna et al., 2021). Supply Chain Risk Management (SCRM) is a risk management process for supply chain risks. SCRM aims to identify, assess, mitigate, and monitor adverse events in supply chain activities (Ali et al., 2022; Baryannis et al., 2019). Supply chain risks provide deviations from organizational goals (Mittal et al., 2018). SCRM management through a coordinated approach among supply chain members. The hallmark of SCRM is the identification and reduction of risks across all supply chain activities (Ho et al., 2015). SCRM embodies safe, proactive, and innovative performance (Foli et al., 2024; Hatami-Marbini et al., 2024). SCRM is a short-term and long-term risk assessment (Lavastre et al., 2012). Rapid Agricultural Supply Chain Risk Assessment (RapAgRisk) is a method for determining the severity, potential loss, and options for risk management (Jaffee et al., 2010). The purpose of Rapagrisk is to help supply chain actors understand the risks inherent in agricultural commodities (Murtono et al., 2019).

Corn plants have diverse planting patterns, which pose a risk of price fluctuations. Uneven corn harvest patterns every month cause corn price fluctuations. Fluctuations in corn prices harm every actor in the supply chain. There are three actors in the corn supply chain at UD. XYZ, namely farmers, collectors, and UD. XYZ. Each actor in the supply chain faces risks in each of its activities. Every risk event that occurs in each supply chain actor can harm the supply chain actor. Examples of risk events in the farmer tier are pest attacks, price fluctuations, and climate change. Examples of risk events in the collector trader tier are price fluctuations and decreased product quality. Examples of risk events in the MSME tier are rising raw material prices and product damage during storage.

The function of risk identification and risk mitigation at each tier is to ensure proper supply chain management. The risks that arise affect the demand and supply of corn, which affects corn production. This study aims to identify, analyze, and evaluate risks at each food corn supply chain tier. In addition, provide recommendations for risk mitigation on prioritized risks. The novelty of this research is taking the sample area's current condition (existing condition). Risk is dynamic, so risk identification needs to be done continuously. The gap from previous research on risk management in corn products in Kediri Regency is that research focuses on identifying and providing risk strategies at the farmer level. Research on risk identification, risk analysis, risk evaluation, and risk mitigation efforts on the overall corn food supply chain problem has not been conducted.

METHOD

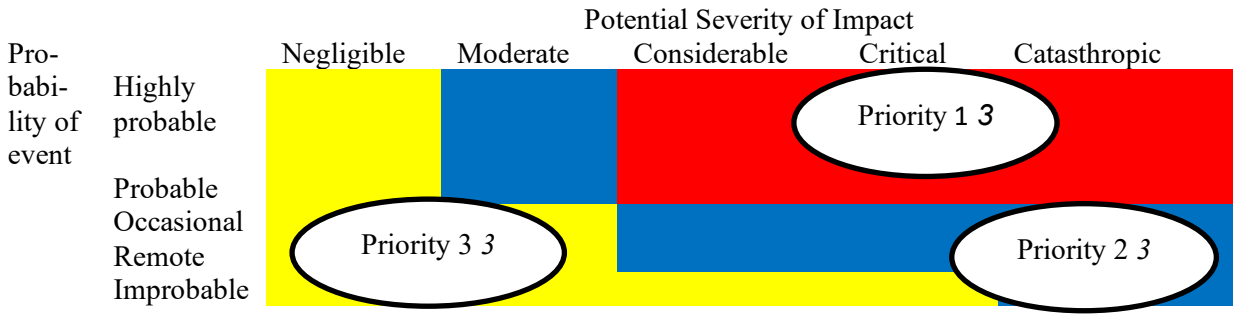
The research period is November 2024 – January 2025. The research location is Kediri Regency, East Java Province. Sampling uses convenience and snowball sampling. The research sample is 50: farmers, collector traders, and UD XYZ. The details of the respondents are presented in Table 1.

Table 1. Respondent details

Respondent	Number of Respondents
Farmer	46
Collector trader	3
MSME	1

Source: Primary Data, 2024

Data collection using observation, interviews, and surveys. The study used in-depth interviews. The focus of in-depth interviews is the intensive implementation of individual interviews with respondents. The research stages are preliminary survey, problem identification, goal setting, literature study, data collection, corn supply chain mapping, risk identification, probability of risk occurrence, impacts caused, and risk management capabilities at each tier, risk mapping using the RapAgRisk method, risk analysis, and providing risk mitigation recommendations. Risk analysis is mapped based on the Expected Loss Ranking Matrix presented in Figure 2 and Table 2. Risk vulnerability measurement is mapped based on the Vulnerability Risk Event Matrix presented in Tables 3 and 4. Mitigation recommendations consider data on the event's probability, potential impact severity, and capacity to manage risk. Explanation of capacity to manage risk is presented in Table 5. Risk mitigation recommendations are based on the results of interviews with experts. Data analysis uses descriptive analysis.



Source: Jaffee et al., 2010

Figure 1. Expected loss ranking matrix

Information:
Priority 1 : High expected loss
Priority 2 : Medium expected loss
Priority 3 : Low expected loss

Table 2. Expected loss ranking matrix

No	Probability of event		Potential severity of impact	
1	Highly probable	Always happens in every condition	Negligible	No downside, very little financial loss
2	Probable	Risk often occurs in every condition.	Moderate	It still can be resolved with little financial loss.
3	Occasional	Risk occurs under certain conditions.	Considerable	Impact of moderate loss and moderate financial loss
4	Remote	Risk sometimes occurs under certain conditions.	Critical	High impact losses and many financial losses
5	Improbable	Risk is rare, only in certain conditions.	Catastrophic	The impact of the loss is huge, and there are many financial losses.

Source: Jaffee et al., 2010

Table 3. Vulnerability risk event matrix

Expected losses	Capacity to Manage Risk				
	1	2	3	4	5
High					
Medium					
Low					

Source: Jaffee et al., (2010)

Table 4. Vulnerability scale

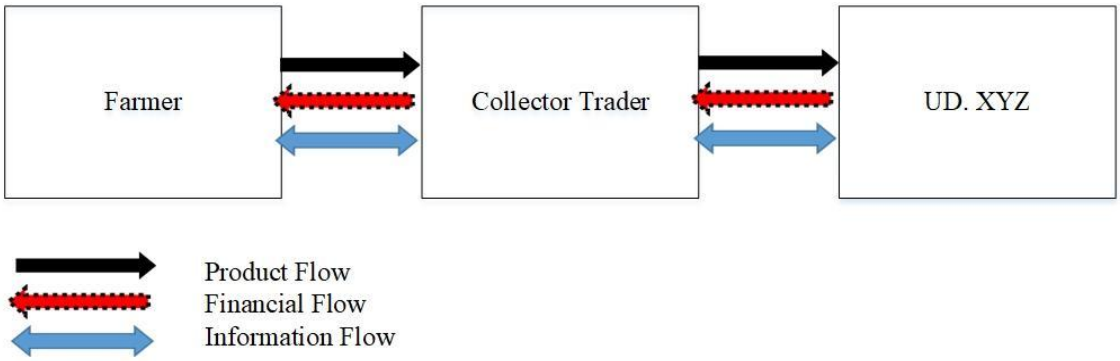
Scale Description	Code	Characteristic Key
Extremely vulnerable		High expected loss, low capacity
Highly vulnerable		Medium-high expected loss, low-medium capacity
Moderate vulnerability		Medium expected loss, low-medium capacity
Low vulnerability		Low-medium expected loss, medium-high capacity
Limited vulnerability		Low expected loss, high capacity

Source: Jaffee et al., 2010

RESULT AND DISCUSSION

Mapping the Food Corn Supply Chain in Kediri Regency

The interview results showed several actors in the corn supply chain in Kediri Regency who sell corn to UD. XYZ, namely farmers, collector traders, and UD XYZ. Farmers have a role as corn producers. Activities at the farmer level are planting, caring for, and harvesting corn. Collector traders have a role as temporary storage before being sold to UD. XYZ. Some activities at collectors are drying, packaging, and distribution of corn. The supply chain pattern of the Food Corn Supply Chain in Kediri Regency is presented in Figure 2 below. These supply chains involve three primary flows: product, information, and finance.



Source: Data Processed, 2024

Figure 2. Food corn supply chain in Kediri Regency

Risk Identification of the Food Corn Supply Chain in Kediri Regency

Risk identification is the process of describing potential hazards or threats (Wu, 2024). Risk identification collects information about possible risks in the Corn supply chain. Information is obtained from risk owners through in-depth interviews. The technical aspect of risk identification involves conducting in-depth interviews with each supply chain actor using an interview guide. The interview guide contains questions about risk events, causes, and impacts. Tables 5, 6, and 7 show the identified risks, their impacts, and causes for each tier.

Table 5. Risks at farmer tier

Risk code	Risk Event	Cause	Impact
F 1.1	Long storage risk	Corn has not been sold so it is stored.	Corn weight decreases, color changes to wrinkled, and corn is damaged by fungal attack.
F 1.2	Risk of poor storage conditions or places.	Storage is carried out in inappropriate conditions, such as humid conditions.	Corn damage due to fungal attacks
F 1.3	Risk of being attacked by fall armyworm (FAW) pests.	Climate, inappropriate pest control, and rapid mobility of FAW caterpillars.	Reduces the amount of corn harvest
F 1.4	Risk of being attacked by rat pests.	Environmental factors, availability of food, and shelter.	Reducing the amount of corn harvest.
F 1.5	Risk of downy mildew.	Corn seed varieties are susceptible to disease, soil conditions, too close planting distance, asynchronous corn planting, and high humidity.	Reduces the amount of corn harvest.
F 1.6	Risk of being attacked by seed fly pests.	Humid environment, vulnerable plant conditions, lack of pest control measures, and pest life cycle.	Reduces the amount of corn harvest.
F 1.7	Risk of being attacked by stem or leaf borer pests.	Pest life cycle and environmental conditions.	Reduces the amount of corn harvest.
F 1.8	Risk of leaf blight disease.	High rainfall and humidity, corn varieties that are susceptible to disease.	Reduces the amount of corn harvest
F 1.9	Risk of labor shortage	The number of workers is limited due to simultaneous planting and harvesting patterns.	Plant care is not optimal; there is a delay in planting or harvesting schedules.
F 1.10	Risk of low selling prices.	Farmers as price recipients.	Causing losses to farmers.
F 1.11	Risk of limited water availability for irrigation.	Low rainfall and climate change	Corn care is not optimal, thus reducing the amount of corn harvest.
F 1.12	Fluctuating price risk.	Farmers as price recipients, supply and demand are not comparable.	Losses at the farmer tier and other supply chain tiers.
F 1.13	Risk of climate and weather changes.	Global warming.	Pest and disease attacks.
F 1.14	Risk of increasing agricultural production facilities.	External factors, namely policies from agricultural kiosks, distributors or companies.	The cost of cultivating corn crops increases which reduces farmers' income.
F 1.15	Risk of fraud in payments.	Traders take corn and do not make payments.	Harmful to farmers.

Source: Data Processed, 2025

Table 6. Risks in the collector trader tier

Risk code	Risk Event	Cause	Impact
CT 2.1	Fluctuating price risk.	Supply and demand, simultaneous corn harvest.	Collector trader income decreases
CT 2.2	Risk of weight loss.	Corn storage that is too long	Causing losses to collector traders.
CT 2.3	Risk of miscalculation of harvest yields.	Inaccurate prediction of harvest yields.	Harvest yields do not match predictions, resulting in losses.
CT 2.4	Risk of decreasing corn quality.	Inappropriate corn storage	A fungus causes damage to corn.
CT 2.5	Risk of low selling price	Unpredictable corn price.	Causes losses because it is not comparable to the purchase price.
CT 2.6	Changes in demand for quality and quantity	Special requests from consumers.	Inability to meet customer needs quickly.
CT 2.7	Risk of errors in weighing.	Scales are not calibrated continuously.	Weighing results are inaccurate and reduce farmer confidence.

Source: Data Processed, 2025

Table 7. Risk at MSME tier

Risk code	Risk Event	Cause	Impact
C 4.1	Risk of rising raw material prices (corn).	MSMEs as price recipients.	Increasing production costs.
C 4.2	Risk of shortage of raw materials (corn, etc.).	Limited number of suppliers.	Inhibits the production process
C 4.3	Risk of delay in raw materials (corn, etc.).	The supplier carries out raw material delivery.	Hinders the production process.
C 4.4	Risk of undercooked corn boiling.	Workers are less careful.	Corn boiling results are not up to standard.
C 4.5	Risk of unclean corn	Less careful employees	Reducing product standards
C 4.6	There is a risk of fungal attack on corn during the drying process.	Employees are not careful, and drying is still manual	Raw materials cannot be used.
C 4.7	Risk of burnt marning products.	Frying using manual methods, and employees are not careful.	Marning products cannot be sold
C 4.8	Risk of error in the product weighing process.	Employees are less careful in weighing products.	Harms producers and consumers.
C 4.9	Risk of product damage during storage.	Inappropriate product storage conditions and locations.	Harmful to producers.
C 4.10	Risk of unsold products	An uncertain number of consumers	Harmful to producers
C 4.11	Risk of late payment.	Consumers take the product first and make payment 10-15 days after taking the product.	Inhibits the turnover of business capital, thus harming producers

Source: Data Processed, 2025

Risk Analysis of the Food Corn Supply Chain in Kediri Regency

Risk analysis aims to determine the level of risk (Kuo et al., 2024). The technical implementation of risk analysis involves interviewing each supply chain actor (farmers, collector traders, and UD. XYY). The purpose of these interviews is to compile an expected loss ranking matrix for each risk event based on probability and severity parameters. The second stage of the interview is to compile a vulnerability risk event matrix for each risk event based on expected losses and capacity to manage risk. The priority of each risk is the basis for whether a risk should be given special treatment or ignored.

1. Risk Analysis at Farmer Tier

The severity and probability values at the farmer tier are presented in Table 8. Table 9 shows the risk mapping at the farmer tier. Risk consists of three levels: Low, Medium, and high. Risk levels are assessed based on severity and impact. Risks classified as medium are risks F 1.3, F 1.4, F 1.14, F 1.10, F 1.11, F 1.12, F 1.1, F 1.9, and F 1.13. Risks that are classified as high are risks F 1.5. The vulnerability risk event matrix shows the risk owner's ability to manage risk based on the risk level value and capacity to manage risk. Vulnerability risk event matrix at the farmer tier is presented in Table 10. The vulnerability risk event matrix shows that extremely vulnerable are at risk F 1.10 and F 1.12. The vulnerability risk event matrix shows that the highly vulnerable are at risk F 1.4, F 1.5, and F 1.14. The vulnerability risk event matrix shows that moderate vulnerability occurs at risks F 1.3, F 1.13, and F 1.15. Vulnerability risk event matrix showing low vulnerability occurs at risk F 1.9 and F 1.1. High-risk vulnerability factors include high expected losses and low capacity to manage risk. Two risks that indicate extremely vulnerable levels at the farmer level are the risk of low selling prices and fluctuating price risk. These two risks indicate high expected losses and low capacity to manage risk. The risk of low selling prices and fluctuating prices arises because corn farmers only accept the price. Collector traders control corn pricing. The impact of the risk of low selling prices is critical. Low corn selling prices significantly impact the sustainability of farmers' businesses as the main actors in the upstream supply chain. The risk of low selling prices reduces farmers' incomes (Azizu & Azizu, 2023). The imbalance between production costs and sales revenues reduces farmers' profit margins, thus affecting their welfare (Upe & Aswan, 2021). Another impact is dependence on collector traders. Low prices and limited market access are factors that lead farmers to sell their crops to collector traders at prices lower than market prices. This dependence weakens farmers' bargaining position in the supply chain. Fluctuating price risk causes farmers' incomes to become unstable. Fluctuating corn prices make it difficult for farmers to estimate their potential profits. Price uncertainty complicates long-term farming planning (Khadka & Chi, 2024; Rasyid & Sirajuddin, 2021).

Table 8. Risks in the collector trader tier

Risk Code	Severity	Probability	Risk Code	Severity	Probability
F 1.1	**3**	**4**	**F 1.9**	**3**	**4**
F 1.2	2	4	F 1.10	4	2
F 1.3	4	3	F 1.11	4	2
F 1.4	4	3	F 1.12	4	2
F 1.5	5	2	F 1.13	2	3
F 1.6	2	4	F 1.14	4	3
F 1.7	2	4	F.1.15	4	4
F 1.8	2	4			

Source: Data Processed, 2025

Table 9. Risk mapping at farmer tier

Pro-ba-bili-ty of Event		Potential Severity of Impact				
		Negligible	Moderate	Considerable	Critical	Catastrophic
	Highly probable					
	Probable		F 1.13			F 1.5
	Occasional				F 1.3, F 1.4, F 1.14	
	Remote		F 1.2	F 1.1 F 1.9	F 1.10, F 1.11, F 1.12	
	Improbable		F 1.6, F 1.7, F 1.8		F 1.15	

Source: Data Processed, 2025

Table 10. Vulnerability risk event matrix at farmer tier

Expected losses	Capacity to Manage Risk				
	1	2	3	4	5
High			F 1.5		
Medium	F 1.10, F 1.12	F 1.4, F 1.14	F 1.3, F 1.13, F 1.15	F 1.9, F 1.11	F 1.1
Low				F 1.6, F 1.7, F 1.8	F 1.2

Source: Data Processed, 2025

2. Risk Analysis on Collector Trader Tier

The severity and probability values on the collector trader tier are presented in Table 11. Table 12 shows the risk mapping on the collector trader tier. The vulnerability risk event matrix on the collector trader tier is presented in Table 13. The vulnerability risk event matrix that shows low vulnerability occurs at risks CT 2.1, CT 2.2, CT 2.3, CT 2.4, and CT 2.5. The vulnerability risk event matrix on the collector trader tier does not show any extremely vulnerable, highly vulnerable, or moderate vulnerability values.The low-risk vulnerability value for risk events in the collector trader tier is due to several factors, including a strong bargaining position, large capital capacity, and broad access to market information. Collector traders have broader market access and direct relationships with the food industry. Broad market access strengthens collector traders' bargaining position compared to farmers, enabling them to set prices (Grabs & Carodenuto, 2021). Collector traders collect harvests from various farmers, thereby increasing market access. Collector traders secure better prices with industry stakeholders, strengthening their bargaining power (Van Nguyen & Abwao, 2023). Collector traders have a larger capital capacity than farmers, enabling them to absorb large corn stocks. This greater capital capacity reduces the impact of price fluctuations on business continuity (Mgale & Yunxian, 2020). Collector traders have better access to market price information, demand trends, and harvest times in various regions. Access to price information helps collector traders make faster and more strategic business decisions (Herlyani & Astaman, 2024).

Table 11. Severity and probability values for the collector trader tier

Risk code	Severity	Probability	Risk code	Severity	Probability
CT 2.1	4	3	CT 2.5	3	3
CT 2.2	3	3	CT 2.6	2	5
CT 2.3	4	4	CT 2.7	2	4
CT 2.4	3	3			

Source: Data Processed, 2025

Table 12. Risk mapping at the collector trader tier

		Potential Severity of Impact				
Probability of Event		Negligible	Moderate	Considerable	Critical	Catasthropic
	Highly probable					
	Probable					
	Occasional			CT 2.2, CT 2.4, CT 2.5		
	Remote		CT 2.7	CT 2.1	CT 2.3	
	Improbable		CT 2.6			

Source: Data Processed, 2025

Table 13. Risk mapping at the collector trader tier

Expected losses	Capacity to Manage Risk				
	1	2	3	4	5
High					
Medium				CT 2.1, CT 2.2, CT 2.3, CT 2.4, CT 2.5	
Low				CT 2.6	CT 2.7

Source: Data Processed, 2025

3. Risk Analysis at the MSME Tier (UD. XYZ)

The severity and probability values at the MSME tier (UD. XYZ) are presented in Table 14. Table 15 shows the risk mapping at the MSME tier. The vulnerability risk event matrix at the MSME tier is presented in Table 16. The vulnerability risk event matrix that shows highly vulnerable occurs at risks C 4.1, C 4.2, C 4.10, and C 4.11. The highly vulnerable risk assessment is based on medium-high expected losses and low-medium risk management capacity. The risk of rising raw material prices (corn) arises because MSMEs act as price recipients. Collector traders determine corn prices. Corn producers depend on the availability and price stability of corn as their primary raw material. Rising raw material prices increase production costs and reduce MSME profit margins (Shilomboleni et al., 2023). A limited number of suppliers causes the risk of shortages of raw materials (corn, etc.). Raw material shortages cause production disruptions, reduced capacity, and even temporary operational shutdowns for MSMEs (Suguna et al., 2022). Declining production and increasing costs lead to decreased producer income. The broader impact is a threat to business sustainability (kumar Sahoo et al., 2025; Tambunan, 2021). The uncertainty of the number of consumers causes the risk of unsold products. Unsold corn marning products will pile up in warehouses, risking product quality degradation. Another impact is financial losses due to non-recovery of production costs, weakening cash flow, and hampering the continuity of MSME businesses (Gupta & Kumar Singh, 2023; Kaur et al., 2023). The risk of late payment is caused by consumers taking the product first and making payment 10-15 days after taking it. Late payments impact MSME cash flow (Adiningrat et al., 2023). MSMEs rely on timely payments to cover operational costs such as raw material purchases and labor wages. Unstable cash flow hampers the production cycle of marning products. The vulnerability risk event matrix that shows

moderate vulnerability occurs at risk C 4.7. The vulnerability risk event matrix that shows low vulnerability occurs at risk C 4.6. The vulnerability risk event matrix at the MSME tier does not show an extremely vulnerable value.

Table 14. Severity and probability values for the collector trader tier

Risk code	Severity	Probability	Risk code	Severity	Probability
C 4.1	4	3	C 4.7	3	3
C 4.2	4	3	C 4.8	2	4
C 4.3	3	5	C 4.9	2	4
C 4.4	2	4	C 4.10	4	3
C 4.5	2	4	C 4.11	5	3
C 4.6	3	3	C 4.12		

Source: Data Processed, 2025

Table 15. Risk mapping at MSME tier (UD. XYZ)

Probability of Event	Potential Severity of Impact				
	Negligible	Moderate	Considerable	Critical	Catasthropic
Highly probable					
Probable					
Occasional			C 4.6, C 4.7	C 4.1, C 4.2, C 4.10	C 4.11, C 4.12
Remote		C 4.4, C 4.5 C 4.8, C 4.9			
Improbable			C 4.3		

Source: Data Processed, 2025

Table 15. Vulnerability risk event matrix at MSME tier (UD. XYZ)

Expected losses	Capacity to Manage Risk				
	1	2	3	4	5
High					
Medium		C 4.1, C 4.2 C 4.10, C 4.11	C 4.7	C 4.6	
Low				C 4.4, C 4.5, C 4.8, C 4.9	C 4.3

Source: Data Processed, 2025

Risk Evaluation of the Food Corn Supply Chain in Kediri Regency

Risk evaluation compares the risk analysis results with the risk criteria (Tao et al., 2024). The risk evaluation stage is carried out by categorizing risks based on the results of the risk analysis. The risk categories are compiled based on the expected loss value and the vulnerability risk value for each risk event. The vulnerability risk value is obtained based on the vulnerability scale table explained in the research methods chapter. The risk evaluation stage categorizes each risk event for each supply chain actor. Risk evaluation aims to make decisions based on the results obtained from the risk analysis. The decisions taken include what actions should be taken for each risk. The risk evaluation process determines which risks require special mitigation and how to mitigate them. Risk categories are based on the risk level (expected loss) and the vulnerability of the risk event, presented in Table 17.

Table 17. Food corn supply chain risk categories

Tier	Risk Code	Expected Loss	Vulnerability Risk Event
Farmer	F 1.1	Medium	Limited vulnerability
	F 1.2	Low	Limited vulnerability
	F 1.3	Medium	Moderate vulnerable
	F 1.4	Medium	Highly vulnerable
	F 1.5	High	Highly vulnerable
	F 1.6	Low	Limited vulnerability
	F 1.7	Low	Limited vulnerability
	F 1.8	Low	Limited vulnerability
	F 1.9	Medium	Low vulnerable
	F 1.10	Medium	Extremely vulnerable
	F 1.11	Medium	Low vulnerable
	F 1.12	Medium	Extremely vulnerable
	F 1.13	Medium	Moderate vulnerable
	F 1.14	Medium	Highly vulnerable
	F.1.15	Low	Low vulnerable
Collector Trader	CT 2.1	Medium	Low vulnerable
	CT 2.2	Medium	Low vulnerable
	CT 2.3	Medium	Low vulnerable
	CT 2.4	Medium	Low vulnerable
	CT 2.5	Medium	Low vulnerable
	CT 2.6	Low	Limited vulnerability
	CT 2.7	Low	Limited vulnerability
MSME (UD. XYZ)	C 4.1	Medium	Highly vulnerable
	C 4.2	Medium	Highly vulnerable
	C 4.3	Low	Limited vulnerability
	C 4.4	Low	Limited vulnerability
	C 4.5	Low	Limited vulnerability
	C 4.6	Medium	Low vulnerable
	C 4.7	Medium	Moderate vulnerable
	C 4.8	Low	Limited vulnerability
	C 4.9	Low	Limited vulnerability
	C 4.10	Medium	Highly vulnerable
	C 4.11	Medium	Highly vulnerable

Source: Data Processed, 2025

Risk Mitigation of the Food Corn Supply Chain in Kediri Regency

Risk mitigation is an action to reduce the negative impact of a risk (Hoseyni et al., 2024). Risk mitigation for each supply chain actor is crucial because supply chains are interconnected. A risk at one point can disrupt the entire flow of goods and services. One small risk can cause a domino effect if not mitigated early. Risk mitigation is obtained from interviews with supply chain actors and experts. The experts selected are agricultural extension workers and MSME experts who understand the real-world conditions of each supply chain actor and have experience in managing these risks. The results of the interviews with the agricultural experts are conveyed to the supply chain actors. The supply chain actors then provide feedback on whether the mitigation can be implemented. Risk mitigation is carried out on risk events that are extremely vulnerable, highly vulnerable, moderately vulnerable, and low vulnerability because they have expected losses (medium-high) and the capacity to manage risk (low) (Jaffee et al., 2010). Risks with limited vulnerability are not given mitigation recommendations because the risk has low financial losses with high-risk handling capabilities by the perpetrators. Risk mitigation at the farmer, collector trader, and MSME tiers is presented in Tables 18, 19, and 20.

Table 18. Risk mitigation at the farmer tier

Risk code	Risk mitigation
F 1.3	- Planting crops simultaneously - Continuous monitoring of crop conditions - Use of pesticides to control armyworm pests - Rotate crops
F 1.4	- Maintaining the sanitation of corn fields (ex: Cleaning weeds around corn fields) - Planting simultaneously - Installing mouse traps - Installing fences or barriers around corn fields. - Making owl houses
F 1.5	- Selection of corn seeds that are resistant to downy mildew - Treat corn seeds with fungicide - Planting simultaneously - Planting time - Uproot and destroy plants infected with downy mildew to prevent the spread of the disease
F 1.9	- Establish cooperation with workers outside the village - Schedule planting, maintenance, and harvesting of corn plants
F 1.10, F 1.12	- Increase market access through cooperation or partnership with collectors, wholesalers, and consumers directly - Access to market information - Proper harvest scheduling
F 1.11	- Irrigating plants at the right time - Building reservoirs to collect rainwater that can be used for irrigation. - Choosing drought-resistant corn varieties - Using weather information systems to monitor weather conditions
F 1.13	- Use of corn seed varieties that are resistant to extreme climate conditions - Access to weather information to plan corn cultivation activities
F 1.14	- Efficient Use of Agricultural Production Facilities - Collective purchase of agricultural production facilities to obtain lower prices - Government support and policies in the form of subsidies for fertilizers, pesticides, and seeds - The government supervises the prices of agricultural production facilities to prevent speculation and hoarding (price supervision)
F.1.15	- Making written agreements between farmers and consumers or traders - Keeping complete records of every transaction, including invoices, receipts, and proof of payment. - Documenting the quality and volume of the harvest delivered. - Selecting Trusted Buyers - Selecting the right and mutually beneficial payment method

Source: Data Processed, 2025

Table 19. Risk mitigation at the collector trader tier

Risk code	Risk Mitigation
CT 2.1	- Increase market access through direct cooperation or partnership with collector traders, wholesalers, and consumers. - Access market information - Demand analysis and stock management - Join a trader association to get information, support, and cooperation opportunities.
CT 2.2	- Proper storage by considering storage location, temperature, and humidity. - Inventory management with FIFO (First-In, First-Out) system. - Stock monitoring. - Predicting market demand to avoid excess or shortage of inventory.
CT 2.3	- Consider factors that affect crop yields, such as weather, pests, and diseases. - Conduct a thorough field survey before purchasing crops. - Make clear written agreements with farmers regarding price, volume, quality, and harvest time.
CT 2.4	- Proper storage is done by considering storage location, temperature, and humidity. - Inventory management with FIFO (First-In, First-Out) system. - Maintaining warehouse and storage area sanitation.
CT 2.5	- Increase market access through direct cooperation or partnership with collector traders, wholesalers, and consumers. - Access market information - Demand analysis and stock management - Join a trader association to get information, support, and cooperation opportunities.

Source: Data Processed, 2025)

Table 20. Risk mitigation at the MSME tier

Risk Code	Risk Mitigagtion
C 4.1	- Building relationships with multiple suppliers to reduce the risk of dependency. - Regularly evaluating supplier performance, including price, quality, and availability of raw materials. - Efficient utilization of raw materials. - Regularly monitoring market developments, including raw material price trends, demand, and supply.
C 4.2	- Building relationships with multiple suppliers to reduce the risk of dependency. - Regularly evaluating supplier performance, including price, quality, and availability of raw materials. - Identifying alternative raw materials that can be used in the event of a shortage of primary raw materials.
C 4.6	- Use of machine drying methods. - Maintaining the cleanliness of the drying area. - Training and conducting regular employee evaluations.
C 4.7	- Use of temperature control devices on stoves. - Training and conducting regular employee evaluations
C 4.10	- Conducting market research to understand consumer needs, preferences, and trends. - Effective Marketing Strategy (Digital marketing, online marketing, promotions and discounts). - Setting competitive prices. - Using a pre-order system.
C 4.11	- Create a clear written contract regarding payment terms, due dates, payment methods, and late penalties. - Prepare a reserve fund to anticipate late payments.

Source: Data Processed (2025)

CONCLUSIONS

This study aims to identify, analyze, evaluate, and mitigate risks at each food corn supply chain tier. Several food corn supply chain risk events occur at the farmer, collector trader, and MSME tiers. The risks at the farmer tier are 15 risks. The risks at the collector trader and MSME tiers are seven risks and 11 risks. Risk analysis is based on the vulnerability risk event matrix value. The vulnerability risk event matrix at the farmer tier shows extremely vulnerable (F 1.10 and F 1.12), highly vulnerable (F 1.4, F 1.5, and F 1.14), and moderate vulnerability (F 1.3, F 1.13, and F 1.15). Risk mitigation for risk of low selling prices (F 1.10) and Fluctuating price risk (F 1.12) is to focus on increasing market access through cooperation or partnership with collectors, wholesalers, and consumers directly, and access to market information. The vulnerability risk event matrix at the collector trader tier shows low vulnerability at risks CT 2.1, CT 2.2, CT 2.3, CT 2.4, and CT 2.5. Risks that frequently arise for collector traders are the risk of decreasing corn quality (CT 2.4) and fluctuating price risk (CT 2.1). Mitigation for fluctuating price risk involves demand analysis and stock management. To reduce the risk of lower corn quality, store corn correctly, considering location, temperature, and humidity. The vulnerability risk event matrix at the MSME tier (UD. XYZ) shows highly vulnerable (C 4.1, C 4.2, C 4.10, and C 4.11), moderate vulnerability (C 4.7), and low vulnerability (C 4.6). Risk mitigation for risk of late payment (C 4.11) is to create a clear written contract regarding payment terms, due dates, payment

methods, and late penalties. Risk mitigation is carried out on risk events that are extremely vulnerable, highly vulnerable, moderate vulnerability, and low vulnerability.

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