Agro Bali : Agricultural Journal
Vol. 9 No. 1: 69-82, March 2026
e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

Risk Management of Monoculture Rice Farming Production in Subak Munggu, Cempaga Village, Bangli Regency, Indonesia

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Article history: submitted: March 21, 2025; accepted: March 26, 2026; available online: April 9, 2026

Abstract. Monoculture rice farming in subak institutions faces multidimensional risks that can threaten production stability and farmers' cash flow, yet empirical prioritization of these risks at the subak institutional level remains limited. This study aims to identify and prioritize risks in monoculture rice farming in Subak Munggu, Balı, using Failure Mode and Effect Analysis (FMEA) Primary data were collected through structured in-depth interviews and questionnaires from 30 purposively selected farmers supported by relevant secondary sources Qualitative information was used to compile and validate risk events and risk agents, while quantitative S-O-D scoring (1-10) was applied to calculate Risk Priority Numbers (RPN) and determine priority risks The analysis identified eight risk events (E1-E8) and twelve risk agents (A1-A12) The highest priority risk agent was demand fluctuations (A1) with RPN 490, the only factor classified in the red (intolerable) zone followed by erratic weather and climate (A4 RPN 342), human error in cultivation and input use (A9 RPN 276) declining government subsidies (A10, RPN 224), and pests and diseases (AS RPN 236) Risk mapping indicates that most risks fall within the ALARP category with one dominant intolerable risk that may control overall business stability These findings imply that mitigation should prioritize market-demand risk management and its upstream linkages to seed and input procurement, alongside climate-adaptive practices and institutional strengthening to reduce exposure in monoculture systems in subak.

Keywords: FMEA; management; risk; subak; traditional organization

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1. Introduction

Risk can be defined in a variety of ways, such as as an adverse event or as a deviation from the expected outcome (Hasanah et al., 2018). This is in line with the opinion of Wulandari & Wahyudi (2014) in Marita et al. (2021), who stated that risk is defined as the possibility of loss, uncertainty, or the probability of results that are not in accordance with expectations. According to Sinha et al. (2004) in (Pujawan & Geraldin, 2009), risk is a function of the level of uncertainty and impact of an event. It is very important to remain cautious in all aspects of life because risk is very closely related to the unpleasant. This includes people, activities, companies, and more. According to Sari and Pardian (2018) in (Baroroh & Fauziyah, 2021), production risk, financial risk, market risk, and human resource risk are the sources of risk. On the other hand, increasing uncertainty requires them to expend more resources (Vanany et al., 2009).

Every agricultural or farming activity faces a situation of uncertainty and risk at any time with an unknown time (Prihantini et al., 2023). Climate change significantly increases production risks in agriculture (Wulandari et al., 2024). According to Kountur (2008) in Siswani et al. (2022), whatever risks farmers face, whether in terms of yield or production, are caused by crop failure, pest and disease attacks, low productivity, differences in climate and weather, human resource errors, and the use of production inputs. This is in line with the research of Offayana (2016) in Damayanti et al. (2021) which states that the sources of risk in agricultural production are weather, pests, diseases, labor and seed quality.

To manage rice field farming in Bali, there is a practice of irrigation with farmers called Subak (Simanjuntak, 2020). The term subak is a traditional organization in Bali that regulates the irrigation system of paddy fields based on the philosophy of

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

Tri Hita Karana (Parhyangan, Pawongan and Palemahan) (Suamba et al., 2023). In essence, subak is a system and association of rice farmers that aims to regulate irrigation management as best as possible based on the principle of pure mutual cooperation, regardless of the origin, position and class of its members (Lesmana et al., 2022). According to Bali Provincial Regulation No. 9 of 2012 (Budiasa et al., 2015), subak is defined as a traditional organization for water and/or plant management at the agricultural level, which is a custom of the socio-agrarian society in Bali. Agriculture, developed since ancient times, has proven to be a buffer for development and the fulfillment of economic and cultural needs (Geria et al., 2019). Subak Sawah is usually mostly used for rice cultivation (Janiawati, 2016).

Subak has customary rules that govern all activities from planting to harvesting, known as awig-awig. One of the things that is regulated in the awig-awig is the planting pattern system of its members. Planting only one commodity in a farming system is known as monoculture. Planting patterns in monocultures have advantages, such as making manufacturing, management, harvesting, and supervision easier. Monocultures have better growth and yields than other types of agriculture, so monocultures make land use more efficient. Based on the results of research by Nurmas A. et al. (2023), monoculture planting patterns have a higher potential for pest and disease attacks (Nurmas et al., 2023). This is because one type of plant can quickly spread diseases and pests. Yield variations caused by various difficult factors during the cultivation process, such as weather and climate, and disturbances from plant pests, constitute production risks (Astuti et al., 2019).

This is in line with Gliessman's theory that monocultures generally go hand in hand with modern agricultural patterns. These systems tend to encourage increasingly intensive cultivation, the use of inorganic fertilizers, planned irrigation, the use of chemicals to control pests and weeds, and the selection of very specific varieties. Because large expanses are planted with the same type of plant, plants become more interesting. Similar problems can also arise in large-scale organic monocultures, because the root of the problem lies in the uniformity of the plant and the size of the planting area (Gliessman, 2015).

With a monoculture planting pattern, planting one type of plant definitely carries risks, both continuous and unexpected, that can affect their income and food needs. According to Noor et al. (2018) in (Fitratunnas et al., 2020), basically in carrying out risk management, several processes are needed, namely risk identification, risk evaluation and measurement, and risk management. In this study, risk is divided into two levels of analysis, namely risk events (E) and risk agents (A). Risk events (E) are incidents or problems that occur directly in the monoculture rice farming process. Meanwhile, risk agents (A) are causative or triggering factors that increase the chances of risk events.

One of the subaks that still operates rice farming today is Subak Munggu in Bangli Regency. Every year, farmers in Subak Munggu apply a monoculture planting pattern to meet their food needs and income. Subak Munggu was chosen as the research location because it aligns directly with the study's focus. Farmers who can reduce production and price risks by increasing productivity, diversifying, using appropriate planting patterns, strengthening farmer institutions, and improving their bargaining position will be able to increase their household food security. Monoculture vulnerability makes disruptions to one factor of production can spread quickly and have systemic impacts.

Based on the background, the formulation of the research problems is as follows 1) What are the risks that may occur

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

in monoculture rice farming in Subak Munggu, Cempaga Village, Bangli Regency?. 2) How to determine the potential priority of monoculture rice farming risks in Subak Munggu, Cempaga Village, Bangli Regency using the Failure Mode and Effect Analysis (FMEA) method?. This study is very important because subak in Bali has existed for ten years.

2. Materials and Methods

Study Location

The research was conducted in Subak Munggu, Cempaga Village, Bangli Regency, because Subak Munggu is one of the subaks that implements a monoculture pattern. This research was conducted for 6 months from March to October 2024.

Research Stages

The research is divided into stages, namely: (1) collecting primary data through interviews and filling out questionnaires by respondents, (2) analysis of primary and secondary data, and (3) discussion and drawing a conclusion. In full, the stages of the research are presented in the form of a hype to explain the systematics of activities, as shown in **Figure 1.**

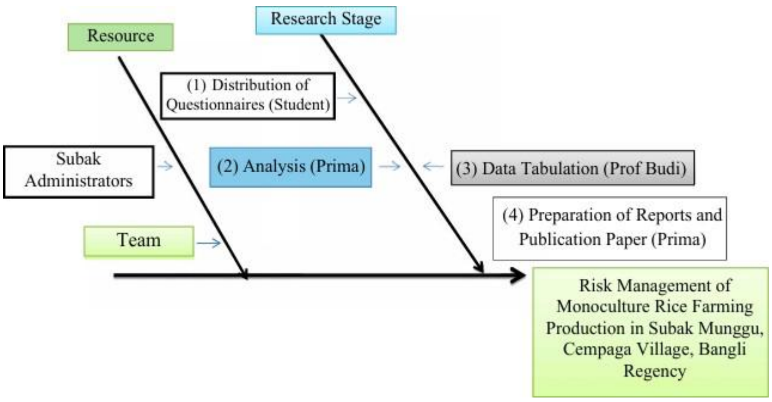

Figure 1. Systematic Activity

Recorded Parameters

The main parameters recorded in this survey are as follows: Farmer characteristics include age, education, number of children, land area, and land ownership status.

Data Collection and Processing

In this study, the two data types used are quantitative and qualitative. Quantitative data consists of numbers that can be calculated, such as the area of cultivated land and farming costs, while qualitative data consists of words, sentences, and images. Using a qualitative approach, the researcher explored respondents' overall experience (Zakaria et al., 2023). The data collected in this study came from two sources: primary data and secondary data. The data collection methods used in this study are as follows: 1) Interviews, or interviews, are used to collect information and data by conducting direct and in-depth interviews with farmers using structured interview instruments, 2) Literature study, used to collect data by reviewing and recording several relevant literature.

Population and Sample

A population is a group of objects or subjects that have certain qualities and characteristics, as determined by the researcher, to be analyzed to obtain relevant conclusions (Iba & Wardhana, 2023). Populations can be grouped into two

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

categories, namely homogeneous and heterogeneous (Iba & Wardhana, 2023). Samples are part of the population, determined by the technique for selecting the number of samples based on size and attention to the population's characteristics and distribution, so that the sample can represent the population. Sampling techniques are grouped into 2 categories (Suriani et al., 2023). This study involved all Subak Munggu farmers, with 30 farmers deliberately sampled. The selection of these 30 farmers was also based on their performance, as reflected in their scores from the assessment and field clarifications.

Data Analysis

The data analysis in this study uses quantitative descriptive methods, specifically FMEA, implemented in Microsoft Office Excel. Failure Mode and Effect Analysis (FMEA) is a method used to examine the causes of defects or failures in the production process and to evaluate risk priorities (Mu'adzah & Firmansyah, 2020). Failure modes can include design errors, conditions outside of predetermined specification limits, or product changes that interfere with product functionality. The main focus in the FMEA method is to proactively assess potential failure mode risks so that appropriate corrective action can be taken before failure occurs (Pangestuti et al., 2022). The FMEA element is built on the information contained in the analysis. According to the research of Sutrisno & Lee (2011) in (Prasetya et al., 2021), the FMEA method aims to increase the Risk Priority Number (RPN) results to find out other problems. The RPN score was obtained by multiplying three elements, namely severity (S), occurrence (O), and detection (D) (Widianti, 2015). Operationally, the FMEA method in this study is carried out through the following stages:1) Determination of the scope of the analysis, 2) Risk identification and coding, 3) S-O-D Assessment, 4) Risk Priority Number (RPN) Calculation, 6) Prioritization and risk rating, 7) Formulation of risk mitigation strategies.

3. Results and Discussion

Risk Identification

This risk identification is based on the results of in-depth interviews and discussions, as well as historical data in Subak Munggu related to monoculture rice farming. The identification of this risk event has been confirmed by all monoculture rice farmers in Subak Munggu. Risks arising in the production chain can have significant impacts if not given sufficient attention in the supply chain risk management process. Therefore, special attention is needed in determining risk events and risk agents. The risk event is exemplified by the code Ei. Then the cause of the risk is found (risk agent), exemplified by the code Ai. The code continues with the next risks. The following is the identification of risk events and risk agents in the production risks of monoculture rice farming in Subak Munggu, Cempaga Village, Bangli Regency. The results of risk identification are presented in **Table 1.**

RPN Score Assessment

Regular, continuous risk assessment is needed so companies can reduce potential losses from negative-impact risks. Risk analysis is carried out by measuring the identified risks. There are three factors assessed in the FMEA method: severity (level of severity), occurrence (level of probability of occurrence), and detection (level of detection ability), each rated on a scale of 1 to 10. Then the RPN (Risk Priority Number) is calculated by multiplying the assessment results for severity (S), occurrence (O), and detection (D) on a scale of 1-1000. Qualitatively, the values of S, O, and D are estimated to be in accordance with the criteria that have been set in in-depth discussions with competent parties. Given their fairly

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

high position, it is, of course, correlated with the risk problems that occur. The results of the RPN assessment can be seen in the following table. An illustration of the relationship between the risk agent (A) and the risk event (E) is presented in **Figure 2.**

Table 1. Risk Identification

CODE (Ei)	RISK EVENT	CODE (Ai)	RISK AGENT
E1	Risk of Seed Supply Delays	A1	Demand fluctuations
		A2	Long delivery flow from manufacturers
		A3	Convoluted recruitment (licensing) requirements
		A4	Bad and unpredictable weather
		A5	Fluctuations in the price of goods
E2	Risk of Seeds Not Conforming to Standards	A6	Non-standard storage bins (temperature, humidity and more)
		A7	Human error (negligence in non-standard storage bins (temperature, humidity and more)
E3	Risk of Damage During the Planting Process Due to Pests, Plant Diseases and Climate	A4	Bad or erratic weather and climate
		A8	Plant pests and diseases interfere with growth and reduce the quality of seedlings
		A9	Human error (less diligent / intense in the planting process
E4	Risk of Rising Fertilizer and Pesticide Prices	A1	Demand fluctuations
		A10	Declining government subsidies
E5	Risk of Fluctuating Crop Yields	A4	Bad or erratic weather and climate
		A8	Plant pests and diseases
		A9	Human error (unskilled labor, irregular maintenance, inappropriate use of fertilizers and pesticides)
E6	Risk of damage during post-harvest handling	A6	Non-standard storage bins (temperature, humidity and more)
		A9	Human error (farmers' mistakes/negligence in every process)
E7	Risk of Fluctuating Demand from Companies	A1	Demand fluctuations
		A11	Price competition between farmers
E8	Risk of Competitors from Other Regional Farmers	A1	Fluctuations in demand so that it is unable to meet consumer demand
		A12	Different product quality, price competition between farmers

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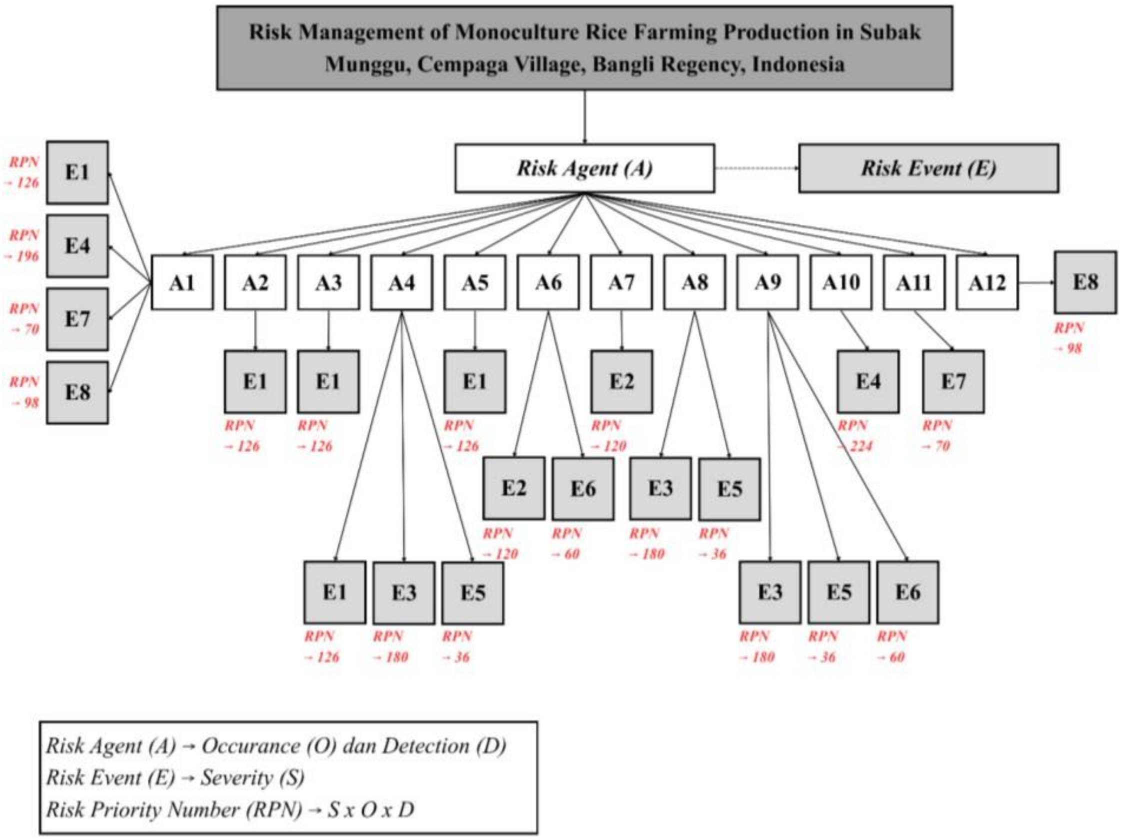

Figure 2. Illustration RPN Score Assessment

Risk Level Mapping

Furthermore, the detailed results of determining the RPN Score is presented in **Table 2.** After conducting the RPN Score Assessment, the risk rating is carried out. The results of the risk ranking are presented in **Table 3.** Based on the results of the farming risk research, the ranking results from the highest to the lowest RPN values were obtained, so the top position is the cause of risk with a Risk Priority Number (RPN) value of 490, namely fluctuations in demand so that it is unable to meet consumer demand (A1). The cause of risk with the lowest RPN value, namely A11, is 70, namely price competition between farmers. Clearly graph is presented in **Figure 3.**

e-ISSN 2655-853X
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Table 2. RPN Score Assessment

CODE	RISK EVENT	S	CODE	RISK AGENT	O	D	RPN
E1	Risk of Seed Supply Delays	7	A1	Demand fluctuations	2	9	126
			A2	Shipping Flow from a long manufacturer	2	9	126
			A3	Convoluted recruitment (licensing) requirements	2	9	126
			A4	Bad and unpredictable weather	2	9	126
			A5	Fluctuations in the price of goods	2	9	126
E2	Risk of Seeds Not Conforming to Standards	5	A6	Non-standard storage bins (temperature, humidity and more)	3	8	120
			A7	Human error (negligence in choosing suppliers)	3	8	120
E3	Risk of Damage During the Planting Process Due to Pests, Plant Diseases and Climate	6	A4	Bad or erratic weather and climate	5	6	180
			A8	Plant pests and diseases interfere with growth and reduce the quality of seedlings	5	6	180
			A9	Human error (less diligent / intense in the planting process	5	6	180
E4	Risk of Rising Fertilizer and Pesticide Prices	7	A1	Demand fluctuations	7	4	196
			A10	Declining government subsidies	8	4	224
E5	Risk of Fluctuating Crop Yields	3	A4	Bad or erratic weather and climate	4	3	36
			A8	Plant pests and diseases	4	3	36
			A9	Human error (unskilled labor, irregular maintenance, inappropriate use of fertilizers and pesticides)	4	3	36
E6	Risk of Damage during Post-Harvest Handling	5	A6	Non-standard storage bins (temperature, humidity and more)	4	3	60
			A9	Human error (farmers' mistakes / negligence in every process)	4	3	60
E7	Risk of Fluctuating Demand from Companies	5	A1	Demand fluctuations	7	2	70
			A11	Price competition between farmers	7	2	70
E8	Risk of Competitors from Other Regional Farmers	7	A1	Fluctuations in demand so that it is unable to meet consumer demand	7	2	98
			A12	Different product quality Price competition between farmers	7	2	98

e-ISSN 2655-853X
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Table 3. Risk Ranking

CODE	RISK AGENT	RPN
A1	Fluctuations in demand so that it is unable to meet consumer demand	490
A4	Bad or erratic weather and climate	342
A9	Human error (unskilled labor, irregular maintenance, inappropriate use of fertilizers and pesticides)	276
A10	Declining government subsidies	224
A8	Plant pests and diseases interfere with growth and reduce bib quality	216
A6	Non-standard storage bins (temperature, humidity and more)	180
A5	Fluctuations in the price of goods	126
A3	Convoluted recruitment (licensing) requirements	126
A2	Shipping Flow from a long manufacturer	126
A7	Human error (negligence in choosing suppliers)	120
A12	Different product quality Price competition between farmers	98
A11	Price competition between farmers	70

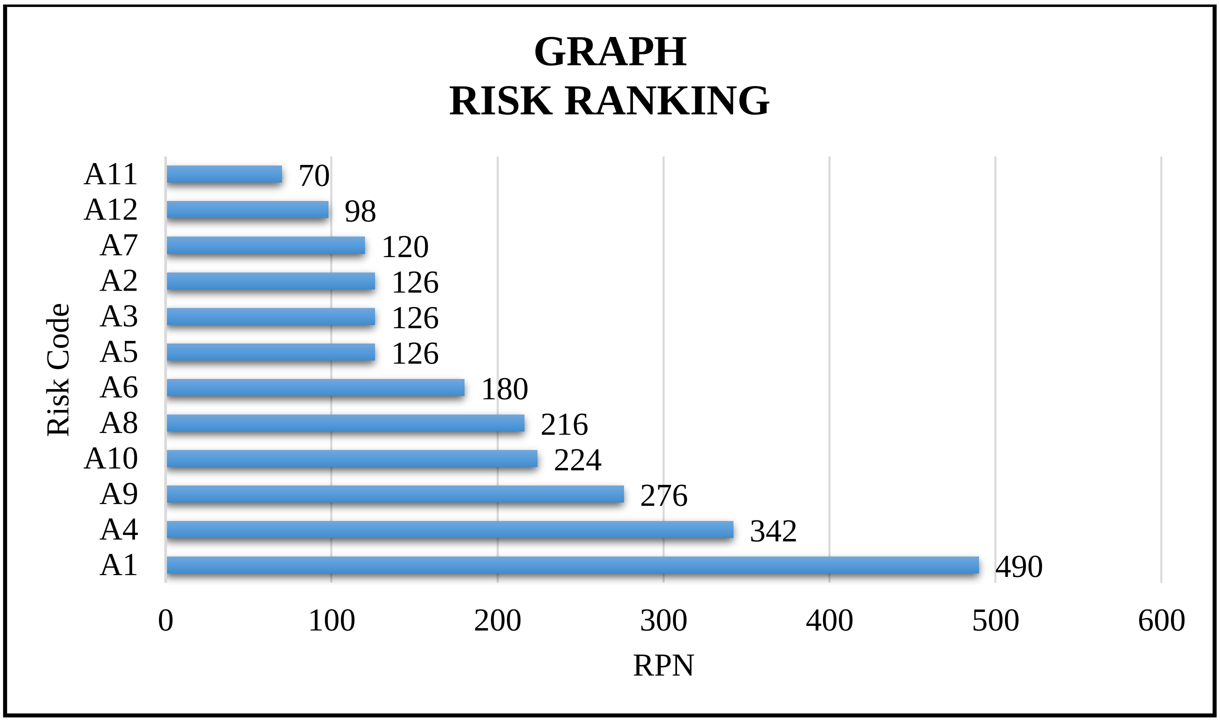

Figure 3. Graph Risk Ranking

The mapping of the risk levels that occur in monoculture rice farming is presented in the image below, which shows the position of the risk causes. The numbers listed in the mapping image are the risk cause codes. After determining the risk ranking, the next step is to map the risk based on the risk level. The results of risk mapping are presented in **Table 4.**

Agro Bali : Agricultural Journal
Vol. 9 No. 1: 69-82, March 2026
e-ISSN 2655-853X
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Table 4. Risk Mapping

RISK LEVEL		RPN <71	RPN >71 - <391	RPN >391 - 1000
SEVERITY	1 - 6	A11	A4, A6, A7, A8, A9	
	7 - 8		A2, A3, A5, A10, A12	A1
	9 - 10			

Based on the map, there are 6 risk agents in the green area, 5 in the yellow area (late), and 1 in the red area. The green area shows the position of the Broadly Acceptable (BA) category, namely, the existing risk is acceptable and only requires control with the existing system. The area in yellow shows the As Low as is Reasonably Practicable (ALARP) category, where the risk requires risk management or control actions to be determined immediately. The red color indicates the intolerable (INT) category, meaning the risk in the area requires quick action from management. Risks in the ALARP and INT categories are risk agents that require mitigation because they are considered to interfere with monoculture rice farming. This risk is the focus of other risk management processes. Risk agents that require mitigation action planning are listed in the following table. After conducting risk mapping, based on the category INT, ALARP is included in the risk level mapping, which is presented in **Table 5.**

Table 5. Risk Level Mapping

Code	Risk Agent	Category	RPN
A2	Shipping Flow from a long manufacturer	INT	490
A3	Convoluted recruitment (licensing) requirements	ALARP	126
A5	Fluctuations in the price of goods	ALARP	126
A10	Declining government subsidies	ALARP	224
A12	Different product quality Price competition between farmers	ALARP	98

The illustration is from the mapping of risk levels based on risk codes with RPN scores categorized into INT and ALARP is presented in **Figure 4.**

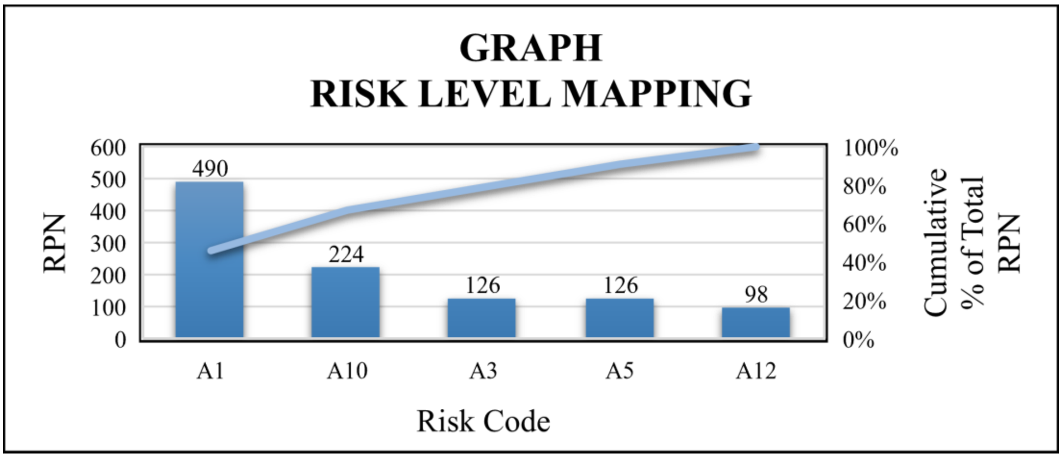

Figure 4. Graph Risk Level Mapping

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

A1 emerged as the most critical risk agent and was the only one to enter the red zone in the matrix (RPN threshold >391), with a severity value in the 7 – 8 group. From an agricultural economics perspective, this condition indicates a systemic market risk where demand fluctuations not only affect the sales side (E7 and E8), but also spread upstream through the price mechanism and the availability of inputs, especially when demand expectations affect the procurement of seeds (E1) and the price of fertilizers or pesticides (E4). A1 also has a strong association with risk events (E) coded E4 (increase in fertilizer and pesticide prices), E1 (delay in seed supply), and E7 and E8 (market risk).

In the monoculture rice production system, dependence on a single commodity increases exposure to the demand cycle because there is no income buffer from diversification. Therefore, A1 can be understood not only as a marketing issue but also as a factor that determines cash flow stability and the ability to finance inputs, ultimately affecting productivity. FMEA mapping also shows an asymmetrical risk structure of monoculture rice farming. Most risk agents are concentrated in the yellow zone (moderate), while only one risk agent is in the red zone (extreme). The categorization limit on the map places the RPN <71 as low (green), 71 – 391 as medium (yellow), and >391 – 1000 as high (red). This arrangement suggests that the production system is not dominated by many small risks but is strongly driven by a single dominant risk that can control financial performance and business stability.

1. Dominance of market risk agents

The risk agent with the highest priority is A1 (RPN = 490) and the only one that enters the red zone. Substantively, this dominance aligns with rice's status as a strategic commodity closely linked to price stabilization policies and demand dynamics across regions. In the rice value chain, demand shocks or market uptake can quickly spread to the producer level through changes in grain prices, uncertainty of uptake of traders or mills, as well as crop scheduling that is not aligned with market needs (Ruspayandi et al., 2022). In monocultures, the concentration of income in one commodity increases exposure to the demand cycle because farming households lack a cushion from diversifying into other commodities or other sources of income.

As a result, disruptions on the demand side, such as a decrease in market absorption or price weakness during the harvest, do not stop as a marketing problem, but turn into financial risks through cash flow channels where retained receipts or price declines weaken working capital capacity to finance inputs and cultivation operations in critical phases (follow-up fertilization, OPT control, labor wages, and post-harvest costs). In such situations, farmers tend to make technical adjustments that are cost-saving, but have the potential to reduce the implementation of optimal cultivation practices (e.g. reducing fertilizer doses or delaying control), so that market risk becomes an indirect determinant of productivity and yield stability (Firmansyah et al., 2025). Thus, A1 should be treated as a systemic risk that affects the sustainability of farming through interactions among market uncertainty, liquidity, and input-use decisions. At the level of risk occurrence, such market pressure is reflected in the relatively high RPNs for E7 (RPN = 175) and E8 (RPN = 160), which generally represent demand or competition risks and, in monocultures, tend to strengthen when harvests occur simultaneously.

2. Climate risk as a lever for production and post-harvest risk

The A4 risk agent (RPN = 342) is at the top of the yellow zone, indicating that climate is not just a background factor but one that probabilistically and materially magnifies the intensity of production risk events. In the FMEA results, biophysical stress was identified in E6 (RPN = 180) as one of the highest-risk events. In monoculture systems, the pressure from plant pest organisms (OPT) often increases as well because the

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

homogeneity of varieties and uniform planting calendars increases the likelihood of population explosions.

3. Input policy risks

The incidence of E5 risks related to subsidies and E4 (RPN = 120) related to the increase in input prices shows that production costs, especially fertilizers, are the main channel for policy risk transmission to the farming level. When access to fertilizers is disrupted or prices increase, farmers' liquidity needs in the planting phase also increase. The consequences arise in two layers: 1) farmers face financing pressures that can encourage a reduction in fertilization doses or incur high costs, which ultimately suppresses productivity and increases production risks; 2) Fertilizer uncertainty emphasizes the need for more adaptive nutrient management, such as balanced fertilization based on location recommendations, partial substitution with organic inputs, and institutional strengthening of input access through cooperatives.

4. Post-harvest and quality risks

Although the FMEA map places many risk agents in the yellow zone, this does not mean that the impact is small, especially for risks that affect quality and yield shrinkage. Post-harvest loss in cereals can manifest as a loss of quantity or quality and is affected by humidity, temperature, storage infrastructure, and handling practices. In many contexts, loss is dominant in the near stages of production. Therefore, even if post-harvest risk does not always appear as the highest RPN, the economic consequences can still be significant, including declining quality and lower selling prices, thereby weakening farmers' bargaining position in a competitive market.

Then, in the remaining 6 risk agents, the safe area (green, BA) indicates that the risk is still acceptable and sufficient to carry out control with the existing system. Based on the analysis carried out, it was found that there is a tendency for risk agents to be more in the green area (BA). This is not wrong because, in fact, monoculture rice farming still exists today.

4. Limitations and Future Directions

The limitations of this study are contextual and cannot be generalized to the entire monoculture rice farming system, as it is conducted in a single location. In addition, the limited number of samples is also a limitation of the research and its findings in the field. Similar research in the future is suggested to cover more locations, expand the sample size for more comparative analysis, and improve the generalizability of the findings. In addition, combining FMEA methods with other methods can also strengthen the validation of risk mitigation priorities.

5. Conclusion

Based on the results of the analysis and discussion, it can be concluded as follows: 1) this study identified 8 risk events (E1–E8) and 12 risk agents (A1–A12) in the monoculture rice farming system in Subak Munggu. This identification shows that risks come not only from the technical aspects of cultivation, but also include market factors, inputs, climate, and farming management behaviors, 2) FMEA results show that A1 (demand fluctuation/market risk) is the most critical risk agent with RPN 490 and is the only one to enter the red zone (intolerable). Meanwhile, other risk agents, such as A4 (weather/climate uncertainty), A9 (human error in cultivation/input use), A10 (decreased subsidies), and A8 (plant pests and diseases), are in the ALARP category, meaning they still require control but are under extreme risk. Suggestions for similar studies in the future can be applied to different agricultural contexts to ensure that the risk-priority pattern remains consistent and continues at the mitigation stage, by combining the FMEA method with the AHP to assess risk priorities and validate risk-priority mitigation. For relevant stakeholders to prioritize A1 (market/demand risk) through mitigation efforts to strengthen

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

absorption certainty (more synchronous harvest planting schedules, purchase agreements, or strengthening collective bargaining positions), because A1 is the only INT risk and most determines business stability.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the author used AI to help proofreading, grammar correction, and improve the readability of the manuscript. This tool is not used to generate research data, conduct analysis, or determine results and conclusions. After using the tool, the author carefully reviews, verifies, and revises the manuscript as needed and takes full responsibility for the accuracy and integrity of the final publication.

Authorship Contribution Statement

Ni Luh Prima Kemala Dewi[1] contributes to Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing original draft, and Interpretation of results. Furthermore, Ketut Budi Susrusa[2] contributed to Conceptualization, Methodology, Formal analysis, Writing review & editing, and Interpretation of results. Then there are two people who contribute to conducting the investigation, Data curation (data tabulation), writing, review & editing, and report writing/documentation, namely Anak Agung Ngurah Surya Yuda Pratama Wibawa[3] and A.A. Putu Endang Sri Lestari Putri[4].

Declaration of Competing Interest

The authors state that they have neither competing financial interests nor known personal relationships that could influence the work reported in this article. Any support/funding received does not affect the research design, data collection, analysis, interpretation, or decision to publish.

Acknowledgements

The author expressed his gratitude to Udayana University for the support of funding for this research. The author also expressed his gratitude to Subak Munggu (subak management/institution) and all respondents who were willing to provide the necessary information and data. Appreciation was also expressed to related parties who supported the smooth collection of data and the implementation of research.

References

Astuti, L. T. W., Daryanto, A., Syaukat, Y., & Daryanto, H. K. (2019). Analisis Risiko Produksi Usahatani Bawang Merah pada Musim Kering dan Musim Hujan di Kabupaten Brebes. *Jurnal Ekonomi Pertanian dan Agribisnis (JEPA)*, *3*(4), 840–852. https://doi.org/10.21776/ub.jepa.2019.003.04.19

Baroroh, S., & Fauziyah, E. (2021). Manajemen Risiko Usahatani Jeruk Nipis di Desa Kebonagung Kecamatan Ujungpangkah Kabupaten Gresik. *Jurnal Ekonomi Pertanian dan Agribisnis*, *5*(2), 494–509. https://doi.org/10.21776/ub.jepa.2021.005.02.18

Budiasa, I. W., Setiawan, B. I., Kato, H., Sekino, N., & Kubota, J. (2015). The Role of the Subak System and Tourism on Land Use Changes Within the Saba Watershed, Northern Bali, Indonesia. *J.ISSAAS*, *21*(2), 31–47. https://www.cabidigitallibrary.org/doi/pdf/10.5555/20163105342

Damayanti, Nahraeni, W., Masithoh, S., & Rahayu, A. (2021). Analisis Risiko Usahatani Jeruk Pamelo. *Jurnal Agribisnis*, *7*(1), 11–23. http://dx.doi.org/10.30997/jagi.v7i1.4366

Firmansyah, A. F. B., Sari, D. P., & Puspita Sari, D. (2025). Analisis Volatilitas Harga Beras dan Segmentasi Wilayah Berbasis Data Digital Pemanfaatan data crawling dari Panel Harga Pangan Nasional. *Seminar Nasional Official Statistics 2025*, 277–285. https://doi.org/10.34123/semnasoffstat.v2025i1.2420

Fitratunnas, Astuti, A., & Setya Ratri, W. (2020). Manajemen Risiko Produksi Petani pada Usahatani Padi Organik di Kecamatan Imogiri, Kabupaten Bantul, Daerah Istimewa Yogyakarta. *Jurnal Ilmiah Agritas*, *4*, 52–65. https://jurnal.ustjogja.ac.id/index.php/agritas/article/view/14477

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

Geria, I. M., Sumardjo, Sutjahjo, S. H., Widiatmaka, & Kurniawan, R. (2019). Subak sebagai Benteng Konservasi Peradaban Bali. *AMERTA: Jurnal Penelitian dan Pengembangan Arkeologi*, *37*(1), 39–54. https://doi.org/10.24832/amt.v37i1.39-54

Gliessman, S. R. (2015). *Agroecology The Ecology of Sustainable Food Systems* (E. W. Engles, Ed.). CRC Press. https://share.google/jjDaW7F9lF4rTjfjo

Hasanah, J., Rondhi, M., & Hapsari, T. D. (2018). Analisis Risiko Produksi Usahatani Padi Organik di Desa Rowosari Kecamatan Sumberjambe Kabupaten Jember. *Jurnal Agribisnis Indonesia*, *6*(1), 37–48. http://journal.ipb.ac.id/index.php/jagbi

Iba, Z., & Wardhana, A. (2023). *Metode Penelitian* (M. Pradana, Ed.). CV. EUREKA MEDIA AKSARA. https://www.researchgate.net/publication/382060682

Janiawati, I. A. A. (2016). *Sistem Subak dan Subak Abian pada Tatanan Lanskap di Bali*. https://www.scribd.com/doc/312821076/Sistem-Subak-Dan-Subak-Abian-Pada-Tatana-1

Lesmana, I. K. A. Y., Suamba, I. K., & Astiti, N. W. S. (2022). Dampak Alih Fungsi Lahan terhadap Eksistensi Subak Kedungu, di Desa Pererenan, Kecamatan Mengwi, Kabupaten Badung. *Jurnal Agribisnis dan Agrowisata (Journal of Agribusiness and Agritourism)*, *11*, 486–496. https://doi.org/10.24843/jaa.2022.v11.i02.p01

Marita, L., Arief, M., Andriani, N., & Wildan, M. A. (2021). Strategi Peningkatan Kesejahteraan Petani Indonesia, Review Manajemen Strategis. *AGRIEKONOMIKA*, *10*(1), 1–18. https://doi.org/10.21107/agriekonomika.v10i1.9391

Mu'adzah, & Firmansyah, N. A. (2020). Analisis Enterprise Risk Management Menggunakan FMEA pada PT XYZ. *Teknoin*, *26*(2), 154–164. http://dx.doi.org/10.20885/teknoin.vol26.iss2.art6

Nurmas, A., Mallarangeng, R., & Adawiyah, R. (2023). Jenis, Populasi dan Intensitas Serangan Hama pada Tumpangsari Kubis dan Bawang Daun serta Produktivitas Lahan. *Journal of Agronomy Research*, *11*(1), 57–66. https://doi.org/10.33772/bpa.v11i1.441

Pangestuti, D. C., Nastiti, H., & Husniaty, R. (2022). Analisis Risiko Operasional Dengan Metode FMEA. *Jurnal Akuntansi, Ekonomi dan Manajemen Bisnis*, *10*(2), 177. http://dx.doi.org/10.30871/jaemb.v10i2.3235

Prasetya, R. Y., Suhermanto, S., & Muryanto, M. (2021). Implementasi FMEA dalam Menganalisis Risiko Kegagalan Proses Produksi Berdasarkan RPN. *Performa: Media Ilmiah Teknik Industri*, *20*(2), 133. https://doi.org/10.20961/performa.20.2.52219

Prihantini, I. C., Kasmiati, & Amin, M. (2023). Analisis Risiko Produksi Agroindustri Beras (Studi Kasus: CV. Karma Indah Kabupaten Kolaka, Sulawesi Tenggara). *Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, *9*(2), 3133–3151. https://jurnal.unigal.ac.id/mimbaragribisnis/article/view/10882

Pujawan, I. N., & Geraldin, L. H. (2009). House of Risk: A Model for Proactive Supply Chain Risk Management. *Business Process Management Journal*, *15*(6), 953–967. https://doi.org/10.1108/14637150911003801

Ruspayandi, T., Bantacut, T., Arifin, B., & Fahmi, I. (2022). Market-Approach-Based Policy to Achieve Rice Price Stability in Indonesia—Can It Be a Complement? *Economies*, *10*(12), 1–19. https://doi.org/10.3390/economies10120296

Simanjuntak, D. F. (2020). Penanganan Risiko dalam Pengelolaan Irigasi dari Perspektif Kultural di Subak Deman, Daerah Irigasi Penatahan, Tabanan, Bali. *Jurnal Sosek Pekerjaan Umum*, *12*(1), 21–34. https://garuda.kemdikbud.go.id/documents/detail/1644122

Siswani, S. P., Rosada, ida, & Amran, F. D. (2022). Analisis Risiko dan Faktor-faktor yang Mempengaruhi Produksi Usahatani Jagung (Zea Mays L.) (Studi Kasus di Desa Bonto Majannang, Kecamatan Sinoa, Kabupaten Bantaeng). *WIRATANI : Jurnal Ilmiah Agribisnis*, *5*(2), 116–124. http://jurnal.agribisnis.umi.ac.id

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2290

Suamba, I. K., Sumiyati, Krisnandika, A. A. K., Tika, I. W., Sulastri, N. N., & Arisena, G. M. K. (2023). The Subak-Based Agro-Tourism Management Model in The Cultural Heritage Area of Catur Angga Batukaru Tabanan Regency, Bali Province, Indonesia. *African Journal of Food, Agriculture, Nutrition and Development*, *23*(2), 22534–22547. https://doi.org/10.18697/ajfand.117.21970

Suriani, N., Risnita, & Jailani, M. S. (2023). Konsep Populasi dan Sampling Serta Pemilihan Partisipan Ditinjau dari Penelitian Ilmiah Pendidikan. *IHSAN: Jurnal Pendidikan Islam*, *1*(2), 24–36. http://ejournal.yayasanpendidikandzurriyatulquran.id/index.php/ihsan

Vanany, I., Zalaini, S., & Pujawan, N. (2009). Supply Chain Risk Management: Literature Review and Future Research. *Int'l Journal of Information Systems and Supply Chain Management*, *2*(1), 16–33. https://www.researchgate.net/publication/220297467_Supply_Chain_Risk_Management_Literature_Review_and_Future_Research

Widianti, T. (2015). Failure Mode and Effect Analysis (FMEA) sebagai Tindakan Pencegahan pada Kegagalan Pengujian. In *10th Annual Meeting on Testing and Quality 2015 Lembaga Ilmu Pengetahuan Indonesia*. https://www.researchgate.net/publication/290899548

Wulandari, R., Siregar, H., Firdaus, M., & Beik, I. S. (2024). Agricultural Credit Supply in Developing Eight Organization's Member Countries: The Behavior Towards Agricultural Risk. *Agro Bali : Agricultural Journal*, *7*(3), 739–751. https://doi.org/10.37637/ab.v7i3.1773

Zakaria, R. S., Rachmina, D., & Tinaprilla, N. (2023). Sharecropping and Production Risk of Rice Farming. *Agro Bali : Agricultural Journal*, *6*(2), 303–314. https://doi.org/10.37637/ab.v6i2.1203