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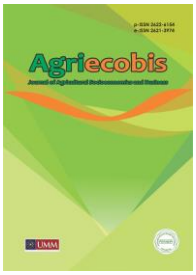

Research Article

Risk Management of Green Bean Farming Production in GluranPloso Village, Gresik District

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ABSTRACT

Green beans are the most important food crop in Indonesia and production continues to increase to meet domestic demand. However, production is still insufficient due to several risks faced by farmers. This research analyzes the risk management of green bean production in Gluranploso Village using the Coefficient of Variation (KV) and Failure Mode and Effect Analysis (FMEA) methods. The results showed that yield variation was relatively low with a KV value of 17%, indicating good yield stability. The FMEA analysis identified four main sources of risk affecting production: seed aspect with an RPN value of 5.808, weather with an RPN value of 7.04, pests and diseases with an RPN value of 12.936, and technical aspects with an RPN value of 47.88, particularly delays in pest and disease control spraying. In addition, the market aspect is also a source of risk with the largest value in the increase in production input prices at 12.288. These sources require special attention in risk management. The study concludes that the implementation of appropriate risk management strategies, focusing on the identified key risk sources, can help farmers improve yield stability and farm profitability. These strategies include improving seed quality, mitigating weather risks, controlling pests and diseases, and improving technical procedures in cultivation and market risks. Thus, effective risk management can be key in increasing the productivity and sustainability of green bean farming in Gluranploso village.

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INTRODUCTION

Indonesia with its various beauties has an abundance of natural resources, especially in the farming sector, making most of the population dependent on the profession as farmers (Arisaputra, et al., 2021). Many domestic products come from the agricultural sector, especially food crops, which play an important role in meeting nutritional needs as well as the domestic market in Indonesia. An example of a food crop developed in Indonesia is green beans (Vigna radiata L.). according to Petropaulus (2020), green beans have high nutritional content, such as 58% carbohydrates, 22.9% protein, 4.9% iron, 0.52% vitamin B1, 0.29% vitamins A and C, 0.89% potassium, and other minerals. According to Hasen et.al (2019), Green beans are a strategic commodity that can survive in dry rice fields in the dry season with a more prominent chance of success than other commodities. However, green bean plants are very sensitive to low temperatures and water shortages (Prazak, 2020).

Green bean, also known as Vigna radiata, is a secondary crop that grows in the tropics. Included in the Fabaceae family, green beans have many benefits, especially as a source of high protein for the body (Hou, 2019). Green beans are the third most important legume crop in Indonesia after soybeans and peanuts. Green bean seeds are of high economic value and can be consumed. Once cooked, it makes an alternative to the staple menu. In addition to its dry nature, the development of introduced bean varieties has made a valuable contribution to the development of the global agricultural industry (Ma, et., al, 2022).

Green beans have advantages that include short planting time, resistance to various pest organisms and diseases, tolerance to drought, easy cultivation methods, and the ability to grow well on less fertile land. The potential for green bean development is huge due to its high economic value and stable price. However, the ever-increasing population growth in Indonesia has led to a demand for green beans, while limited production remains a challenge to meet market needs.

Increasing the area under green bean cultivation, especially in Central and East Java, is essential to increase production. The use of superior varieties and the application of more sophisticated cultivation technologies are also very effective in increasing yields. According to Faizin (2019), superior varieties have better resistance to diseases and pests, as well as better adaptability to climate change. In addition, modern cultivation technologies, such as effective irrigation, proper fertilization according to procedures, and integrated pest control methods, can increase productivity and quality of crops.

Farmers can achieve more optimal yields by selecting superior varieties and using innovative cultivation technologies. This can increase their income and meet the growing market demand. When market demand rises, farmers' welfare tends to improve in several ways. Increased demand usually causes the price of agricultural products to rise, allowing farmers to allocate their crops at the right price and increase their income. In addition, larger sales volumes mean additional income for farmers. With higher incomes, farmers can invest in better farming technology, quality seeds, and modern equipment, all of which are capable of increasing yields, efficiency, and reducing production costs in the long run.

Higher incomes enable farmers to improve their quality of life, such as gaining accessibility to education, healthcare, and rural infrastructure. In addition, farmers' bargaining power with buyers and middlemen becomes stronger, allowing them to negotiate better prices and get a fairer deal. With better capital, farmers can also diversify their businesses, such as growing different crops or starting side businesses, which helps reduce the risk of dependence on one type of product and increases income stability (Hidayat, 2023).

However, to ensure that increased demand actually improves farmers' welfare, supportive policies are needed, such as price protection, fair market access, and infrastructure support. Without the right policies, the benefits of increased market demand may not be fully realized by farmers. Research and development continues to discover new superior varieties and more effective cultivation techniques, to ensure the sustainability of green bean production in the future.

Government efforts to increase green bean production include seed breeding programs, production facility assistance, and extension services. According to Aristya (2019), plant breeding in the public sector is hampered by the use that suits the needs and interests of farmers. The development of plant breeding technology for strategic commodities needs to be done by taking into account the market, preferences, and needs of farmers through research and innovation. Although green bean production in Indonesia has increased, it is still not enough to meet national consumption needs. Indonesia still imports green beans from other countries to meet these needs.

Based on the information in Table 1, the production and harvest area of green beans during the 2019-2023 period experienced unstable fluctuations and tended to decline. Data from the Central Statistics Agency (BPS) shows that:

Table 1. Green Bean Productivity Production in Indonesia

Years	Production	Harvest Areas	Productivities (Ton/Ha)
2019	245.000 ton	208.000 ha	1,18
2020	235.000 ton	198.000 ha	1,19
2021	272.758 ton	204.824 ha	1,33
2022	280.000 ton	207.000 ha	1,35
2023	285.000 ton	209.000 ha	1,36

Source : Central Bureau of Statistics, (Badan Pusat Statistik, 2023)

According to Anugrahtama, et. al (2020), green bean production in 2019 decreased by 2.7% compared to 2020 and has not been able to meet the national demand of 350,000 tons per year for various purposes such as food, seeds, and feed. Therefore, to increase national green bean production, it is necessary to develop the utilization of suboptimal land, such as saline land (Abdillah, 2021). The decline in yield is influenced by various factors, such as the area of productive land, the quality and genetic superiority of seeds, soil type, fertilizer type, medicines, and

farmers' knowledge in cultivation practices. The main challenge in increasing green bean production is the reduction of land used for production, which indirectly causes a decrease in yield every year.

Although green bean production data from 2019-2023 shows an increase in productivity, there are several risks that cause this increase in productivity to be unstable or variable. According to Faizin (2019), seeds are a major source of risk in green bean production because the quality of seeds greatly affects various important aspects of the cultivation process. High-quality seeds support better and faster plant growth. Plants from good seeds can photosynthesize optimally and produce quality green beans. In addition, seed resistance to pests and diseases is very important because resistant seeds will reduce the risk of losses due to pest attacks and reduce the need to use pesticides that have a negative impact on the environment.

The second source of risk is weather. According to Taek et al (2022), extreme and unpredictable weather changes and irregular rainfall patterns greatly affect green bean farming activities and increase food insecurity. These extreme weather patterns can cause floods, landslides or droughts, making it difficult for farmers to predict planting and harvesting times. In addition, traditional farming methods such as slash and burn and the lack of application of appropriate technology also affect family food security.

The third source of risk is pest and disease attacks. According to Firdaus et. al (2023), pest attacks such as Agromyza phaseoli Cog, Phenacoccus manihoti, Spodoptera, Aphidoidea, and Callosobrunchus chinesis L, often reduce green bean production. Farmers generally use chemical pesticides such as Biopatek, Nopatek, and Biowasil, spraying 25 times from 10-14 days after planting until the last harvest in 3-4 months.

The fourth source of risk is technical risk. According to Arifin et al (2022), the decline in green bean production in Indonesia is caused by inappropriate cultivation techniques, such as tillage, fertilization, and pest and disease control. To increase green bean production, it is necessary to intensify and apply appropriate cultivation techniques. Intensification includes improving cultivation methods by using technology packages that can produce optimal yields with minimal inputs.

Next is market risk. According to Mardiana et al. (2022), market risk in green bean production often occurs due to changes in agricultural product prices that are influenced by product supply and demand, as well as production costs that differ each period. By understanding and managing these various sources of risk, farmers can increase the stability and sustainability of green bean production, thereby meeting the growing market demand and improving their welfare.

The Ministry of Agriculture provides great support to green bean production centers across Indonesia, including East Java Province, with key areas such as Mojokerto, Jombang and Lamongan. Within the framework of this support, Gresik District plays an important role as one of the main centers of green bean production in the province, with a land area of 1,100 hectares and a production value of IDR 1.2 trillion in 2020 (BPS East Java, 2021). Several sub-districts in Gresik Regency, such as Benjeng, Kedamean, Balongpanggang, Bungah, and Panceng, are known as major production centers. Increased green bean production is expected to increase farmers' income and boost the local economy.

However, farmers face various challenges that can affect production outcomes, such as market price fluctuations, technological limitations, and unpredictable weather conditions. To overcome these problems, the government needs to provide solutions in the form of counseling, access to appropriate technology, and a price guarantee system. Gresik district, which is currently ranked 7th in East Java with a productivity of 1.42 tons per hectare, shows significant achievements.Despite progress, challenges such as weather and climate change still limit the potential for greater increases in production.

At the village level, Gluranploso village in Benjeng sub-district showed prominent productivity in 2020 and continued to increase until 2023. However, this increase is still hampered by the risks and challenges faced by farmers, as described by previous researchers. Identifying and analyzing risks in green bean production is essential for designing effective preventive measures such as selecting kutilang variety seeds, using mulch on the soil, using pesticides, and using pesticides.

This study aims to use the Failure Mode and Effect Analysis (FMEA) and Coefficient of Variation methods to evaluate the potential failures and severity of risks in green bean production in Gluranploso Village. With this approach, it is expected to provide in-depth insight into production risks and develop effective strategies to increase production yields in a sustainable manner.

METHODS

To achieve the Observation objective, the approach applied is descriptive quantitative, which is useful to provide an in-depth understanding of the phenomenon being studied through numerical and qualitative data analysis obtained from faizin (2019). This approach is based on relevant literature from previous research, as well as comprehensive data collection techniques.

Data Collection Techniques

This research relied on three main techniques for the data collection:

1. Questionnaires: Questionnaires are useful for collecting primary data from respondents. The questionnaire was designed to obtain structured information on farmers' experiences, cultivation techniques, and challenges faced in green bean production. The questions in the questionnaire covered technical aspects, risks, and practices of green bean cultivation relevant to this study.
2. Observation: Observation was conducted to obtain direct data on field conditions, cultivation techniques applied, and other factors affecting green bean production. These observations helped the researcher understand the practical context of the information obtained through the questionnaire.
3. Interviews: In-depth interviews were conducted with green bean farmers to gain a more in-depth perspective on the challenges and risks they face. These interviews also allowed the researcher to explore issues that may not be covered by questionnaires and observations.

Data Type

The data used in this study consists of:

1. Primary Data: The data were collected through a survey involving interviews and questionnaires as well as field observations. The data includes direct information from respondents on cultivation techniques, experiences and challenges in green bean production.
2. Secondary Data: The secondary data was obtained from reports and documents provided by relevant agencies. This secondary data provides additional context and historical information on green bean production in the study area.

Research Location

This research was conducted in Gluranploso Village, Benjeng Sub-district, Gresik District, East Java. This location was chosen because it has characteristics that relevant to the study of green bean production and shows the potential and challenges in green bean cultivation**.**

Sampling Technique

The sampling technique used is purposive sampling. Purposive sampling is a method of selecting samples based on special considerations from researchers. This technique selects subjects based on the characteristics of the farmer, namely the recommended respondent of the Gapoktan leader/manager, and those who have at least 5 years of experience in green bean farming. In this case, the sample was taken from green bean farmers who had experience and a minimum land area of 1 hectare in Gluranploso village. These characteristics ensure that respondents have significant knowledge and experience related to green bean production.

Data Analysis Method

Descriptive quantitative data analysis in this study was conducted with two main methods:

1. Failure Mode and Effect Analysis (FMEA): FMEA is a systematic technique for identifying potential failures in a design, process, or product and assessing their impact. FMEA helps in identifying possible failures, evaluating their impact on the system, and developing mitigation strategies to reduce risks. According to Wang et. al (2009), FMEA uses 3 scales with each rating of 1-10, namely the severity, occurrence, and detection scales, from the average results of the severity, occurrence, and detection scales calculated by the formula RPN

RPN = Severity(S) x Occurence (O) x Detection (D)

2. Coefficient of Variation: The coefficient of variation is necessary in measuring the level of variability in production data. It is the ratio between the standard deviation and the average, which gives an idea of how consistent the production results are compared to the average. According to Hernanto (1999), the coefficient of variation is the ratio of the risk that must be borne to the amount of production costs, calculated by the formula:

KV = Va/Qi

Description:
KV = Coefficient of Variation
Va = Standard Deviation
Qi = average production output (kg/ha)

Data obtained from questionnaires, observations, and interviews will be analyzed descriptively to describe existing patterns, trends, and relationships, using FMEA and Coefficient of Variation methods. This research aims to provide an in-depth insight into the risks and challenges in green bean production, as well as develop strategies to sustainably increase production output

RESULTS AND DISCUSSION

The results of risk analysis on green bean farming using the Failure Mode and Effect Analysis (FMEA) method aim to show the Risk Priority Number (RPN) for various potential problems. This RPN is obtained by multiplying the values of three main criteria: severity, occurrence, and detection. This approach allows the evaluation and ranking of risks based on impact, frequency of occurrence, and effectiveness of detection methods. As such, this analysis provides a clear picture of the most significant risks and those that require primary attention in green bean production. The RPN results of this analysis are shown in Table 2, which reflects how risks are prioritized based on severity, frequency of occurrence, and detectability.

Table 2. Risk Priority Number (RPN) Results

No.	Indicators	RPN Value
1	Delayed pest and disease control spraying	47,88
2	Green bean pod checking	25,2
3	Green beans damaged after harvesting	18,72
4	Green beans infested with pests and diseases	12,93
5	Price of production inputs rises	12,28
6	Low quality seed	5,80
7	Green bean selling price decreases	7,68
8	Nutrients are absorbed by weeds	7,29
9	Environmental temperature is too hot	7,04
10	Uneven distribution of solid fertilizer	4,75
11	Uneven harvest of green beans	4,60

Source : Data Processing Research Results (2024)

Based on the processed data in Table 2, the RPN values in the table indicate the priority of risk handling in green bean farming. For example, the delay in spraying pest and disease pesticides has the highest RPN value of 47.88, indicating that this issue is crucial and must be prioritized to prevent production failure. Next, the activity of checking green bean pods has an RPN of 25.2, while damaged green beans after harvest shows an RPN value of 18.72. Other risks include green beans being attacked by pests and diseases with an RPN value of 12.99, low quality seeds with an RPN value of 5.80, and a decrease in the selling price of green beans with an RPN value of 7.68. Additional risks include nutrients being absorbed by weeds (RPN 7.29), excessively hot ambient temperatures (RPN 7.04), uneven distribution of solid fertilizer (RPN 4.75), and uneven harvesting of green beans (RPN 4.60).

The results of risk analysis using the FMEA method calculated using the RPN formula show some of the main risks in green bean farming. The implications of these findings are very significant in the research conducted by Prasetyo (2022), to increase the productivity and efficiency of green bean farming. First, risks with the highest RPN values, such as delays in spraying pesticides, require immediate attention and handling. It shows a huge impact on plant health and production yields. Therefore, it is important to optimize pesticide spraying schedules and techniques to prevent greater losses.

In addition, the analysis also highlights the need for improved management techniques and agricultural technologies, such as environmental temperature monitoring and more efficient fertilizer distribution. Appropriate technology development and implementation can reduce risks related to seed quality and environmental conditions. The research also underscores the importance of better planning and risk management, by developing mitigation strategies for key risks. Policy support and extension programs from the government and relevant agencies are also needed to help farmers overcome these challenges.

Finally, price stabilization and market security policies should be considered to reduce the impact of price fluctuations on farmers. Overall, the results of this analysis provide deep insights into critical areas that require strategic action to improve the resilience and productivity of green bean farming. These findings are consistent with research by Khasanah, et. al. (2023), Pests and plant diseases are major factors that severely limit crop production. They not only cause significant physical damage to various parts of the plant such as leaves, stems, roots, and fruits, but also disrupt various important physiological processes occurring within the plant, including photosynthesis, respiration, and nutrient absorption. This damage has a direct impact on plant

growth and development, ultimately resulting in reduced productivity and crop quality. Therefore, pest and disease control efforts are very important to ensure that plants can grow optimally and produce adequate yields.

Coefficient of Variation (KV)

Before discussing the coefficient of variation (CV) further, it is important to understand the results of the study, which showed that the CV value for green bean production risk was 0.17. This coefficient of variation is a statistical measure that describes the relative level of variation in green bean production over time.

A KV value of 0.17 is low, which means that the variation or fluctuation in green bean production is not significant. In this context, a low KV value indicates that production output tends to be stable and does not experience major changes from year to year. This means that although there are minor fluctuations, there are no drastic changes that affect the overall consistency of production.

To provide a clearer picture, the green bean production data used in this analysis can be seen in Table 3, which details the production results over time. Meanwhile, Table 4 presents the results of the standard deviation, which provides additional information on how far the green bean production data spreads from the mean. This information helps in understanding the stability of production and provides a basis for further analysis of production fluctuations.

Table 3. Green Bean Production Per Ha

	Total Production	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	900.00	1	20.0	20.0	20.0
	1000.00	1	20.0	20.0	40.0
	1200.00	1	20.0	20.0	60.0
	1300.00	1	20.0	20.0	80.0
	1400.00	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Source : Data Processed, 2024

Table 4. Standart Deviation Results

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Production	5	900.00	1400.00	1160.0000	207.36441	43000.000
Valid N (listwise)	5					

Source : Data Processed, 2024

The results of data analysis of green bean production show that the standard deviation value obtained is 207.36441. By dividing this standard deviation by the average production yield (Qi), a Coefficient of Variation (KV) of 0.17 was obtained. KV is a measure that reflects the degree of fluctuation or variation in production over time. A KV value of 0.17 indicates that the variation in green bean production is relatively low, indicating high stability in yields from year to year. This means that green bean production does not experience significant fluctuations, so yields tend to be consistent.

The implications of this low KV are very positive in the context of agriculture. First, production stability provides farmers with certainty regarding their yields, allowing them to better plan production and distribution activities. It also reduces the risk of income uncertainty, providing a sense of security for farmers. Secondly, stable production supports consistent availability of green beans in the market. As such, green bean prices can be more stable, and consumer demand can be optimally met, benefiting the entire supply chain.

Furthermore, the low KV indicates that the farming practices are efficient and well adapted to environmental conditions and climate change. This reflects the success of the cultivation techniques and shows the potential for continued growth in the green bean farming sector.

When combined with the results of the Failure Mode and Effect Analysis (FMEA), where the highest Risk Priority Number (RPN) value is 47.88, it indicates that the technical risks in green bean production are at a low to moderate level, meaning that the potential for failure in the production process or technology used is not significant. The low KV value underlines that production fluctuations remain minimal, and yields tend to be stable. With the combination of non-high RPN and low KV values, green bean producers can feel more confident in the stability of their yields and production processes. Therefore, the risk management strategies implemented can be maintained or even improved to ensure sustainability and increased productivity in the future. This research is also in line with the findings by Firdaus et al. (2023), which showed that low KV values

in soybean farming indicate stable profits despite risks, emphasizing the importance of good risk management for farm sustainability. This is in accordance with the research conducted by Pani., et al (2023), who explained that the results of the production and price risk analysis showed that the KV value < 0.5, which means that soybean farming carried out by farmers is profitable in terms of production and price. However, the profit risk analysis shows a KV value of > 0.5, which indicates that farmers suffer losses due to price fluctuations because the KV results are more than 0.5.

Efforts to Control Production Risks of Green Bean Farming

Control Efforts due to seed

In green bean farming, seed-related risks are an important factor that can affect success or failure in production. Based on the interviews and analysis that has been conducted, there are key indicators that could potentially lead to seed-related risks, namely: Low seed quality and seeds that are susceptible to pest attacks. Low seed quality is a significant risk in green bean production. Poor quality seed can inhibit plant growth, result in low yields, or even cause crop failure. Some of the factors causing low seed quality include lack of proper seed selection, disease infection of the seeds, or seeds with low viability.

One of the main steps is the use of certified seeds. Certified seeds have usually gone through a rigorous selection and testing process, so their quality can be ensured. To ensure seed quality, quality tests should be conducted before planting. These tests may include germination tests and tests to detect pathogens in the seeds.

Research conducted by Faizin, M., Nadrawati, E. T., & Turmudi, E. (2019) that emphasizes the importance of high-yielding varieties as a component of production technology that is effective, easily adopted by farmers, and environmentally friendly, is closely related to previous studies that have also highlighted the importance of selecting high-yielding varieties in increasing crop productivity. Previous research has shown that improved varieties can provide higher yields, have better resistance to pests and diseases, and are able to adapt to different environmental conditions. In addition, several studies have also confirmed that the use of improved varieties is one of the most effective and economical strategies in increasing agricultural yields without having to rely on the use of high inputs such as chemical fertilizers and pesticides, thus supporting more sustainable agriculture, thus Faizin and his colleagues' research strengthens previous findings by providing concrete evidence through testing of green bean varieties such as Vima 1, Vima 2, Vima 3, Murai, Kenari, Sriti, and Kutilang types, which are proven to have superior quality. This research also adds to the knowledge of the superiority of these varieties and encourages the adoption of superior varieties by farmers to achieve better production and be more environmentally friendly. Among these varieties, the Kutilang seed variety is one of the recommended choices for farmers due to its superior quality.

By implementing the use of certified seeds and conducting seed quality testing, farmers can reduce the risk of crop failure and significantly increase green bean production yields.

Weather-Related Control Measure

Excessively hot ambient temperature, with a Risk Priority Number (RPN) of 7.04, is a significant source of risk in green bean production as it can cause plant stress. Stress due to high temperatures inhibits the photosynthesis process, reduces gas exchange, and disrupts the function of plant enzymes, which in turn can reduce productivity and yield.

To address the risk of hot temperatures, several mitigation measures can be applied. The use of organic mulches such as straw, compost, or dry leaves is an effective method to reduce water evaporation and maintain soil moisture. It can also improve soil fertility over time. Another alternative is the use of plastic mulch, which serves to reflect some of the sun's rays, reduce soil temperature, and reduce water evaporation. In addition, plastic mulch also helps control weeds that compete with green bean plants for water and nutrients.

Research by Febriyantiningrum et al. (2021) reinforces these findings by providing empirical evidence on the effectiveness of biofertilizers in enriching soil nutrient content and improving crop growth in challenging land conditions such as drylands. This research also adds insight into how biofertilizers can act as environmentally friendly biological agents, which not only support plant health, but also contribute to environmental sustainability and long-term agricultural success. As such, this research is in line with previous efforts in promoting the use of biofertilizers as an important component in modern sustainable agriculture. Besides the application of mulch, other mitigation measures include delaying the initial planting schedule, harrowing to loosen the soil, and land conversion. To ensure quality and quantity of production, farmers are

advised to follow Good Agricultural Practices (GAP) and establish Indonesian National Standards (SNI) for green beans. This will help produce high-quality green beans, maintain the quality of local green beans, and reduce uncertainty in production yields.

Pest and Disease Control Measures

Pest and disease infestation, with an RPN value of 12.936, is one of the main risks in green bean production. The high RPN value indicates that attacks by pests such as caterpillars, aphids and leafhoppers, as well as diseases such as late blight, can significantly damage the crop and reduce yields. Pests can damage plant parts, while diseases can cause leaves to turn yellow, wilt and fall off, resulting in a drastic reduction in yield.

To control pests and diseases, an important first step is early detection. This can be done through regular field inspections to identify early signs of infestation. Regular monitoring allows farmers to take preventive measures before the problem spreads further. In addition, the use of traps such as pheromone traps can help monitor pest populations and determine the right time for intervention.

In pest control, the use of pesticides can also be applied in several ways. First, natural pesticides made from ingredients such as Neem seed powder, garlic, ginger rhizomes, papaya leaves, and chili marinade can be used. According to Indiati (2022), these natural pesticides are environmentally friendly options that are safe for the agricultural ecosystem and effective in controlling pests. Secondly, the use of chemical pesticides, if needed, should be done judiciously with the recommended dosage, which is 2-3 times a month with an application dose of 0.5-1.5% active ingredient. According to Ria (2023), it is also important to rotate pesticide types to prevent pest resistance. Finally, pesticide application should be done at the right time, usually in the morning or evening, to minimize side effects and increase effectiveness.

These mitigation measures will help reduce the risk of damage caused by pests and diseases, and thus increase the overall yield of green bean production.

Technical Control Measures

Delays in spraying for pest and disease control in green beans, with a Risk Priority Number (RPN) value of 47.88, indicate a high risk that requires immediate attention. To address this issue, it is important to organize and adhere to a timely spraying schedule. This will help to effectively prevent the development of pests and diseases, thereby reducing losses caused by such delays.

Regular inspection of green bean pods, which have an RPN value of 25.2, is also a crucial step to ensure pod health and quality. By conducting regular inspections, farmers can detect and address pod health issues before they significantly affect yields.

The problem of uneven green bean harvest, reflected by the RPN value of 4.608, can be improved by implementing good tillage practices. This includes ensuring an even distribution of water and nutrients across the field, so that each plant gets optimal growing conditions.

Damage to green beans after harvesting, which has an RPN value of 18.72, can be prevented by proper storage. Storing green beans in a dry and well-ventilated area will help avoid mold growth. Fungicides can also be applied if needed to protect the crop.

Nutrients absorbed by weeds, with an RPN value of 7.296, require regular weeding to remove weeds that compete with the green bean crop. The use of mulch or herbicides can also be used to control weed growth and ensure that green bean plants get enough nutrients.

The problem of uneven distribution of solid fertilizer, which has an RPN value of 4.752, can be addressed by using a proper fertilizer spreading device. This tool will ensure that the fertilizer is spread evenly across the field. To improve the effectiveness of fertilization, technological innovations can be applied, as proposed by Arifin et al (2022). They showed that fertilizing with cow manure, which is rich in macro and micronutrients, can improve soil physical, chemical and biological properties. This will increase nutrient availability to plants and support healthier and more productive growth of green beans.

By implementing these mitigation measures, the risks associated with green bean production can be reduced, and the stability and productivity of the crop can be improved.

Market-Driven Control Measures

The decline in green bean prices, reflected in the Risk Priority Number (RPN) value of 7.68, is a risk that needs to be addressed to reduce the negative impact on farmers' income. To address this issue, several control measures can be implemented. Firstly, improving the quality of green beans through the application of

more sophisticated post-harvest processing technologies can help maintain product quality and positively affect selling prices. In addition, training by authorities on efficient and sustainable green bean cultivation is essential to improve farmers' skills and their yields. This effort should also include training in creating added value from green beans, which will increase the product's competitiveness in the market.

This study is in line with research conducted by Mardiana et. al (2022) supporting this approach, showing that partnerships between farmers and industry can reduce the risk of unstable prices. In the study, farmers who partnered with the industry had lower price risk than non-partnered farmers. Therefore, the government's role in creating policies conducive to price stability and risk management is crucial. In addition, effective and efficient land intensification, crop diversification to reduce dependence on one commodity, and providing education and training to farmers to improve their capabilities in community-based enterprises can contribute to improving farmers' income stability

CONCLUSION

The results of this study show that production risks in green bean farming involve several key factors, namely seed quality, weather, pests and diseases, cultivation techniques, and market risks. Analysis using the Failure Mode and Effect Analysis (FMEA) method identified that delays in pest and disease control are the biggest risk, with the highest Risk Priority value of 47.88. This indicates that delays in control measures can have a serious impact on green bean production. The second largest risk is pest and disease infestation with an RPN value of 12.936, which also requires serious attention. Rising production input prices, with an RPN value of 12.288, represent a significant negative impact on farm profitability. The associated risk of seed quality being susceptible to pest attacks has an RPN value of 11.424, emphasizing the importance of using quality seeds. Meanwhile, overheating of the environment has the lowest RPN value of 7.04, but should still be considered.

With a Coefficient of Variation (KV) value of 0.17%, indicating relatively good production stability, suggestions for improving the productivity and profitability of green bean farming include several strategic measures. First, the selection of high-quality seeds is crucial to ensure optimal yields. Second, the use of pesticides should be done wisely and in a timely manner to control pests and diseases. Third, the application of crop rotation techniques can help reduce the risk of pest and disease attacks and improve soil fertility. Fourth, counseling and training farmers on effective cultivation practices and risk management will be very helpful in increasing the productivity and resilience of green bean farming. With these measures, it is hoped that green bean farming can face challenges.

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