**AGRISOCIONOMICS**
Jurnal Sosial Ekonomi dan Kebijakan Pertanian
ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

# Risk Analysis of Mulu Bebe Banana Farming in West Halmahera Regency Province North Maluku

**Fatmawati Kaddas[1*], Firlawanti Lestari Baguna[2], Hamidin Rasulu[3] and Mila Fatmawati[1]**

[1]Program Study of Agribussines, Universitas Khairun, Jl. Yusuf Abdurrahman Kampus II Kel. Gambesi Kota Ternate, Indonesia
[2] Program Study of Forestry, Universitas Khairun, Jl. Yusuf Abdurrahman Kampus II Kel. Gambesi Kota Ternate, Indonesia
[3] Program Study of Food Technology, Universitas Khairun, Jl. Yusuf Abdurrahman Kampus II Kel. Gambesi Kota Ternate, Indonesia
*Correspondence Email: fatmawati.kaddas@unkhair.ac.id

Submitted 26 March 2025; Approved 16 August 2025

## ABSTRACT

Food production problems can contribute to global food and energy inflation; therefore, this study aims to identify the risks faced by farmers in developing Mulu Bebe banana farming, analyze the levels of production and income risks, and explore appropriate mitigation strategies. The research was conducted in West Halmahera Regency, which serves as the main production center for Mulu Bebe bananas. The study employed interviews and Focus Group Discussions (FGDs) to identify key risks experienced by local farmers. These findings were analyzed using a comprehensive risk assessment approach, including calculations of the likelihood and consequences of each risk, categorization into risk levels, grouping of risks, and prioritization of mitigation strategies, all of which were visualized through a risk map. The risks associated with Mulu Bebe banana farming were classified into two main categories: production risk and income risk. Based on the analysis, both risk types showed a coefficient of variation (CV) of less than 0.5 and a lower limit value (L) greater than 0. These indicators suggest that Mulu Bebe banana farmers generally operate under low-risk conditions and are likely to avoid significant losses in both production and income. This farming system is not entirely free from risk. Risk identification based on production and income aspects revealed several sources of risk ranging from low to high levels. The most critical risk, categorized as high, is related to technical errors in the cultivation process. Medium-level risks include pest attacks, input prices such as fertilizers and herbicides, fruit quality, seed availability, planting area, weather and climate conditions, and banana distribution infrastructure. Meanwhile, consumer preference was identified as a relatively low risk.

***Keywords****: Mulu Bebe Banana, Risk Analysis, Production Risk, Income Risk, Risk Mitigation.*

## BACKGROUND

Global problems related to food and energy inflation can be caused by various factors such as climate change that affects global food production, world crises and wars that disrupt import and export, monetary policy that involves lowering the cost of capital, increasing investment, and boosting economic growth or vice versa (Allam et al., 2022). Fiscal policy can improve people's income and welfare and control inflation. Food and energy inflation harms farming because it can reduce consumer purchasing power and thus reduce farmer income and demand, increase operational

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

costs, increase product selling prices, and increase the risk of crop failure due to environmental conditions (Abeysekera, 2024).

Uncertainty and instability affecting production, prices, and markets can put farms at risk. (Pratama, 2019) states that farming has production, price, and income risks. Production risk is the possibility of differences between expected production results and actual production results. Price risk is the risk associated with fluctuations or changes in the price of agricultural products in the market. Income risk is the possibility of differences between expected income and income received (Kaddas et al., 2023a; Kizilay & Akçaöz, 2016; Waseem et al., 2020).

Mulu Bebe banana farming in West Halmahera Regency is a feasible commodity for commercial development. This is because the Mulu Bebe banana is an icon of West Halmahera as the center of banana production in North Maluku (Dadi & Kholil, 2020). Mulu Bebe banana farming is very profitable because revenue is greater than production costs and contributes 6.11% of total household income (Kaddas et al., 2023b). The selling price and production quantity are low. This condition needs to be considered to be able to prosper farmers sustainably.

Every farm has potential risks that can reduce farmer's income and disrupt the production process either from natural or human factors. The uncertainty factor of the events that occur in the development of farming is necessary to reduce the impact of farming risks that harm farmers (Guanyi et al., 2015; Khatri et al., 2024; Kizilay & Akçaöz, 2016; Oladimeji et al., 2019). Farmer as decision-makers in developing farms need to implement control strategies to minimize risk conditions effectively. The research objectives were to identify the risks faced by farmers in developing Mulu Bebe banana farming in West Halmahera Regency, and to analyze the levels of production, price, and income risks as well as the mitigation strategies (control) applied to manage these risks. The novelty of this study lies in its focus on the Mulu Bebe banana—an indigenous and under-researched variety—by providing a comprehensive risk analysis specific to the socio-economic and agroecological conditions of West Halmahera, which has not been previously explored in existing literature.

Agriculture remains a vital sector in Indonesia, with nearly half of the population depending on it for their livelihood. As a key driver of national development, agriculture contributes not only to food security but also to economic resilience (Wang et al., 2024). Banana farming—particularly Mulu Bebe bananas in West Halmahera Regency—represents an important subsector. However, like many agricultural enterprises, banana farming is exposed to various risks that can affect both productivity and farmer income (Chen et al., 2022). Understanding and analyzing these risks is essential to develop effective mitigation strategies and ensure the sustainability of banana cultivation in the region (Achmad, B Sanudin Siarudin, M Widiyanto, A Diniyatim D Sudomo, A Ruswandi, 2022). A more limited interpretation of agriculture refers solely to the cultivation of food crops, when examined more comprehensively, agricultural activities encompass both crop and livestock production to meet human needs (Monteiro et al., 2021).

Risk analysis is a critical component in agricultural decision-making, particularly in regions where farming is highly vulnerable to environmental, technical, and market-related uncertainties. In the context of Mulu Bebe banana farming in West Halmahera Regency, risk analysis serves to systematically identify, assess, and prioritize the various uncertainties that may threaten farm productivity and profitability. These risks include both production risks—such as pest infestations,

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

climate variability, and technical errors in cultivation—and income risks stemming from price fluctuations and market access issues, this study evaluates the likelihood and impact of each identified risk by applying quantitative tools such as the coefficient of variation (CV), lower limit values (L), and risk mapping. The ultimate goal of risk analysis in this context is not only to measure the level of exposure but also to guide farmers and policymakers in developing targeted mitigation strategies that enhance resilience, reduce vulnerability, and ensure sustainable agricultural practices. Agriculture serves as a fundamental sector that shapes market dynamics, influencing the broader development process (Giller et al., 2021; Yeomans et al., 2024). It fosters both forward and backward linkages, which, under favorable conditions, can significantly enhance economic growth. Lastly, this sector provides a crucial source of revenue for development while also serving as the primary source of employment and income for the majority of rural populations in developing countries (Kitole et al., 2024).

The agricultural sector contributes to economic development in several ways by (Choudhary et al., 2022):

1. Ensuring a growing food surplus to meet the needs of an expanding population.
2. Driving higher demand for industrial goods, which in turn stimulates the expansion of secondary and tertiary sectors.
3. Generating additional foreign exchange earnings through the continuous export of agricultural products, allowing for the import of capital goods essential for development.
4. Increasing rural income, which can be leveraged by the government for economic mobilization.
5. Enhancing overall community welfare.

Food production remains the dominant agricultural activity in less developed nations. When productivity rises, agricultural output increases, leading to higher earnings for farmers. Per capita income grows, significantly boosting food demand in such economies, the income elasticity of demand is typically high, ranging between 0.6 and 0.8 percent (Kapari et al., 2023).

The agricultural sector plays a crucial role as the backbone of national economic development, particularly during times of crisis and economic recovery. To maximize its impact, agriculture must be consistently supported and positioned as a key sector by fostering a resource-based economy (Huangfu et al., 2024). The rural economy holds significant potential in shaping overall national economic stability, and any structural changes in rural economies should be closely monitored, especially regarding their effects on employment opportunities and income distribution in rural communities (Del Olmo-García et al., 2023).

## RESEARCH METHODS

This research was conducted in West Halmahera Regency, North Maluku Province. The location was selected purposively (purposive sampling), based on the consideration that this area is the main production center for Mulu Bebe bananas. The study was carried out from March to October 2024. Risk analysis of Mulu Bebe banana farming was conducted using the Focus Group Discussion (FGD) method, which helped identify the key risks faced by farmers. The FGD was used to support decision-making by identifying the criteria and sub-criteria related to problems arising in the farming

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

process. This used to determine the best decision by identifying criteria and sub-criteria of problems that arise in farming (Mardiana et al., 2022). This study employs both primary and secondary data collection methods. The collected data are then analyzed systematically to address the research objectives. The data analysis methods used in this study are as follows

1. To determine the risk of Mulu Bebe banana production using the coefficient of variation (CV) and standard deviation formula (Asminar et al., 2021) as follows;
   Coefficient of variation (CV)
   $$cv = \frac{\sigma}{Q}$$
   Standard deviation ($\sigma$)
   $$\sigma = \sqrt{\frac{\Sigma_i^n = (xi - \bar{x})}{n-1}}$$
2. Determining the lower limit value of income (Norhalis et al., 2020) with the following formula;
   $$L = E - 2V$$
3. Decision Making Criteria (Norhalis et al., 2020); (Asminar et al., 2021) as follows;
   a. If CV < 0.5 and L > 0 then Mulu Bebe banana farmers will always be from losses and the risk of farm production is low.
   b. If CV > 0.5 and L < 0 then Mulu Bebe banana farmers are likely to lose money and the risk of farm production is high.
4. The level of risk (R) of Mulu Bebe banana farming was analyzed using the Likelihood (L) value approach and the value of risk consequences (K), the equation (Ghozali & Wibowo, 2019) can be seen as follows;
   $$R = L\ x\ K$$
   The risk likelihood assessment of Mulu Bebe banana farming is evaluated according to field conditions related to the possibility of risk occurrence and the probability level with a value range of 1-5. The risk likelihood assessment parameters can be seen in the following Table 1;

**Table 1.** Risk likelihood level

| Level | Parameter | Risk likelihood level |
|---|---|---|
| 5 | Almost certain | This may occur in most circumstances |
| 4 | Likely | This may occur in most circumstances |
| 3 | Possible | This may occur in some situations |
| 2 | Unlikely | This may occur at at sometimes |
| 1 | Rare | May only occur in abnormal conditions |

Sources : (Baki, 2019)

To assess the likelihood of various risks in Mulu Bebe banana farming, the study adopted a qualitative risk rating scale. Risk likelihood was evaluated using a five-level parameter scale (Table X), ranging from Level 1 (Rare) to Level 5 (Almost Certain). Each level represents the probability of a risk event occurring, based on farmer experiences and expert judgment gathered through Focus Group Discussions (FGDs). For example, a risk categorized as "Almost Certain" (Level 5) is expected to occur under most farming conditions, while a "Rare" risk (Level 1) is unlikely and may only occur

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

under exceptional or abnormal circumstances. This classification framework allowed researchers to systematically evaluate and rank the probability of identified risks in the banana farming process. The range of risk consequence parameter values for Mulu Bebe Banana farming is 1–5 with the following assessment.

**Tabel 2.** Risk consequence level

| Level | Parameter | Risk Consequence Description |
|---|---|---|
| 5 | Catastrophic | Very large losses, very significant consequences on the objectives of banana farming |
| 4 | Major | Large losses, significant consequences on the objectives of banana farming |
| 3 | Moderate | Moderate losses, moderately significant consequences on the objectives of banana farming |
| 2 | Minor | Low losses, minor impact on the objectives of banana farming |
| 1 | Insignificant | Very low losses, negligible impact on the objectives of banana farming |

Sources : (Baki, 2019)

To assess the severity of risks associated with Mulu Bebe banana farming, a risk consequence scale was employed (Table 2). This scale categorizes consequences into five levels: Insignificant (1), Minor (2), Moderate (3), Major (4), and Catastrophic (5). Each level describes the potential impact on farm objectives, ranging from negligible effects to severe financial losses or disruption to farming operations. This consequence assessment, when combined with likelihood ratings, enables the construction of a comprehensive risk matrix and facilitates the identification of priority risks.

Evaluation of the risk level of the Mulu Bebe Banana farming business from the calculation of the calculation of likelihood, and consequence of the risk, risk categories and risk groups and their handling priorities which will be described in the risk map as follows;

**Table 3.** Risk level and prioritization of risk management

| Risk Level | Risk Group | Risk Category | Risk Handling Priority |
|---|---|---|---|
| 16 – 25 | Extreme | Not accepted | Handled immediately with extra effort |
| 10 – 16 | High | Not accepted | Handled by emphasizing roles and responsibilities |
| 4 – 9 | Medium | Not accepted | Handled if resources are still available |
| 1 – 3 | Low | Accepted | Monitored to stay in the accepted category |

The next stage of the risk group description based on the level of risk that is accepted and not accepted and needs to be prioritized for handling in the Mulu Bebe banana farming is described in the risk map as follows;

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

**Table 4.** Risk Ranking

| | | | Impact | | | | |
|---|---|---|---|---|---|---|---|
| | | | *1* | *2* | *3* | *4* | *5* |
| | | | *Insignificant* | *Minor* | *Moderate* | *Major* | *Catastrophic* |
| **Probability** | *5* | *Almost Certain* | Medium | High | High | Extreme | Extreme |
| | *4* | *Likely* | Medium | Medium | High | High | Extreme |
| | *3* | *Possible* | Low | Medium | Medium | High | Extreme |
| | *2* | *Unlikely* | Low | Low | Medium | Medium | High |
| | *1* | *Rare* | Low | Low | Low | Medium | High |

Sources : (Baki, 2019)

Descriptive analysis to describe Mulu Bebe banana farmers in facing farming risks.

The table presents a Risk Ranking Table that categorizes risk levels based on Probability and Impact, serving as a decision-making tool for assessing and managing risks in Mulu Bebe banana farming. The table is structured into five probability levels, ranging from Rare (1) to Almost Certain (5), and five impact levels, from Insignificant (1) to Catastrophic (5). Each combination of probability and impact results in a specific risk ranking, color-coded to indicate the severity: Risk levels are categorized as Low, Medium, High, and Extreme. Risks classified as Extreme and High are considered unacceptable and require immediate mitigation actions to prevent significant threats such as crop failure, pest outbreaks, or climate-related events that could severely impact Mulu Bebe banana production. Medium-level risks require consistent monitoring and the implementation of preventive measures, while Low-level risks are generally acceptable and may only require minimal intervention. This classification system allows for effective prioritization in managing farming risks, ensuring that critical threats—such as plant diseases, extreme weather conditions, or soil degradation—are addressed first to support the productivity and sustainability of Mulu Bebe banana farming in West Halmahera.

## RESULT AND DISCUSSION

### Characteristics of Mulu Bebe Farming

Banana Mulu Bebe is an iconic banana type spread in the West Halmahera Region (Hidayat et al., 2021). The characteristics of Mulu Bebe Banana farming in West Halmahera Regency based on the amount of production, production costs, revenue, and income are as follows in Table 5.

It is important to note that the production data for Mulu Bebe banana farming in the three villages Gamnyial, Campaka, and Hoku-Hoku Gam—reflect different scales of measurement that could cause apparent discrepancies. The average production values are reported in kilograms per hectare (Kg/Ha), representing productivity intensity, while the minimum and maximum production figures are expressed as total kilograms produced per year per farm (Kg/Year).

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

**Table 5.** Characteristics of Mulu Bebe Farming

| Description | Gamnyial | Taba Campaka | Hoku-hoku Gam |
|---|---|---|---|
| Total production (Kg/Ha/Year) | 12.660 | 11.775 | 9.750 |
| Production Cost (Rp/Year) | 418.467 | 515.172 | 401.724 |
| Revenue (Rp/Tahun) | 63.300.000 | 58.875.000 | 48.750.000 |
| Income (Rp/Kg/Year) | 62.881.353 | 58.359.828 | 48.348.276 |
| BCR | 150,20 | 113,28 | 120,35 |
| RCR | 151,20 | 114,28 | 121,35 |

Source: (Kaddas et al., 2023b)

This difference arises because farm sizes vary significantly between villages and among farmers within the same village. In Hoku-Hoku Gam Village, although the average production per hectare is relatively low at 321 Kg/Ha, the minimum and maximum total production per year (2,700 Kg and 10,800 Kg respectively) indicate larger average farm sizes compared to the other villages. This larger farm area accounts for the higher total production despite a lower per hectare yield.

The large standard deviation observed in Hoku-Hoku Gam (2,078.68 Kg) reflects high variability in production among farms, possibly due to differences in farm size, management practices, or environmental factors. Such variability should be considered when interpreting the risk analysis results. For clearer interpretation, future studies should include detailed data on farm size to allow normalization of total production figures. This will facilitate more accurate comparisons of production risk across different locations. (Hidayat et al., 2021).

Revenue is the value of products produced in one production or multiplication of the amount of production and selling price in units of Rp/Kg /Year (Sukantana, 2006). The acceptance of Mulu Bebe farming depends on the amount of production and selling price. The production of Mulu Bebe banana in West Halmahera Regency is 34,185 kg/year. The production of Mulu Bebe banana based on the results of interviews with respondents stated that banana production from the number of plants planted is only partially fruitful and harvested. Erratic harvest conditions make it necessary for farmers to cultivate other crops as intercrops. This condition can affect the productivity of banana plants due to less intensive cultivation systems and competition for plant nutrients.

Income or profit is an incentive obtained by farmers who allocate resources and conduct production for Mulu Bebe banana farming. The more profit earned the better because it can be reinvested into the business or as savings. The ratio of business results to costs (RCR) and the ratio of profits to costs (BCR) of Mulu Bebe banana farming in Halmahera Regency is feasible and profitable. This condition can affect the productivity of banana plants due to less intensive cultivation systems and competition for plant nutrients. Income or profit serves as an incentive for farmers who allocate resources and carry out production activities in Mulu Bebe banana farming. Higher profits are considered more favorable, as they can be reinvested into the farming business or saved as capital reserves, and the ratio of business results to costs (RCR) and the ratio of profits to costs (BCR) in Mulu Bebe banana farming in Halmahera Regency indicate that this agribusiness is both feasible and profitable.

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

These findings are in line with previous research conducted by (Franco et al., 2018), (Ronner et al., 2023) and (Ramírez-Orellana et al., 2021) on small-scale banana farming in other regions of Indonesia, which also showed positive RCR and BCR values, reflecting economic viability. Unlike previous studies that focused on more intensively managed or commercial banana plantations, this research highlights the potential profitability of a local banana variety—Mulu Bebe—under relatively less intensive cultivation. This adds a unique dimension to the literature by demonstrating that even traditional or semi-intensive farming systems can yield viable economic returns when risks are properly managed (Dulal & Kattel, 2020).

Bebe banana farming is a farm that farmers have run for a long time. Mulu Bebe banana farming is one of the commodities in addition to plantation commodities that can support farmers' income. Profitable and economically efficient farming can be analyzed using RCR. RCR shows the ratio between revenue and costs so that it can determine the level of farm efficiency (Suratiyah, 2015).

**Risk Analysis Banana Mulu Bebe Farming**

Risk is always a big challenge in every activity process. Risk becomes a benchmark for decision making in every possible event. While farming activities are activities that have high risk (Yanamisra, 2023). Mulu Bebe banana farming is a cultivation or production business to make profits selling crops. According to (Mitra et al., 2022) every business process always requires costs and means of production for business sustainability.

**Risk Production**

Production risk is a deviation of actual results from expected results so that it affects erratic production and experiences differences every harvest (Abdilah et al., 2022). Analysis of Production Risk of Mulu Bebe Banana Farming in West Halmahera Regency as follows;

**Table 6.** Risk Analysis of Mulu Bebe Banana Farming Production

| Description | Gamnyial | Campaka | Hoku-Hoku Gam |
|---|---|---|---|
| Average production (Kg/Ha) | 422,00 | 392,50 | 321,00 |
| Minimum Production (Kg/Year) | 180,00 | 225,00 | 2.700,00 |
| Maximum Produksi (Kg/Year) | 720,00 | 825,00 | 10.800,00 |
| Standart Deviation (Kg) | 138,58 | 169,07 | 2.078,68 |
| Coefficient Variance(CV) | 0,45 | 0,43 | 0,45 |
| Lower limit value (L) | 28,84 | 54,363 | 432,63 |

Source: Primary Data, IBM SPSS, 2024

The data shows differences in the average production of Mulu Bebe bananas across three villages, with Gamnyial Village producing the highest average yield of 422 Kg/Ha, followed by Campaka Village at 392.50 Kg/Ha, and Hoku-Hoku Gam Village with 321.00 Kg/Ha. Alongside these averages, the standard deviation values highlight the variability in production levels: Gamnyial and Campaka villages have moderate fluctuations with standard deviations of 138.579 Kg/Ha and 169.068 Kg/Ha, respectively, while Hoku-Hoku Gam Village shows a significantly higher variability at 2,078.684 Kg/Ha. This considerable variation in Hoku-Hoku Gam suggests inconsistent farming conditions or external factors affecting yield stability. Recognizing these differences is crucial for

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

formulating effective risk mitigation strategies tailored to each village's unique challenges, ultimately supporting more stable and increased production of Mulu Bebe bananas. The coefficient of variation (CV) value in each village is around 0.4 (Table 1). According to (Norhalis et al., 2020) and (Asminar et al., 2021) , if CV < 0.5 and L > 0, Mulu Bebe banana farmers will always avoid losses and low farm production risks. This is supported by geographical conditions and soil fertility in the West Halmahera area which has fertile volcanic soil.

Mulu Bebe banana farming is quite profitable to run to increase community income. However, Mulu Bebe banana farming has several risks faced by respondent farmers. Some of the risks identified in Mulu Bebe banana farming are detailed in Table 7.

**Tabel 7.** Risk Production and Control Effort of Mulu Bebe Banana Farming

| Risk Production | Control Efforts |
|---|---|
| Attacks by plant distrupting organisms | Controlling pest attacks (caterpillars) by mechanical means and weeds with herbicides |
| Technical errors in the production process | Conduct the production process following procedures or rules |
| Seed availability | cooperate with farmer groups to plant seedlings together |
| Planting area | Determining the right planting distance |
| Weather and climate influences | Choosing the right time for planting |

Source: Primary Data, 2024

Production risks faced by Mulu Bebe banana farmers and control efforts that have been made by farmers to minimize production events that often arise in Mulu Bebe banana farming. Production risk is an event that is often experienced by farmers in farming businesses such as banana farming in Turkey (Kizilay & Akçaöz, 2016; Waseem et al., 2020). The risks commonly encountered in Mulu Bebe banana farming include attacks by plant-disrupting organisms such as pests and diseases, mistakes in planting techniques, limited availability of quality seeds, constraints in suitable planting areas, as well as adverse weather and climate conditions. These factors can significantly affect both the quantity and quality of banana yields. Many of the risks in Mulu Bebe banana farming can be effectively managed through a combination of cultural and mechanical control methods. Mechanical controls typically include manual removal of pests and infested plant parts, hand weeding to reduce competition, and the use of physical barriers or traps to limit pest movement. For weed management, commonly used herbicides in the region include glyphosate and paraquat, applied carefully and selectively to minimize damage to banana plants while effectively controlling invasive weeds.

Adherence to proper cultivation practices plays a crucial role in mitigating risks. This includes following recommended planting guidelines, such as selecting healthy planting materials and maintaining optimal planting distances to reduce disease transmission and resource competition. Employing polyculture systems by intercropping with complementary plant species can enhance biodiversity, suppress pest populations naturally, and improve soil health. These integrated pest and weed management strategies contribute significantly to sustaining Mulu Bebe banana productivity and reducing vulnerability to production risks. Collaboration among farmer groups further supports

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

knowledge sharing and coordinated actions, while selecting the optimal planting period can mitigate the adverse impacts of climate variability (Salas-Zapata et al., 2023; Simas et al., 2021). Together these strategies form an integrated approach to controlling risks and sustaining productive Mulu Bebe banana farming in West Halmahera (Table 2).

Production risk arises from the uncertainty of production results (Ainun et al., 2022). Farmer respondents have indirectly been able to identify risks that have an impact on the production process of Mulu Bebe banana cultivation. The risks identified are the types of risks that are generally found in the production of crops. In line with the research of (Abdilah et al., 2022), the risks that usually occur in farming are plant-disrupting organisms, technical treatment in cultivation, weather, and climate. However, according to (Alhasany & Fatimah, 2022), production risk is the main risk for farmers even though in farming various risk factors determine the success of farming.

**Risk Income**

The income risk faced by farmers in developing the Mulu Bebe banana farming business is analyzed using the coefficient of variation (CV) calculation. The analysis of the income risk of the Mulu Bebe banana farming business is described as follows;

**Table 8.** Risk Income Analysis of Banana Farming Mulu Bebe

| Description | Gamnyial | Campaka | Hoku-Hoku Gam |
|---|---|---|---|
| Average of Income (IDR/Kg/Year) | 1.530.000 | 1.962.500 | 22.950.000 |
| Minimal of Income (IDR/Kg/Year) | 900.000 | 1.125.000 | 13.500.000 |
| Maximal of Income (IDR/Kg/Year) | 3.600.000 | 4.125.000 | 54.000.000 |
| Standart Deviation (Kg) | 692.894,98 | 845.340,9331 | 10.393.424,65 |
| Coeffisient Variance (CV) | 0,45 | 0,43 | 0,45 |
| Lower limit value (L) | 144.210,05 | 271.818,13 | 2.163.150,71 |

Source: Data olah IBM SPSS, 2024

The income data from the three villages—Gamnyial, Campaka, and Hoku-Hoku Gam—shows considerable variation, particularly in Hoku-Hoku Gam, where both the average and maximum income values are significantly higher than in the other two villages. This discrepancy is likely due to differences in farm sizes and production scales across the villages. Larger landholdings in Hoku-Hoku Gam allow farmers to produce and sell substantially more Mulu Bebe bananas, resulting in higher total income figures.

The standard deviation and coefficient of variation (CV) values also reflect this variability, with Hoku-Hoku Gam exhibiting a much larger standard deviation, indicating greater income dispersion among farmers. Despite these outliers, the coefficient of variation remains below 0.5 for all villages, suggesting that income risks are relatively moderate overall. The lower limit values further confirm that, even accounting for variability, farmers in all villages maintain positive income levels, reinforcing the viability of Mulu Bebe banana farming in the region.

The results of the analysis reveal the income risks associated with Mulu Bebe banana farming in West Halmahera Regency. Respondents reported a wide range of annual income from banana sales, varying between IDR 1,530,000 and IDR 22,950,000 per year. This variation reflects differences in

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

farm size, productivity, market access, and the effectiveness of risk management practices among farmers. Such a broad income range also highlights the economic uncertainty faced by farmers, emphasizing the need for strategies that can stabilize income, improve production efficiency, and enhance market opportunities. Addressing these income risks is critical to ensuring the sustainability and growth of Mulu Bebe banana farming in the region (Table 2). Analysis based on the coefficient of variance (CV) of income risk in several villages in West Halmahera Regency is smaller than 0.5 ($CV < 0.5$) and the lower limit value of production (L) is greater than 0 ($L > 0$). According to (Norhalis et al., 2020) and (Asminar et al., 2021), If $CV < 0.5$ and $L > 0$, Mulu Bebe banana farmers will always avoid losses and low farm production risk. According to (Saputro & Rianti, 2024), the ability of farmers to overcome risks can be done by strengthening the introduction of cultivation technology rather than increasing the amount of fertilizer and herbicide used to get profits quickly.

This condition does not rule out the possibility that there are no risks experienced by farmers in the Mulu Bebe banana farm. The results of the identification of the risk of Mulu Bebe banana farming income in West Halmahera Regency are presented in Table 4.

**Table 9.** Risk Income, and Control Efforts

| Risk Income | Control Efforts |
|---|---|
| Input/Fertilizer/Pesticide/Herbicide prices are expensive | Searching for materials that have similar functions at affordable prices |
| Low farmer selling price | Provision of inputs or rotational planting of seedlings with farmer groups in shifts |
| Banana fruit quality | Harvesting bananas at the right maturity; adjusting production to market demand |
| Consumer preference | Production according to market demand |
| Banana distribution infrastructure | Organize transportation routes and frequency of travel |

Source: Primary data, 2024

Sources of income risk and control measures have been taken by farmers in Mulu Bebe banana farming in West Halmahera Regency. Risks identified as detrimental to farmers' income can be addressed through low-cost products with the same quality and function, planting and collecting seedlings in groups and taking turns, proper harvesting and post-harvesting techniques, banana production according to market demand, and arranging transportation routes and travel frequency. The results of risk identification showed that pesticide/herbicide prices are expensive and far from the farm location, the selling price of banana fruit is low, poor fruit quality affects income, consumer preferences for banana fruit, and infrastructure that supports distribution (Table 4).

Factors triggering risk in farming include a less clean farming environment and lack of intensive care, resulting in the emergence of plant-disrupting organisms that can reduce the selling price of bananas, as well as the cost of fertilizers and pesticides/herbicides that are expensive. According to (Saputro & Rianti, 2024), income risk is related to the price received by farmers, especially the price of production inputs such as fertilizers and pesticides, because in farming farmers

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

cannot determine the price of products and production prices that will be borne so they can risk the income received (Rianti & Maula, 2023).

**Risk Level**

Risk in the agricultural sector is always inherent and widespread with the potential for serious impacts on stakeholders and consumers (Suryani et al., 2023) The results of the analysis of production risk and income risk based on the level of risk and priority of handling are as follows;

**Table 10.** Risk Level of Mulu Bebe Banana Farming

| **Risk Production** | **Control Efforts** | **Probability** | **Impact** | **Risk Level** |
|---|---|---|---|---|
| Attacks by plant-disrupting organisms | Controlling pest attacks (caterpillars) by mechanical means and weeds with herbicides | 4 | 2 | 12 |
| Technical errors in the production process | Conduct the production process per procedures or rules | 4 | 3 | 16 |
| Seed availability | Cooperate with farmer groups to plant seedlings together | 3 | 2 | 10 |
| Planting area | Determining the right planting distance | 3 | 2 | 10 |
| Weather and climate influences | Choosing the right time for planting | 3 | 2 | 10 |
| **Risk Income** | **Control Efforts** | **Probability** | **Impact** | **Risk Level** |
| Input/Fertilizer/Pesticide/Herbicide prices are expensive | Looking for materials that have similar functions at affordable prices | 4 | 2 | 12 |
| Low farmer selling price | Procure inputs or rotate planting seedlings with farmer groups in shifts | 3 | 3 | 14 |
| Banana fruit quality | Harvest bananas at the right maturity; Adjust production to market demand | 4 | 2 | 12 |
| Consumer preference | Production according to market demand | 2 | 2 | 7 |
| Banana distribution infrastructure | Adjust transportation routes and frequency of travel | 3 | 2 | 10 |

Source: Primary Data, 2024

The results of the analysis of the level of production risk and income risk of Mulu Bebe banana farming in West Halmahera are in the unacceptable risk category (Table 5). This condition indicates that the risk group on Mulu Bebe banana farming is in the category of unacceptable risk with the priority of handling risks by emphasizing roles and responsibilities if resources are still available. Based on the description of risk groups based on the level of risk that is not accepted and needs to be prioritized for handling in Mulu Bebe banana farming is depicted on the risk. This condition indicates that the risk level faced by Mulu Bebe banana farming falls into the category of unacceptable risk, requiring prioritized management efforts that emphasize clearly defined roles and responsibilities, especially when resources are limited. Similar findings were reported in previous studies on banana farming and other horticultural crops, where high-risk classifications demanded urgent attention to

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

risk mitigation strategies to prevent significant production and income losses (e.g., (Heenkenda & Chandrakumara, 2016; Provin et al., 2024; Svensson et al., 2018)). Unlike some earlier research focusing primarily on large-scale or commercial plantations, this study highlights the specific challenges in smallholder Mulu Bebe banana farming in West Halmahera. It underscores the importance of resource allocation and cooperative risk management among farmers to effectively reduce vulnerability and enhance farm resilience. The risk groups identified in this study provide a practical framework for prioritizing interventions, ensuring that critical risks are addressed promptly to sustain banana farming productivity and farmer livelihoods (Zake et al., 2015). The analysis shows the number of risk levels based on the risk group of Mulu Bebe banana farming in West Halmahera as follows;

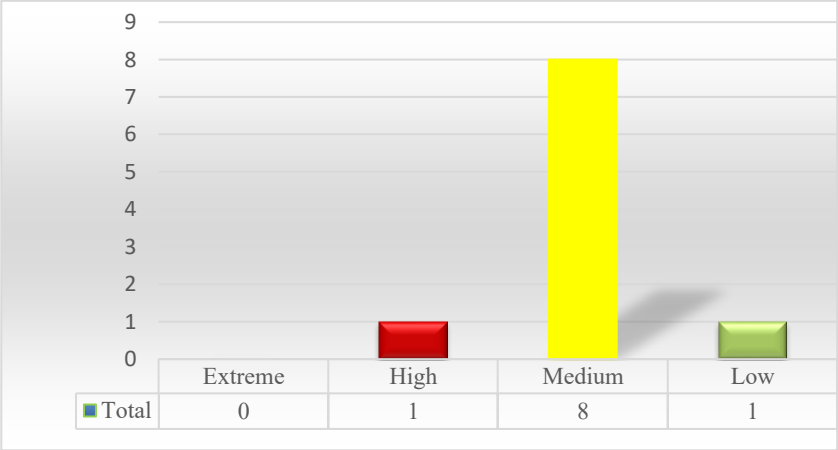


**Figure 1.** Risk Level of Production and Income Risk of Mulu Bebe Banana Farming in West Halmahera
Source: Primary data, 2024

The risk level analysis for Mulu Bebe banana farming shows that most identified risks fall into the medium category, with 8 risk factors classified as medium risk. Only one risk is rated as high, specifically technical errors in cultivation, while one risk is categorized as low, namely consumer preference. No risks were identified as extreme. These findings are illustrated in the figure, which clearly highlights that medium-level risks dominate the farming risk landscape. The medium risks include pest attacks, input prices such as fertilizers and herbicides, banana fruit quality, seed availability, planting area, weather and climate influences, and banana distribution infrastructure. This distribution underscores that while high-risk factors are limited, farmers frequently encounter a range of moderate challenges requiring consistent management and mitigation efforts. According to (Ainun et al., 2022), farming activities always involve imagining risk situations and taking action so that farmers behavior in making decisions to reduce risks and control various efforts in dealing with risks. Each farming business has different risks and risk management strategies depend on the farmer's ability to deal with them.

Risk management is an integral part of farming activity planning and is designed to reduce profits or eliminate risks that affect farming (Suryani et al., 2023). Several control efforts that have been carried out in the Mulu Bebe banana farming business are based on sources of production risk and income risk. Based on the risk map analysis, it is still affected and likely to occur (Figure 1). The

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

sources of risk and levels of risk faced in the Mulu Bebe banana farming business that need to be attempted to reduce the impact and possibility of the risk arising are:

a) Technical errors in farming (Table 5) such as the spacing of banana plants that grow in clusters will affect the quality and quantity of bananas. Based on the results of interviews, banana plants that are planted without considering field conditions such as spacing and selecting seeds that are not resistant to pests and diseases will produce poor bananas. This condition is because the spacing between bananas affects the growth of open banana leaves. Bananas should be planted with a polyculture pattern, as stated by (Triwidodo et al., 2020), planting bananas with a monoculture pattern can trigger a pest explosion. Pests and diseases that often interfere with plants that farmers face is root rot so farmers have to cut down trees that have been attacked.
b) Input prices (Table 5) such as fertilizers and herbicides can reduce farmers' profits and even cause losses for farmers. The results of respondent interviews stated that the cost of purchasing weed killers is currently expensive. The expensive cost of production inputs such as fertilizers and herbicides can reduce the productivity of Mulu Bebe bananas because the nutrients needed by the plants cannot be met by farmers and plant growth is not optimal. Meanwhile, farmers cannot increase the selling price of their harvest. Risk control efforts that have been carried out are using mechanical methods to eradicate weeds and spraying on weeds. However, this effort will still be risky if used not by the procedure. But sometimes farmer cannot predict how much rain will fall or wheather condition. They do not know if therw will be problems with diseases of crop (Baki, 2019).
c) The quality of Mulu Bebe banana fruit (Table 5) is greatly influenced by several factors in cultivation to post-harvest. The quality of Mulu Bebe banana fruit is a critical factor influencing both marketability and farmer income. These bananas are known for their distinct taste, texture, and size, which differentiate them from other common banana varieties. The fruit typically exhibits a firm texture with a balanced sweetness, making it favorable for both fresh consumption and processing. Quality parameters such as fruit size uniformity, peel color, sugar content, and resistance to bruising during harvest and transportation are essential to meet consumer preferences and market standards. Maintaining high fruit quality requires careful management throughout the cultivation process, including timely harvesting at optimal ripeness and minimizing damage during handling. External factors such as pest attacks, diseases, and environmental stress can negatively impact fruit quality, underscoring the need for effective risk control measures in banana farming, farmers can achieve better prices and strengthen the competitiveness of Mulu Bebe bananas in local and potentially wider markets by ensuring consistent and superior fruit quality. Changes in the quality of banana fruit can cause a decrease in selling value and even losses for farmers. The condition of the quality of banana fruit can be triggered by the use of weed killers/herbicides commonly used by farmers with excessive or inappropriate doses, lack of nutrients, or uncertain weather conditions. Thus, affecting the productivity and production of Mulu Bebe bananas.
d) The availability of Mulu Bebe banana seedlings (Table 5) is the key to success in farming. Nursery is the first step in cultivation and farming where farmers get quality seedlings, multiply plants, increase income, and maintain the superiority of Mulu Bebe bananas. However, based on

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

observations, Mulu Bebe banana farmers generally do not carry out Mulu Bebe nurseries as a stock of Mulu Bebe bananas in the planting area. Mulu Bebe Bananas, although they are an endemic plant icon in West Halmahera (Hidayat et al., 2021). However, Mulu Bebe Banana cultivation is less popular with farmers. This is because the purchase price of bananas offered by collectors is lower than the market price. This condition can be risky for the sustainability of Mulu Bebe banana farming.

e) Planted area (Table 5) in Mulu Bebe banana production also affects the quality and quantity of Mulu Bebe bananas. (Mitra et al., 2022) stated that if the production costs and the area of cultivation incurred are large, then the income obtained by farmers is also large. The average banana farmer in West Halmahera Regency has a garden area of around 1 - 2 Ha with different locations. Each farmer's garden is planted with polyculture with different planting blocks. The Mulu Bebe bananas planted are around 50 - 100 banana trees. However, Mulu Bebe banana farmers can only harvest + 50% of the total planted. So it is less attractive to farmers. This was stated by (Maharani et al., 2023) that the area of land is at risk of production costs incurred but has a positive effect on income.
f) Weather and climate (Table 5) pose a risk to Mulu Bebe banana farming. Excessive rainfall can cause waterlogging and low rainfall can cause drought. Weather and climate are conditions that cannot be controlled so they can pose risks in farming. The impact of weather and climate can cause damage to plants, decreased fruit quality, and decreased harvest yields. Respondent farmers have their local wisdom in cultivating Mulu Bebe bananas, such as choosing the time to plant Mulu Bebe bananas during the full moon or at the end of the month so that banana plants are resistant to weather conditions. However, this condition will be different due to global climate change. According to (Siswani et al., 2022) the adaptation efforts that farmers need to make in dealing with climate conditions are to determine planting patterns and planting calendars that take climate conditions into account.
g) Consumer preferences (Table 5) is low risk faced in farming. This risk is an acceptable risk with priority handling if resources are still available. Consumer preferences are risks that cannot be controlled by farmers. Farmers can only set planting and harvest times so that the availability of Mulu Bebe bananas can meet consumer needs. This risk needs to be handled because it can be financially detrimental to farmers and there is an abundance so that the distribution of bananas to the market or consumers remains at all times. According to respondents, bananas that are in high demand by consumers are raja bananas and kepok bananas compared to Mulu Bebe bananas. In line with (Rumapea et al., 2022) opinion that producers or farmers need to know the right marketing strategy according to demand.

Explanation of risks in Mulu Bebe banana farming based on identification results is included in the medium risk group and is unacceptable. So, it needs to be handled by emphasizing the roles and responsibilities in Mulu Bebe banana farming. According to (Siswani et al., 2022), farmers need to understand the risks and their control so that they can prepare strategic plans that can be implemented to deal with risks both before, during and after the farming is carried out to reduce and control the risks experienced. This condition also refers to the behavior of farmers in dealing with risks, according to (Asmara et al., 2022) farmers are categorized into 2 (two) behavioral groups in

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

dealing with risks, namely risk averse and risk taker. Where between the two behaviors, risk-taker farmers tend to be more efficient in improving their farming management strategies by applying technology. While risk averse farmers improve their management strategies using superior seeds to gain profit. So, it can be concluded that the type of farmer behavior category in managing Mulu Bebe banana farming in West Halmahera Regency is included in the risk taker category.

## CONCLUSION AND SUGGESTION

The risk analysis of Mulu Bebe banana farming in West Halmahera district reveals that production and income risks are generally moderate, with coefficient of variation (CV) values below 0.5 and positive lower limits indicating farmers tend to avoid losses. However, several risks remain, ranging from high risks due to technical cultivation errors to medium risks involving pest attacks, input price volatility, seed availability, land area, climate variability, and distribution infrastructure. To strengthen the sustainability and profitability of Mulu Bebe banana farming, targeted policy interventions and institutional support are crucial. Key recommendations include:

1) Implementing comprehensive technical training programs for farmers to reduce cultivation errors and improve farm management.
2) Promoting integrated pest management systems to effectively control pest damage and safeguard banana quality.
3) Facilitating stable access to affordable inputs through cooperative purchasing schemes or government subsidies.
4) Ensuring reliable seed distribution and land-use support to secure planting materials and cultivation area.
5) Encouraging climate-resilient farming practices and infrastructure improvements like irrigation to mitigate weather-related risks.
6) Upgrading distribution and market infrastructure to reduce post-harvest losses and improve market access.
7) Supporting ongoing market research to monitor and respond to consumer preference shifts.

Policymakers and agricultural institutions should prioritize these actions to reduce vulnerabilities in Mulu Bebe banana farming and enhance farmer resilience. Coordinated efforts across technical extension services, financial support, and infrastructure development will be essential to sustain this important agricultural sector in West Halmahera.

## REFERENCES

Abdilah, A., Rofatin, B., & Tedjaningsih, T. (2022). Risiko Produksi Usahatani Padi Organik di Desa Jatisari Kecamatan Subang Kabupaten Kuningan. *Jurnal Agristan*, *4*(1), 94–103.

Achmad, B Sanudin Siarudin, M wIDIYANTO, A Diniyatim D Sudomo, A rUSWANDI, A. (2022). Traditional subsistence farming of smallholder agroforestry systems in Indonesia: A review. *Sustainability*, *14*(4), 8631.

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

Ainun, Y., Mardiyati, S., & Nadir. (2022). Risiko Produksi dan Pendapatan Usahatani Kedelai di Kecamatan Galesong Kabupaten Takalar. *Jurnal Agribisnis Unisi*, *11*(2), 35–41.

Akeaoz, H., Ozcatalbas, O., & Kizilay, H. (2009). Risk Management and Sustainability in Banana Production : A Case Study from Turkey. *Jouynal of Food, Agricultur & Enviroment*, *7*(2), 2830294.

Alhasany, P. F., & Fatimah, S. (2022). Komunikasi Risiko Usahatani Kentang di Luar Daerah Sentra Produksi : Studi Kasus Kelompok Tani Palintang Jaya Desa Cipanjalu Kecamatan Cilengkrang Kabupaten Bandung. *Jurnal Agrikultura*, *33*(2), 147–160.

Asmara, R., Mamilianti, W., Hanan, N., & Mustadjab, M. M. (2022). Potato Fluctuation and Risk Preference of Potato Farming in the Bromo Plateau, Indonesia. *Agrivita : Journal of Agricultural Science*, *44*(2), 225–234.

Asminar, Riki, & Susilawati, W. (2021). Analisis Risiko Usahatani Kelapa Sawit di Kecamatan Limbur Lubuk Mengkuang Kabupaten Bungo. *Jurnal Agri Sains*, *5*(1), 95–106.

Baki, M. B. Z. (2019). *Risk Identification and Risk Assesment of Banana Plantation in Jeli, Kelantan*. Universiti Malaysia Kelantan.

Chen, K., Tian, G., Tian, Z., Ren, Y., & Liang, W. (2022). Evaluation of the coupled and coordinated relationship between agricultural modernization and regional economic development under the rural revitalization strategy. *Agronomy, 12*(5), 990.

Choudhary, D., Banskota, K., Khanal, N. P., McDonald, A. J., Kruprik, T. J., & Erenstein, O. (2022). Rice subsector development and farmer efficiency in Nepal: implications for further transformation and food security. *Frontiers in Sustainable Food Systems*, *5*, 740546.

Dadi, Z., & Kholil. (2020). Analisis Rantai Pasok Pisang Mulu Bebe di Kecamatan Sahu Timur. *Agrikan : Jurnal Agribisnis Perikanan*, *13*(2), 419–425.

Del Olmo-García, F., Domínguez-Fabián, I., Crecente-Romero, F. J., & Del Val-Núñez, M. T. (2023). Determinant factors for the development of rural entrepreneurship. *Technological Forecasting and Social Change*, *191*, 122487.

Dulal, S., & Kattel, R. R. (2020). Resource use efficiency of banana production and impact of insurance scheme adoption on banana farming in Chitwan, Nepal. *International Journal of Applied Sciences and Biotechnology*, *8*(2), 170–178.

Franco, D., Singh, D. R., & Praveen, K. V. (2018). Evaluation of adoption of precision farming and its profitability in banana crop. *Indian Journal of Economics and Development*, *14*(2), 225–234.

Ghozali, M. R., & Wibowo, R. (2019). Analisis Risiko Produksi Usahatani Bawang Merah di Desa Petak Kecamatan Bagor Kabupaten Nganjuk. *Jurnal Ekonomi Pertanian Dan Agribisnis*, *3*(2), 294–310.

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

Giller, K. E., Delaune, T., Silvam, J. V, Descheemaeker, K., Van De Ven, G., Schut, A. G., & Van Ittersum, M. K. (2021). The future of farming: Who will produce our food? *Food Security*, *13*(5), 1073–1099.

Guanyi, Y., Liming, L., Xiaoxing, Q., Chengcheng, Y., & Dong, Z. (2015). Environmental risk assessment in high intensive farming area based on material flow analysis. *Transactions of the Chinese Society of Agricultural Engineering*, *31*(5).

Heenkenda, S., & Chandrakumara, D. P. S. (2016). Entrepreneurial skills and farming performance: Implications for improving banana farming in Sri Lanka. *International Journal of Humanities and Social Sciences*, *7*(1), 14–26.

Hidayat, Y., Cahyaningrum, H., Ramdhani, M., Brimadyasti, S. V, NAFIAH, A., & HUDAYANA, M. H. (2021). *Mulu Bebe : Pisang Unggulan Maluku Utara*. Balai Besar Pengkajian dan Pengembangan Teknologi Pertanian.

Huangfu, Y., Yu, H., Dong, Z., & Wang, Y. (2024). Research on the Risk Spillover among the Real Economy, Real Estate Market, and Financial System: Evidence from China. *Land*, *13*(6), 890.

Kaddas, F., Ibrahim, K., & Baguna, F. L. (2023a). Feasibility Analysis and Income Contribution of Banana Mulu Bebe Farming, West Halmahera District. *Agrikan Jurnal Agribisnis Perikanan*, *16*(2), 382–388.

Kaddas, Fatmawati., Ibrahim, K., & Baguna, F. L. (2023b). Feasibility Analysis and Income Contribution of Banana Mulu Bebe Farming, West Halmahera District. *Agrikan : Jurnal Agribisnis Perikanan*, *16*(2), 382–388.

Kapari, M., Hlophe-Ginindza, S., Nhamo, L., & Mpandeli, S. (2023). Contribution of smallholder farmers to food security and opportunities for resilient farming systems. *Frontiers in Sustainable Food Systems*, *7*, 1149854.

Khatri, P., Kumar, P., Shayka, K. S., Kirlas, M. C., & Tiwari, K. K. (2024). Understanding the intertwined nature of rising multiple risks in modern agriculture and food system. *Environment, Development and Sustainability*, *26*(9), 24107–24150.

Kitole, F. A., Mkuna, E., & Sesabo, J. K. (2024). Digitalization and agricultural transformation in developing countries: Empirical evidence from Tanzania agriculture sector. *Smart Agricultural Technology*, *7*, 100379.

Kizilay, H., & Akçaöz, H. (2016). Farm-Specific Risk Analysis in Dairy Farming: A Case Study from Turkey. *Turkish Journal of Agriculture-Food Science and Technology*, *4*(7), 545–551.

Maharani, I. M., Hanani, N., & Syafrial, S. (2023). Bagaimana Petani dalam Pengelolaan Risiko? Persepsi dan Perilaku Petani Tebu di Jawa Timur. *Jurnal Sosial Ekonomi Pertanian*, *13*(1), 92–98.

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

Mardiana, A., Widayanti, S., Soedarto, T., & Atasa, D. (2022). *Analisis Manajemen Risiko Usahatani Tembakau di Desa Prancak Kecamatan Pasongsongan Kabupaten Sumenep*. *9*(2), 680–898.

Mitra, Y., Milla, A. N., & Tsani, A. (2022). Analisis Risiko Produksi dan Pendapatan Usahatani Kubis di Desa Pasir Datar Indah Kecamatan Caringin Kabupaten Sukabumi. *Jurnal Agrikultura*, *33*(3), 257–265.

Monteiro, A., Santos, S., & Goncalves, P. (2021). Precision agriculture for crop and livestock farming—Brief review. *Animals*, *11*(8), 2345.

Norhalis, Iksan, S., & Fajeri, H. (2020). Analisis Risiko Usahatani Semangka di Desa Muning Tengah, Kecamatan Daha Selatan Kabupaten Hulu Sungai Selatan. *Frontier Agribisnis*, *1*(4), 55–62.

Oladimeji, Y. U., Galadima, S. A., Hassan, A. A., Sanni, A. A., Abdulrahman, S., Egwuma, H., Ojeleye, A. O., & Yakubu, A. (2019). Risk analysis in fish farming systems in Oyo and Kwara States, Nigeria: A prospect towards improving fish production. *Animal Research International*, *16*(1), 3226–3237.

Pratama, J. A. (2019). *Analisis Tingkat Risiko Usahatani Salak di Desa Rumah Lengo Kecamatan Sinembah Tanjung Muda Hulu Kabupaten Deli Serdang*. Universitas Sumatera Utara.

Provin, A. P., d'Alva, A. M., de Aguiar Dutra, A. R., de Andrade, J. B. S. O., & Cubas, A. L. V. (2024). Closing the cycle: circular economy strategies for the textile industry using banana farming waste. *Journal of Cleaner Production*, 143352.

Ramírez-Orellana, A., Ruiz-Palomo, D., Rojo-Ramírez, A., & Burgos-Burgos, J. E. (2021). The Ecuadorian banana farms managers' perceptions: Innovation as a driver of environmental sustainability practices. *Agriculture*, *11*(3), 213.

Rianti, T. S., & Maula, L. R. (2023). Analisis Risiko Harga dan Pendapatan Usahatani Cabai Rawit di Kabupaten Kediri. *Jurnal Agrimanex*, *3*(2), 149–158.

Ronner, E., Van De Ven, G. J., Nowakunda, K., Tugumisirize, J., Kayiita, J., Taulya, G., Uckert, G., & Descheemaeker, K. K. E. (2023). What future for banana-based farming systems in Uganda? A participatory scenario analysis. *Agricultural Systems*, *209*, 103669.

Rumapea, E., Roessali, W., & Prasetyo, E. (2022). Analysis of Consumer Attitudes and Preferences to Banana Purchase Decisions in The Traditional Market of Semarang City. *Agrosocionomics : Jurnal Sosial Ekonomi Dan Kebijakan Pertanian*, *6*(1), 90–104.

Salas-Zapata, W. A., Ramos-Hernández, I. T., Gómez, D. M., Jaramillo-Arango, J. A., Aristizabal-Tique, V. H., & Vélez-Hoyos, F. J. (2023). Knowledge, attitudes, and practices of banana farm workers regarding water management and associated factors. *International Journal of Agricultural Sustainability*, *21*(1), 2219593.

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

Saputro, A. J., & Rianti, T. S. (2024). Tingkat Risiko Pendapatan dan Faktor yang Mempengaruhi Pendapatan Usahatani Tebu Keprasan. *Jurnal Sosial Ekonomi Pertanian*, *20*(1), 1–10.

Simas, J. M. M., Yamauchi, L. Y., & Alencar, M. do C. B. de. (2021). Risk factors associated among respiratory health and banana farming. *Archives of Environmental & Occupational Health*, *76*(4), 181–187.

Siswani, S. P., Rosada, I., & Amran, F. D. (2022). Analisis Risiko dan Faktor-Faktor yang Mempengaruhi Produksi Usahatani Jagung (Zea Masys L.) (Studi Kasus di Desa Bonto Majannang, Kecamatan Sinoa, Kabupaten Bantaeng). *Wiratani : Jurnal Ilmiah Agribisnis*, *5*(2), 116–124.

Sukantana, I. K. (2006). Kontribusi Pendapatan Usahatani Ubi Jalar terhadap Pendapatan Total Rumah Tangga. *Jurnal Agrijati*, *3*(1), 42–50.

Suratiyah, K. (2015). *Ilmu Usahatani*. Penebar Swadaya.

Suryani, A., Masyhuri., Waluyati, L., & Utami, A. W. (2023). Risk Analysis on the Cassava Value Chain in Central Lampung Regency. *Agraris: Journal of Agribusiness and Rural Development Research*, *9*(2), 150–170.

Svensson, O., Bellamy, A. S., Van den Brink, P. J., Tedengren, M., & Gunnarsson, J. S. (2018). Assessing the ecological impact of banana farms on water quality using aquatic macroinvertebrate community composition. *Environmental Science and Pollution Research*, *25*, 13373–13381.

Triwidodo, H., Tondok, E. T., & Shiami, D. A. (2020). Pengaruh Varietas dan Umur Tanaman Berbeda terhadap Jumlah Populasi dan Tingkat Serangan Hama dan Penyakit Pisang (Musa sp.) di Kabupaten Sukabumi. *Agrikultura*, *31*(2), 68–75. https://doi.org/10.24198/agrikultura.v31i2.27077

Wang, H., Wu, W., Xiong, L., & Wang, F. (2024). Is there an environment and economy tradeoff for the National Key Ecological Function Area policy in China? *Environmental Impact Assessment Review*, *104*, 107347.

Waseem, R., Mwalupaso, G. E., Waseem, F., Khan, H., Panhwar, G. M., & Shi, Y. (2020). Adoption of sustainable agriculture practices in banana farm production: A study from the Sindh Region of Pakistan. *International Journal of Environmental Research and Public Health*, *17*(10), 3714.

Yanamisra, T. (2023). *Risiko Produksi dan Harga Usahatani Rumput Laut di Kabupaten Takalar Provinsi Sulawesi Selatan*. Institut Pertanian Bogor.

Yeomans, L., Codlin, M. C., Mazzucato, C., Dal Bello, F., & Demarchi, B. (2024). Waterfowl eggshell refines palaeoenvironmental reconstruction and supports multi-species niche construction at the Pleistocene-Holocene transition in the Levant. *Journal of Archaeological Method and Theory*, *31*(3), 1383-1429.

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 9 (3): 915 -935, November 2025

Zake, J., Pietsch, S. A., Friedel, J. K., & Zechmeister-Boltenstern, S. (2015). Can agroforestry improve soil fertility and carbon storage in smallholder banana farming systems? *Journal of Plant Nutrition and Soil Science*, *178*(2), 237–249.