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# PREVENTIVE RISK MANAGEMENT STRATEGY FOR HYDROPONIC LETTUCE PRODUCTION AT CV SPIRIT WIRA UTAMA TANGERANG SELATAN BANTEN

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**Abstract.** Agribusiness companies face various risks during their production period, which can harm their operations. For instance, CV Spirit Wira Utama, a company engaged in lettuce production, experiences an average of 25% harvest loss due to unmarketable quality. Therefore, preventive measures are necessary to reduce the impact of risk losses. This study aims to identify and measure the risks associated with hydroponic lettuce crop production, map them, and develop preventive risk management strategies. The research design used primary data sources from CV Spirit Wira Utama in South Tangerang, Banten. Data collection involved observation, systematic interviews, and structured questionnaires. Risk measurement was carried out during the lettuce production process using hydroponic systems. The analysis tool used fishbone diagrams, house of risk (HOR), and Pareto diagrams. The results showed that there were 35 risk events and 41 risk agents in lettuce crop production. The preventive risk management strategy should be given to the highest risk measurement value, which is the water temperature in the nutrient toren exceeding 27 C. The risk mapping results obtained a total of 22 risk agents with an impact of 80%, making them a top priority for risk prevention strategies. There are 29 risk prevention strategies available to prevent future risk events. This study's results are vital as the combination of three analytical tools can detect in detail the risks that arise and their impact. This information can help mitigate these risks and serve as a basis for preparing production risk SOPs.

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## INTRODUCTION

Agriculture has become an important global economic activity through food trade. Due to the global COVID-19 pandemic, there was a destabilization of global food markets (Kalogiannidis, 2020), disrupting the supply of raw agricultural materials and food products (Belitski, Guenther, Kritikos, & Thurik, 2022). In addition, climate change, such as El Niño, has made food self-sufficiency essential through innovative solutions to improve production. Hydroponics has become an alternative to enhance the yield, growth, and quality of crops, especially horticulture (Chabla, et al., 2019). The hydroponic planting technique uses water as a medium to meet the plant's nutrient requirements (Nguyen, McInturf, & Mendoza-Cózatl, 2016). Several hydroponic agricultural techniques have become popular in urban farming (Crisnapati, Wardana, & Hermawan, 2017), and they can be operated on medium and small scales (Velazquez-Gonzalez, Garcia-Garcia, Ventura-Zapata, Barceinas-Sanchez, & Sosa-Savedra, 2022). The majority interest in commercial hydroponics is currently relatively small, but it is progressively becoming a growing commercial industry (Lennard & Ward, 2019).

On the other hand, agribusiness companies always face various risks in their agricultural activities (Iskandar, Prasetyowati, & Anwar, 2024), especially due to the perishable nature of agricultural products. Sources of risk can arise from risks of investment, socio-economic, environmental, production, and market (Ali & Kapoor, 2008; Asci, VanSickleb, & Cantliffec, 2014). Understanding risks and risk management helps producers make informed decisions (Wastra & Mahmubi, 2013). The presence of production risks affects the income received by the company (Anugrah, Arifin, & Suryani, 2021). However, these risks are offset by the potential for very promising profit (Damayanti, Nurchaini, & Ulma, 2023). Therefore, identifying the source of risk is crucial in the decision-making process to anticipate the risk.

The application of risk analysis tools has been conducted by several researchers, including: (Wahyuni, Nazaruddin, Muharrami, & Budiman, 2021) on halal risks in risoles cake, (Wahyudin & Santoso, 2016) on yogurt products, both using House of Risk and Pareto Diagram, while (Kurniasih, Syaukat, Nurmalina, & Suharno, 2023) used Fishbone and FMEA (Failure Modes and Effects Analysis) to analyze farmers' perception of the criticality of garlic farming business. The House of Risk (HOR) approach can be combined with analysis tools such as SCOR (Supply Chain Operation Reference) and why analysis on supply chain risks (Rozudin & Mahbubah, 2021). This research uses a combination of Fishbone as a tool to detect risk occurrence and risk causes in hydroponic lettuce farming, followed by risk mapping through a Pareto Diagram and risk mitigation with HOR phases 1 and 2. The novelty of this study is the use of a combination of three risk analysis tools in hydroponic lettuce farming. The importance of this research lies in the result which provides a risk prevention strategy that can be applied by hydroponic lettuce farming companies, ensuring that similar risks will not occur again in the future.

In the case of production risk faced by CV Spirit Wira Utama in South Tangerang, Banten, approximately 25% of the lettuce harvest is discarded due to poor quality making it unfit for sale. There are various sources of risks causing the lettuce to be wasted, including air temperature and nutrient solution temperature in the hydroponic system. Operational constraints of the NFT hydroponic system devices also add to the production risk. Therefore, the objectives of this study are: 1) to identify events and sources of production risks in hydroponic lettuce farming, 2) to measure and map production risks, and 3) to analyze preventive risk management strategies as risk mitigation at CV Spirit Wira Utama.

## METHOD

The object observed in this study is the risks involved in the entire activity of the lettuce production process using the NFT hydroponic system at CV Spirit Wira Utama in South Tangerang, Banten, during mid-2022. This research follows a quantitative approach, with primary data sources including risk events, risk causes, and risk management strategies. The key informants for this study are the CEO (company owner), the Manager of Marketing/Logistics, and the Head of Production.

The data collection method used is an observation method at various stages of the production process to identify the risks affecting lettuce production. Data completeness was obtained through systematic interviews, structured questionnaires, and literature studies. The questionnaire responses, measured using Likert and ordinal scales, were then processed through data selection, coding, and tabulation using Excel. The data was subsequently analyzed using a risk measurement approach and risk management strategies, utilizing analysis tools such as the Fishbone Diagram, House of Risk, and Pareto Diagram, as outlined in the following conceptual framework.

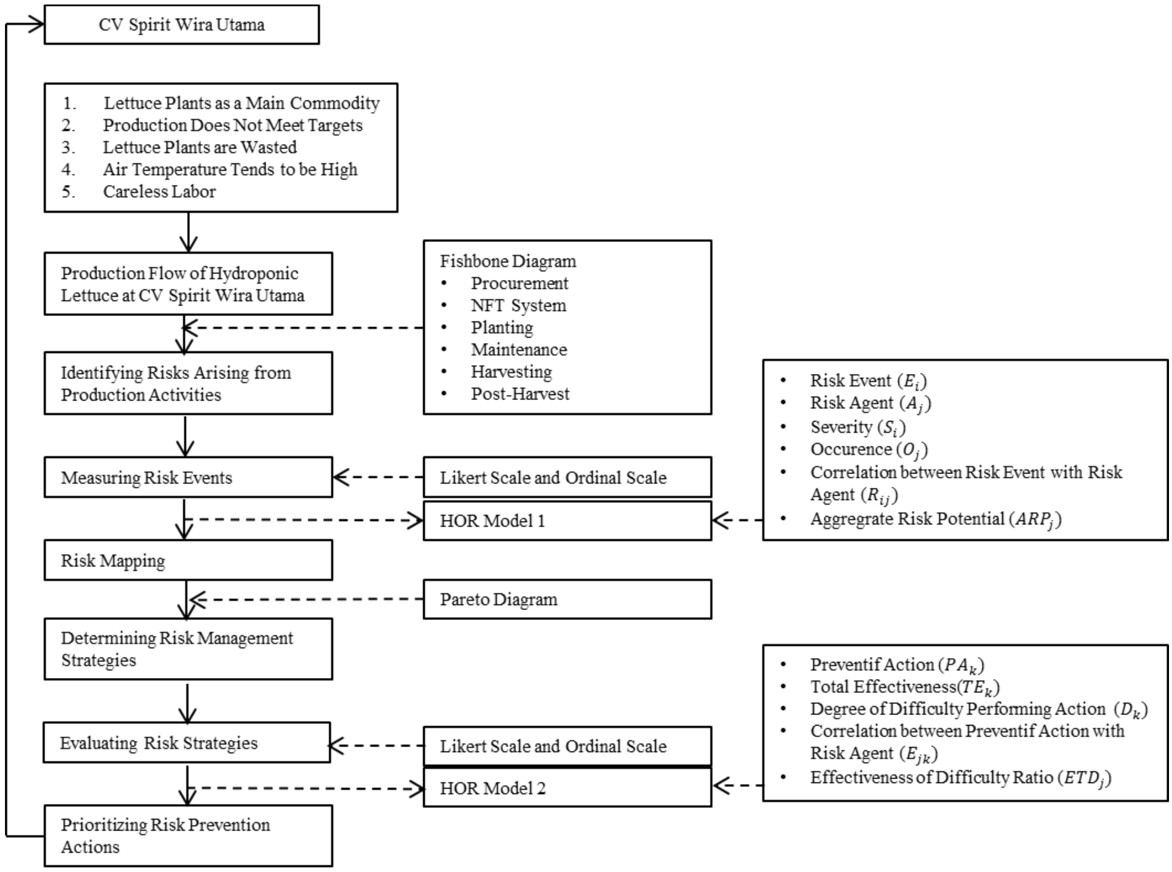


**Figure 1. Conceptual Framework for Preventive Risk Management Strategies in Hydroponic Lettuce Production at CV Spirit Wira Utama, South Tangerang, Banten**

Note: → research process flow, and → measurement and analysis tools

In the stage of constructing the Fishbone diagram, the research problem is placed at the head of the fish, while the risk events and causes are placed on the fishbone. The process classification-type Fishbone, which includes materials, process I, process II, process III, and problems (Kuswandi & Mutiara, 2004), allows for the detection of potential risks in the six stages of lettuce production at CV Spirit Wira Utama. The hydroponic lettuce production process consists of procurement, NFT system, planting, maintenance, harvesting, and post-harvest stages. Through this Fishbone diagram, risk events (Ei) and their causes (Aj) in all activities of the hydroponic lettuce production process can be identified.

The HOR method can be used to proactively control risks by addressing emerging risks (risk events) caused by risk sources (risk agents). HOR phase 1 is used to measure the potential risk, and HOR phase 2 provides prevention strategies for the risk sources (Pujawan & Geraldin, 2009). From HOR phase 1, the calculation of the overall risk potential or aggregate risk potential (ARPj) can be performed as follows:

$$ARP_j = O_j \; \Sigma \; S_i R_{ij} \ldots\ldots\ldots\ldots (1)$$

Where Oj is the likelihood of occurrence of risk source j, Si is the severity level of risk effect i occurring, and Rij is the correlation between risk source j and risk event i (indicating how likely risk source j is to cause the occurrence of risk event i). The variables Oj and Si are measured on a Likert scale of 1-5, while Rij is measured on a scale of 0, 1, 3, and 9.

The Pareto model is very popular in risk management (Charpentier & Flachaire, 2019). The Pareto Diagram is used to identify risk agents that have a significant impact on the company to determine risk prevention strategies in each of its processes (Bairwa, Kushwaha, & Bairwa, 2013). This Pareto Diagram illustrates the 80/20 principle, meaning that 20% of the key parts of a problem contribute to 80% of the resulting impact (Powell & Sammut-Bonnici, 2017). After identifying the most influential risk cause of hydroponic lettuce production in the Pareto Diagram, the next step is to measure risk management strategies through House of Risk (HOR) Phase 2 (Pujawan & Geraldin, 2009). The effectiveness-to-difficulty ratio (ETDk) is calculated using the formula:

$$ETD_k = TE_k / D_k \ldots\ldots\ldots\ldots (2)$$

$TE_k$ is the total effectiveness of risk cause and $D_k$ is the difficulty level in implementing preventive actions to reduce the cause of risk, which is measured on a Likert scale of 1-5.

## RESULT AND DISCUSSION

### *Identification of Events and Causes of Lettuce Production Risks*

Risk identification is conducted through observation, interviews with informants, and related literature based on the process classification-type Fishbone diagram (Figure 2). All activities in the lettuce production process are depicted on each fishbone. The problem under study, which is the production risk of hydroponic lettuce, is listed at the head of the fish. In the body of the fishbone, there are six stages of lettuce production at CV Spirit Wira Utama where risks may occur, namely procurement, NFT system, planting, maintenance, harvesting, and post-harvest. From the body of the fishbone, several fishbone spines serve as indicators. The total number of indicators for hydroponic lettuce production at CV Spirit Wira Utama is 21 indicators. This section of the indicators is where 'risk events' or risk occurrences (Ei) arise, and each small spine of the fishbone has a critical point as the cause or risk agent (Aj).

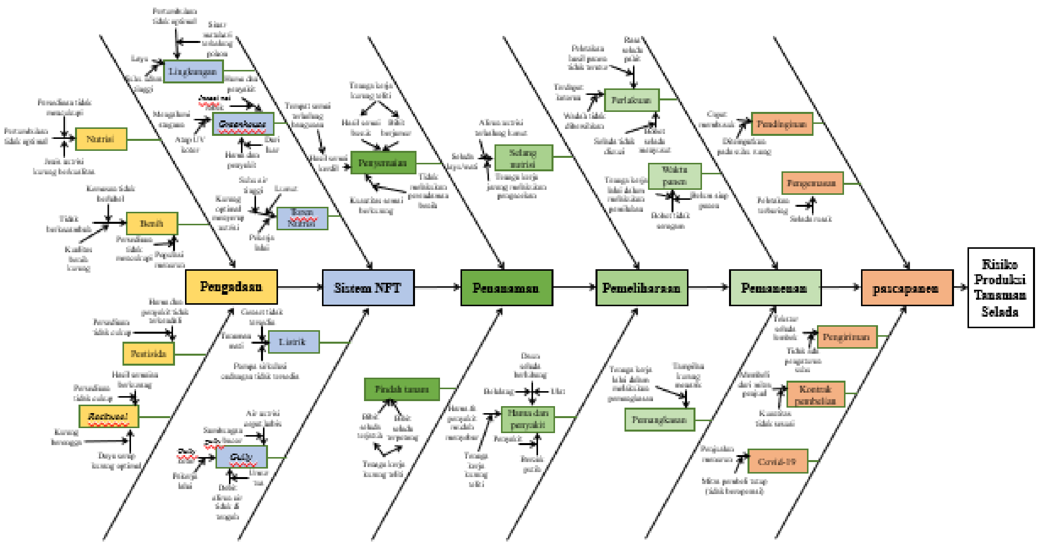


**Figure 2. Identification of Risk Events (Ei) and Risk Causes (Aj) in Hydroponic Lettuce Production Using Process Classification-Type Fishbone Diagram (in Indonesian Language)**

Here is the explanation of Figure 2 regarding the risk indicators in lettuce production:

1. Procurement stage: Four indicators are critical points in lettuce production: availability of nutrients, seeds, pesticides, and rock wool. There are 6 risk events (Ei) and 8 risk causes (Aj),
2. NFT system: 5 indicators are critical points in lettuce production: environment, greenhouse, nutrient tank, electricity, and drainage. There are 10 risk events (Ei) and 13 risk causes (Aj),
3. Planting stage: Two indicators are critical points in lettuce production, namely seedling for 3-4 days and transplanting (2 times). There are 6 risk events (Ei) and 4 risk causes (Aj),
4. Maintenance process (14-20 days): Two indicators are critical points in lettuce production, namely nutrient interval and pest diseases. There are 4 risk events (Ei) and 5 risk causes (Aj),
5. Harvesting stage (when the lettuce plants are 30 days old): Three indicators are critical points in lettuce production, namely treatment, harvest time, and pruning. There are 5 risk events (Ei) and 6 risk causes (Aj),
6. Post-harvest stage: Five indicators are critical points in lettuce production which are cooling, packaging, shipping, purchase contracts, and COVID-19. There are 5 risk events (Ei) and 5 risk causes (Aj).

### *Measuring Risk Causes of Lettuce Production*

Based on the risk indicators identified through the fishbone diagram and the completion of questionnaires by informants to measure the frequency of risk events (Oj), the severity of risk impacts (Si), and the correlation between risk events and risk causes (Rij), the measurement of lettuce production risks using House of Risk (HOR) Phase 1 can be calculated. The potential risk value for each indicator is obtained through the aggregate risk potential (ARPj) as follows:

**Table 1. Measuring Risk Event Frequency (Oj) and Aggregate Risk Potential (ARPj)**

| Code | Risk Cause ($A_j$) | Oj | $ARP_j$ |
|---|---|---|---|
| **1.** | **Procurement stage** | | |
| A5 | The seed quality is subpar. | 3.00 | 216.00 |
| A8 | The supply of Rockwool is insufficient | 4.33 | 189.09 |
| A3 | The seed packaging is unlabelled. | 4.00 | 186.56 |
| A2 | The available nutrients are of poor quality | 3.67 | 143.28 |
| **2.** | **NFT System** | | |
| A14 | The water temperature inside the nutrient tank exceeds 27°C. | 5.00 | 710.10 |
| A10 | The air temperature exceeds 30°C | 5.00 | 660.15 |
| A13 | The plastic or UV roof of the greenhouse is dirty. | 4.67 | 376.96 |
| A17 | A generator set (genset) is unavailable | 4.00 | 314.64 |
| **3.** | **Planting stage** | | |
| A23 | The workers are imprecise during the seeding process. | 4.00 | 230.60 |
| A22 | The seeds are not soaked in water | 4.00 | 222.60 |
| A25 | The workers are imprecise during the transplanting process | 4.00 | 112.08 |
| **4.** | **Maintenance process** | | |
| A28 | The lettuce plants are affected by caterpillars and grasshoppers | 3.67 | 198.29 |
| A30 | The workers are not meticulous in noticing damage to the plants | 2.33 | 195.72 |
| A26 | The nutrient flow is obstructed by moss | 4.33 | 184.76 |
| **5.** | **Harvesting stage** | | |
| A33 | The lettuce is not washed | 5.00 | 450.15 |
| A34 | The lettuce plants are either not ready for harvest or have passed the harvest time. | 2.33 | 205.11 |
| A36 | The workers neglect to perform pruning | 4.67 | 204.00 |
| **6.** | **Post-harvest stage** | | |
| A41 | The partner cafes and restaurants are out of business (not operating) | 5.00 | 411.80 |
| A38 | The packaged lettuce is placed lying down or facing downwards | 4.33 | 276.82 |
| A40 | The lettuce quantity differs from the terms of the purchase contract | 2.00 | 116.04 |

Source: Results of HOR Phase 1 analysis (Author, 2022)

The risk events during the procurement stage that cause the greatest severity are the reduced seedling yield (E6), followed by seeds that do not germinate (E3). The cause of the reduced seedling yield (E6) is the insufficient supply of rockwool (A8). In the event of seeds not germinating (E3), this can be caused by unlabelled seed packaging (A3) and poor seed quality (A5). Based on the highest potential risk value (ARPj), poor seed quality (A5) stands out. This is because seeds are crucial in lettuce cultivation, and poor-quality seeds lead to various other risk events (Herwibowo & Budiana, 2014).

In the hydroponic farming system, one of which is NFT (Nutrient Film Technique), water is used continuously and only decreases due to evaporation. It requires special maintenance in controlling water temperature, water level, acidity (pH) of the nutrient solution, and higher nutrient solution density (Crisnapati, Wardana, & Hermawan, 2017; Lennard & Ward, 2019). However, the hydroponic control process still uses conventional methods, relying on employees. The risk event that has the worst impact on the NFT hydroponic system is the wilting of plants during the daytime (E8), which is caused by air temperature exceeding 30°C (A10) and water temperature in the nutrient tank exceeding 27°C (A14).

Based on Table 1, those two risk agents have the highest incidents and risk potential. High environmental temperatures can hinder the growth and development of hydroponic lettuce to a lethal level. Theoretically, according to (Qadeer, et al., 2020), environmental temperature is a crucial factor, with optimal lettuce growth occurring in a controlled environment with temperatures between 21-25°C day/night. The next disruptive event is the plant's inability to absorb nutrients optimally (E11) and death (E12). The incident E11 is caused by moss (weeds) in the nutrient tank (A15), while E12 is caused by the absence of a generator (A17) when the electricity goes out.

Lettuce cultivation in hydroponics begins with seeding for 3-4 days, followed by the next stages according to the plant age. The risk events with the worst impact are the lettuce seedlings accidentally getting cut during the Rockwool-cutting process (E20) and the reduced number of lettuce seedlings (E16). The cause of the planting risk with a high ARP value is the need for the workforce to be more careful during the seeding process. Seeding hydroponic lettuce is crucial as it is the first step in cultivating it using a hydroponic system. Therefore, if seeding is not done carefully, it can lead to other risky events (Herwibowo & Budiana, 2014). The maintenance phase is conducted to protect the plants for 14-20 days to ensure they are not disturbed until harvest. The risk event impacting the company is the leaves of the plants being perforated and damaged (E23), caused by the plants being affected by caterpillars and grasshoppers (A28). The risk agent in maintenance is the lettuce plants being attacked by pests, which have a high ARP value. Pest infestation will significantly reduce both the quality and quantity of the lettuce crop (Herwibowo & Budiana, 2014).

The risk event during lettuce harvesting is the loss of lettuce weight (E28), caused by the lettuce not being washed (A33). From Table 5, the risk cause with the highest ARP value in harvesting is the unwashed lettuce. Washing lettuce is an important process as it prevents various other risk events, such as the lettuce wilting quickly, becoming dirty/dull, or being contaminated with foreign objects, among others (Gardjito, Widuri, & Ryan, 2015). During the post-harvest phase, the treatments applied include cleaning, grading, weighing, and packaging the lettuce. The risk event that negatively impacts the company is the decrease in sales (E35), caused by risk agents such as company partners not operating (A41).

In the post-harvest phase of lettuce cultivation, there are five critical indicators: cooling, packaging, shipping, purchase contracts, and COVID-19. The highest ARP value is associated with cafes and restaurants partnering with the company being closed during the COVID-19 pandemic. This significantly affected the sales and revenue from the lettuce crop. According to (Aziz, Hanafiah, Hasbollah, Aziz, & Hussin, 2022), the lockdown conditions during the COVID-19 pandemic had a major impact on the economies of Indonesia, Malaysia, and the world. Particularly for small businesses, (Kalogiannidis, 2020) explains that companies facing significant losses during the pandemic tend to shut down their operations. The lowest ARP value risk cause (A39) can be mitigated by shipping lettuce before dawn when the ambient temperature is lower. (Utami, Endaryanto, & Adawiyah, 2023) state that in the supply chain of hydroponic vegetables, the biggest risk is the spoilage of vegetables, which becomes the responsibility of the producer.

Overall, from the 6 lettuce production processes in Table 1, it can be seen that the highest aggregate risk potential (ARPj) value is found in the NFT system, with high-frequency risk causes. This presents a threat that requires priority in preventive risk control. The next priority is the harvesting and post-harvest processes, which also have high-frequency risk causes. These three lettuce production processes should be prioritized for preventive control. Through the Pareto Diagram mapping, 20% of the risk causes that will result in 80% of the impact can be identified. Therefore, a risk control strategy needs to be developed to prevent these risks from recurring.

***Mapping of Risk Cause in Lettuce Production***

The risk mapping is carried out to identify the causes of risks that can be addressed with preventive risk control strategies. As stated by (Krasteva & Dimcheva, 2020), the Pareto Diagram is capable of showing most of the errors in the production process. The comparison in the Pareto chart is 80:20, indicating that the causes of risk that need to be prioritized are the accumulation of ARP up to 80%, while anything above 80%-100% can be ignored. Below is the risk map for each hydroponic lettuce production process.

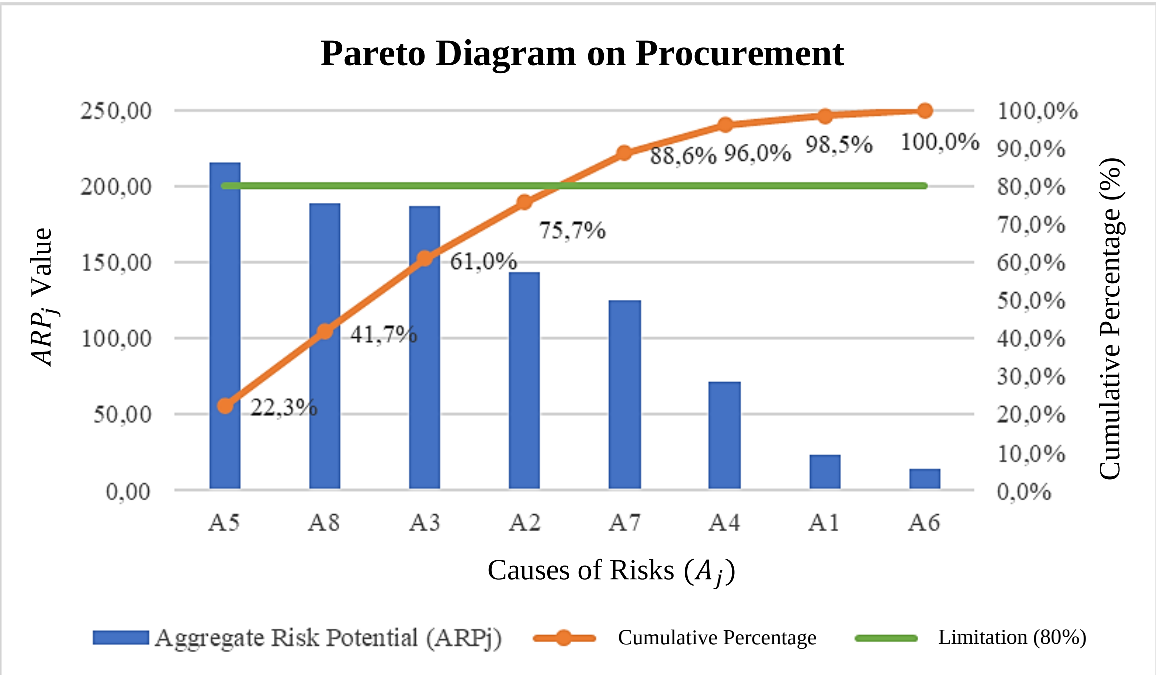


**Figure 3. Pareto Diagram on Procurement**

Based on Figure 3, it can be seen that in the 80% ARP accumulation, there are four risk causes that become the priority for preventive risk management strategies during the procurement phase: 1) poor seed quality (A5), 2) insufficient rockwool inventory (A8), 3) unlabeled seed packaging (A3), and 4) poor-quality available nutrients (A2).

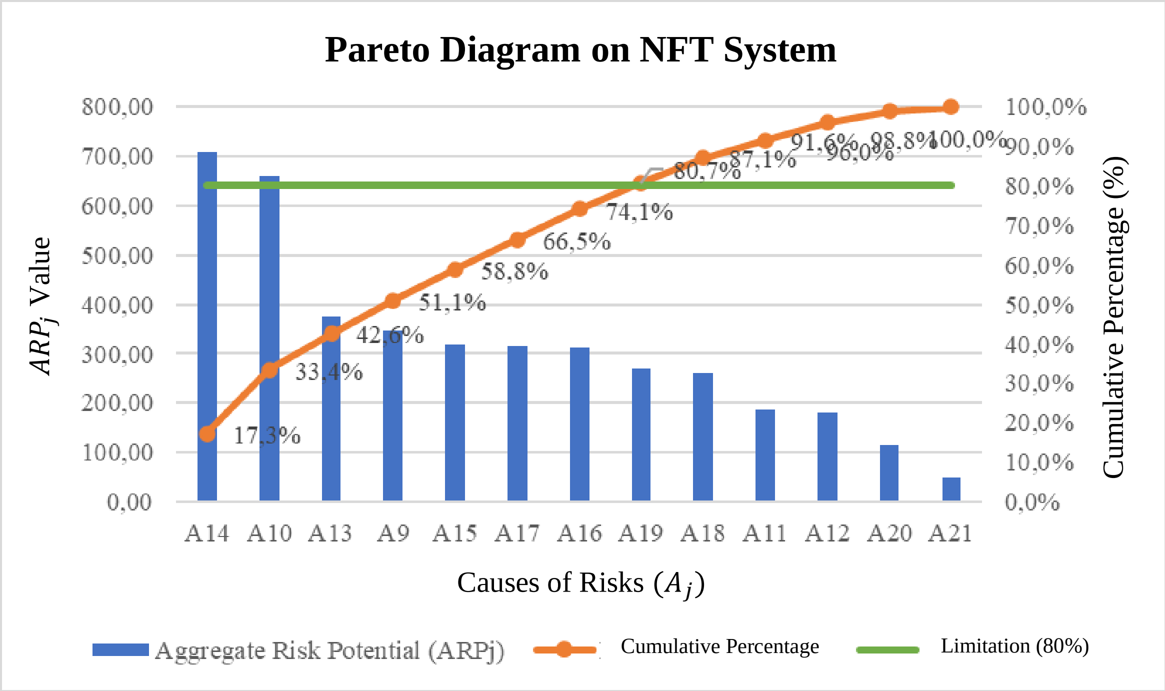


**Figure 4. Pareto Diagram on NFT System**

Figure 4 shows 7 risk agents as priorities for preventive risk management strategies in the NFT system, which are: 1) water temperature in the nutrient tank exceeding 27°C (A14), 2) air temperature exceeding 30°C (A10), 3) UV dirty plastic or greenhouse roof (A13), 4) limited sunlight due to obstruction by trees (A9), 5) moss (weeds) in the nutrient tank (A15), 6) absence of a generator (A17), and 7) workers neglecting to check the nutrients regularly (morning and evening) (A16).

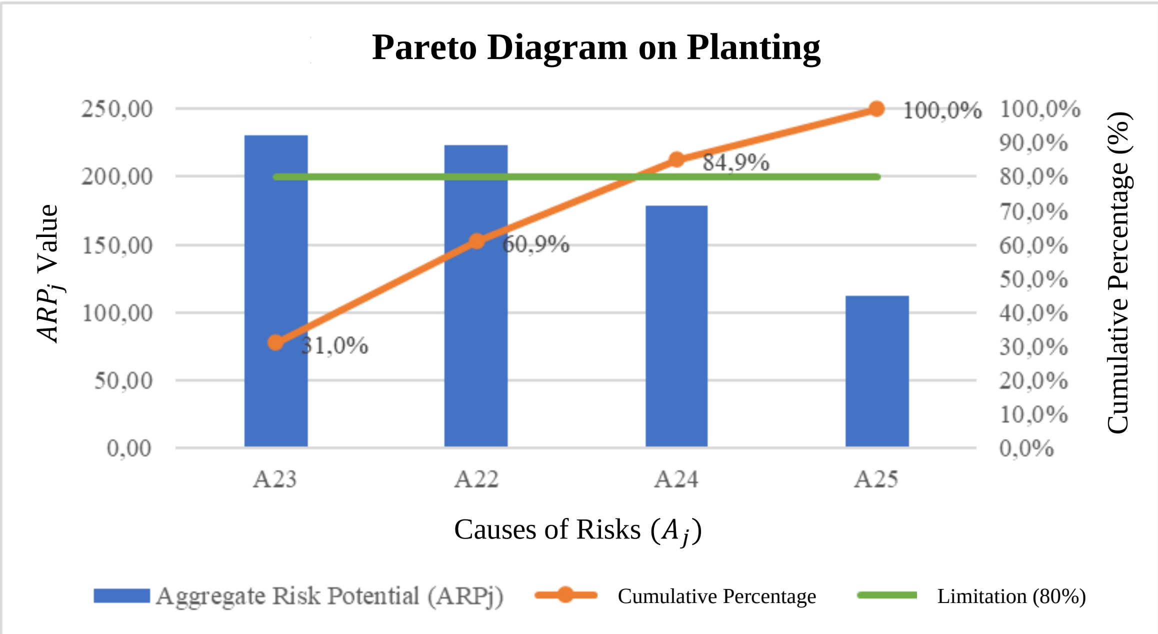


**Figure 5. Pareto Diagram on Planting**

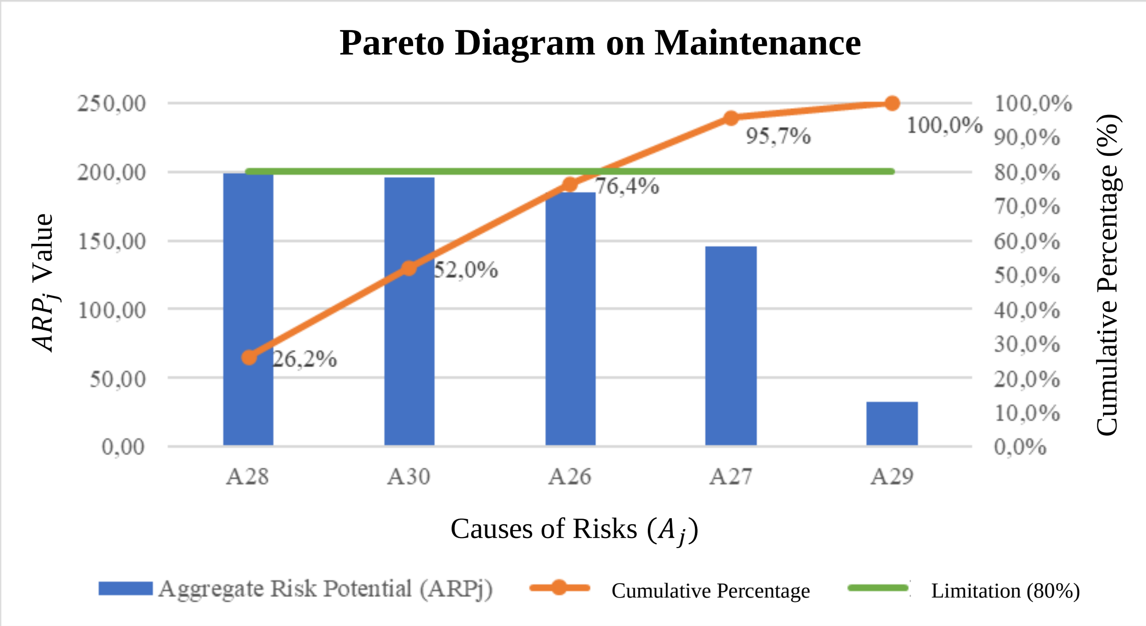


**Figure 6. Pareto Diagram on Maintenance**

In Figure 5, it is shown that there are two risk agents as priorities for the preventive risk management strategy during planting: 1) workers being careless in the seeding process (A23), and 2) the seeds are not soaked in water (A22). From Figure 6, it can be seen that three risk agents are priorities for the preventive risk management strategy during the maintenance process, which are: 1) lettuce plants being affected by pests such as caterpillars and grasshoppers (A28), 2) workers being negligent in observing plant damage (A30), and 3) nutrient flow being obstructed by moss (A26).

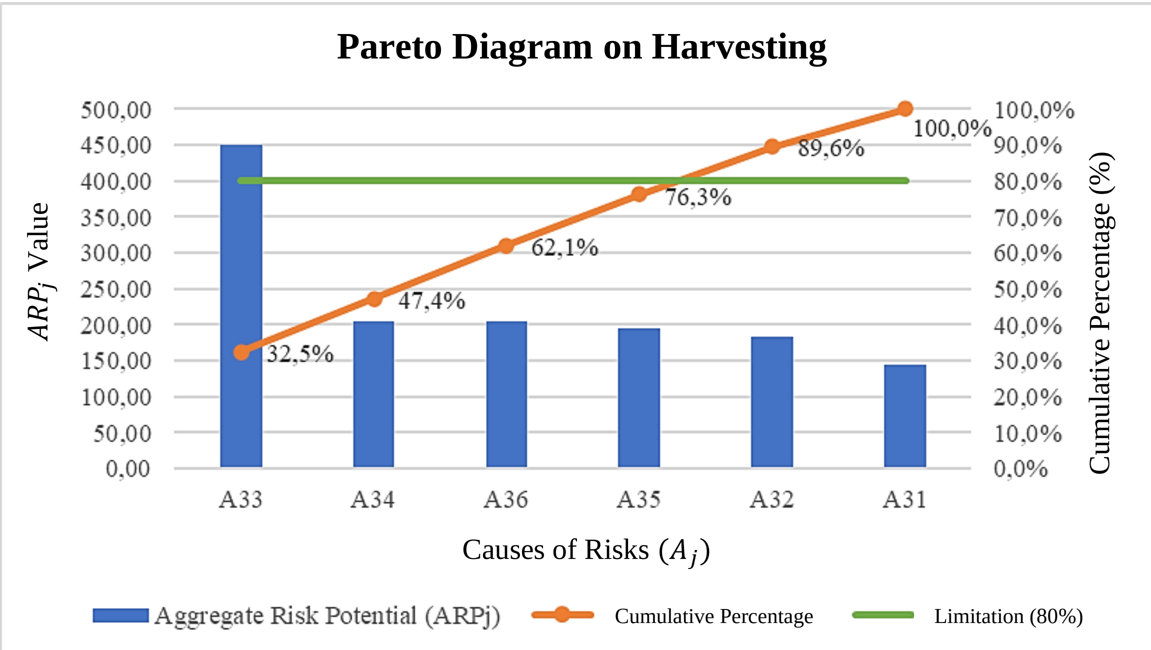


**Figure 7. Pareto Diagram on Harvesting**

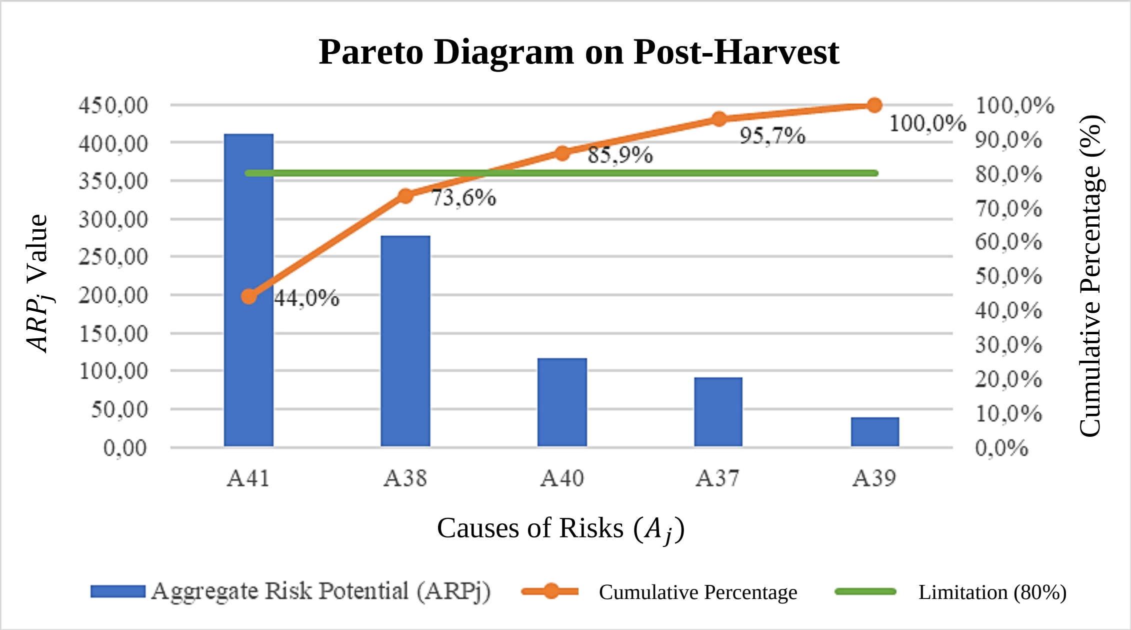


**Figure 6. Pareto Diagram on Post-Harvest**

Based on Figure 7, there are four risk agents as priorities for the preventive risk management strategy during harvesting: 1) lettuce not being washed (A33), 2) lettuce plants are either not yet ready to be harvested or past the harvest period (A34), 3) workers being careless in pruning (A36), and 4) workers being careless in sorting (A35). In Figure 8, there are two risk agents as priorities for the preventive risk management strategy: 1) cafes and restaurants partnered with the company being closed (not operating) (A41), and 2) packaged lettuce being placed or facing downwards (A38). The results of the risk mapping for the entire lettuce production process at CV Spirit Wira Utama show a total of 22 risk causes that are prioritized as risk control strategies. Risk control strategies have been identified to minimize the impact and occurrence of these risk causes.

***Preventive Risk Management Strategies for Lettuce Production***

Additionally, calculations are conducted during HOR Stage 2 to develop a preventive risk management approach. Implementing a preventive risk management plan for priority risk agents will enhance the company's effectiveness and efficiency in addressing these diverse threats. Table 2 presents the recommended handling strategies, their interrelationships, and the priority of these tactics based on the effective difficulty ratio (ETDk) of CV Spirit Wira Utama. The highest priority risk control strategy is the NFT system, especially in the nutrient solution drainage channel of the tank (PA7). Preventive handling strategies for the nutrient solution drainage channel require regular maintenance to avoid water temperatures exceeding 27°C in the nutrient tank. Conventional monitoring constraints, such as employee supervision, can be replaced with technology like sensors connected to control devices via a website (Crisnapati, Wardana, & Hermawan, 2017). However, this decision is quite expensive and requires additional capital, so further consideration is needed. Subsequently, the priority control strategy PA26 is collaboration with customers, as (Belov & Zvolinskaya, 2021) stated that one of the most important aspects of agricultural activities is collaboration with other industries involved in the procurement, processing, and sale of agricultural products (Ramadhina & Trimo, 2022). Furthermore, (Belitski, Guenther, Kritikos, & Thurik, 2022) explain that the pandemic has driven all parties to embrace new practices, such as e-commerce and partnership models.

**Table 2. Preventive Risk Management Strategies, Interconnections between Strategies, And The Order of Risk Handling Priorities**

| Production Process | Risk Cause ($A_j$) | Preventive Mitigation Strategy ($PA_k$) | Correlation | Priority Order (ETDk) |
|---|---|---|---|---|
| Procurement | 1. Subpar seed quality (A5)<br>2. Lacking rockwool supply (A8)<br>3. Unlabelled seed packaging (A3) | 1. Select lettuce seeds from each different brand (PA1)<br>2. Purchase local rockwool (PA3)<br>3. Select the labeled package of lettuce seeds (PA4) | 1. PA1 and PA4 (+)<br>2. PA2 and PA3 (+) | PA1 (682)<br>PA3<br>PA4 |
| NFT System | 1. The water temperature in the nutrient tank exceeds 27°C (A14)<br>2. Dirty roof or plastic of UV greenhouse (A13)<br>3. There is no genset (A17) | 1. Place brick waste with netting in the nutrient tank channel (PA7)<br>2. Provide a fan/blower for the greenhouse (PA8)<br>3. Clean the nutrient tank up (PA11)<br>4. Provide genset (PA12) | 1. PA7 and PA11 (+)<br>2. PA11 and PA13 (+)<br>3. PA6 and PA7 (++) | PA7 (3303)<br>PA8<br>PA13<br>PA11<br>PA9<br>PA12 |
| Planting | 1. Workers' carelessness in seeding (A23)<br>2. Not soaking the seeds in water (A22) | 1. Create SOP for seeding (PA14)<br>2. Monitor the seeding process (PA15)<br>3. Soak the lettuce seeds (PA16) | PA14 and PA15 (+) | PA15 (766)<br>PA14<br>PA16 |
| Maintenance | 1. Caterpillar and grasshopper pests (A28)<br>2. Imprecise workers (A30)<br>3. Moss obstructs nutrient flow (A26) | 1. Routine checking of the nutrient hose (PA21)<br>2. Create SOP for maintenance (PA20)<br>3. Repair the torn insect net (PA18)<br>4. Improve discipline (PA19) | PA19 and PA21 (+) | PA21 (750)<br>PA20<br>PA18<br>PA19<br>PA17 |
| Harvesting | 1. Lettuce is not washed (A33)<br>2. Lettuce is not ready or past the harvest time (A34)<br>3. Workers neglect pruning (A36) | 1. Create a written SOP for washing lettuce (PA22)<br>2. Monitor harvesting regularly (PA23)<br>3. Ensure lettuce harvest age follows SOP (PA24) | PA23 and PA24 (+) | PA22 (1157)<br>PA23<br>PA24 |
| Post-harvest | 1. Partnered cafe and restaurant are closed (A41)<br>2. Lettuce packaged lying down or upside down (A38)<br>3. Lettuce quantity doesn't match the contract (A40) | 1. Collaborate with online-based vendors (PA26)<br>2. Seek alternative new buyer partners (PA27)<br>3. Ensure lettuce is positioned vertically (PA28)<br>4. Ensure the quality of lettuce marketed follows SOP (PA29) | 1. PA28 and PA29 (+)<br>2. PA25 and PA26 (++) | PA26 (1235)<br>PA27<br>PA28<br>PA29<br>PA25 |

Source: Results of HOR Stage 2 analysis (Author, 2022)

## CONCLUSION

In the risk identification process, there are a total of 35 risk events across all stages of hydroponic lettuce production caused by 41 risk agents. The impact of the worst-risk events includes wilting plants, lettuce weight shrinkage, and a decrease in lettuce sales. The most frequent risk agents are water temperature in the nutrient tank exceeding 27°C, unwashed lettuce, and careless labor. The risk measurement in lettuce production is based on the highest ARP value at each stage, especially in the NFT system. If the water temperature in the tank exceeds 27°C, the lettuce is not washed, and partner companies are not operating, then the preventive risk strategies for these issues should be prioritized. The risk mapping results identified 22 risk agents in lettuce production that should be prioritized as part of the risk prevention strategy. These make up 50% of the 41 risk agents identified. Through the risk prevention strategy, 29 strategies were developed to prevent the recurrence of risk events, with the primary focus on the NFT system, particularly the nutrient solution drain tank. The next priority is preventive measures with vendors and creating hygienic Standard Operating Procedures (SOPs).

Based on these conclusions, the following suggestions are provided: CV Spirit Wira Utama should review risk agents by considering the highest ARP values and the risk factors contributing to events, particularly wilting and shrinkage that render the lettuce unmarketable. The priority risk agents to address are: improving labor risk awareness culture, providing training, encouraging active participation, and creating a proactive work environment to address risks, especially in controlling the NFT installation. For the implementation of the proposed risk control strategies, the company should conduct trials first to ensure that the applied strategies will work well in the future.

## REFERENCES


Ali, J., & Kapoor, S. (2008). Farmers' perception on risks in fruits and vegetables production: an empirical study of Uttar Pradesh. *Agricultural Economics Research Review, 21*, 317-326.

Anugrah, D., Arifin, B., & Suryani, A. (2021). Analisis pendapatan dan risiko usahatani cabai merah Di Kecamatan Way Sulan Kabupaten Lampung Selatan. *Jurnal Ilmu-Ilmu Agribisnis (JIIA), 9*(2), 317- 324.

Asci, S., VanSickleb, J. J., & Cantliffec, D. J. (2014). Risk in investment decision making and greenhouse tomato production expansion in Florida. *International Food and Agribusiness Management Review, 17*(4), 1-26.

Aziz, N. A., Hanafiah, M. H., Hasbollah, H. R., Aziz, Z. A., & Hussin, S. (2022). Understanding the survival ability of franchise industries during the COVID-19 crisis in Malaysia. *Sustainability, 14*(6), 3212. Retrieved from https://doi.org/10.3390/su14063212

Bairwa, S. L., Kushwaha, S., & Bairwa, S. (2013). Managing risk and uncertainty in agriculture – A review. In *Agricultural Education, Research and Extension in India* (pp. 212-214). Chittupur, Varanasi, India: Poddar Publication.

Belitski, M., Guenther, C., Kritikos, A. S., & Thurik, R. (2022). Economic effects of the COVID-19 pandemic on entrepreneurship and small businesses. *Small Bus Economics, 58*, 593–609. Retrieved from https://doi.org/10.1007/s11187-021-00544-y

Belov, F. D., & Zvolinskaya, O. V. (2021). Basic principles of farming for effective development in a market economy. *RUDN Journal of Economics, 29*(4), 763-772.

Chabla, R. G., Aviles, K. R., Calle, K., Moran, C., Gavilanez, F., Jacome, D. A., & Chavez, C. (2019). A monitoring system for lettuce cultivation in an NFT hydroponic system: A case study. *ICT for Agriculture and Environment*, 49-58.

Charpentier, A., & Flachaire, E. (2019). Recent econometric techniques for macroeconomics and financial data. In *Pareto models for risk management. Dynamic modeling and econometrics in economics and finance.* Retrieved from https://www.researchgate.net/publication/338228361

Crisnapati, P. N., Wardana, I. N., & Hermawan, A. (2017, August). Hommons: hydroponic management and monitoring system for an IOT-based NFT farm using web technology. *Conference Paper*. doi:10.1109/CITSM.2017.8089268

Damayanti, Y., Nurchaini, D. S., & Ulma, R. O. (2023). Analisis Optimasi dan risiko usaha pada usahatani cabai merah di Kecamatan Kumpeh Kabupaten Muaro Jambi. *SEPA (Jurnal Sosial Ekonomi Pertanian dan Agribisnis), 20*(1), 84 – 95. Retrieved from https://dx.doi.org/10.20961/sepa.v20i1.56415

Gardjito, M., Widuri, H., & Ryan, S. (2015). *Penanganan segar hortikultura untuk penyimpanan dan pemasaran.* Jakarta: Prenadamedia.

Herwibowo, K., & Budiana, N. S. (2014). *Hidroponik Sayuran.* Jakarta: Penebar Swadaya.

Iskandar, M. J., Prasetyowati, R. E., & Anwar, M. (2024). Risiko Produksi Usahatani Padi Model Corporate Farming Di Jawa Tengah. *SEPA (Jurnal Sosial Ekonomi Pertanian dan Agribisnis), 21*(1), 42 – 51. Retrieved from https://dx.doi.org/10.20961/sepa.v21i1.61481

Kalogiannidis, S. (2020). Covid impact on small business. *International Journal of Social Science and Economics Invention, 06*(12), 387 – 391. Retrieved from https://doi.org/10.23958/ijssei/vol06-i12/257

Krasteva, D. G., & Dimcheva, I. (2020). Analysis of defects and their impact on the production losses using pareto diagrams. *E3S Web of Conferences, 207*(03007). Retrieved from https://doi.org/10.1051/e3sconf/202020703007

Kurniasih, D., Syaukat, Y., Nurmalina, R., & Suharno. (2023). Persepsi petani terhadap tingkat kekritisan risiko usahatani bawang putih dan strategi manajemen risikonya (studi kasus di Kabupaten Temanggung). *Jurnal Penyuluhan, 19*(02), 95-112. Retrieved from https://doi.org/10.25015/19202346082

Kuswandi, & Mutiara, E. (2004). *Delta Delapan Langkah dan Tujuh Alat Statistik untuk Peningkatan Mutu Berbasis Komputer.* Jakarta: Elex Media Komputindo.

Lennard, W., & Ward, J. (2019). A comparison of plant growth rates between an NFT hydroponic system and an NFT aquaponic system. *Horticulture, 5*(2), 27. doi:10.3390/horticulturae5020027

Nguyen, N. T., McInturf, S. A., & Mendoza-Cózatl, D. G. (2016). Hydroponic : a versatile system to study nutrient allocation and plant responses to nutrient availability and exposure to toxic elements. *Biology*. doi:10.3791/54317

Powell, T., & Sammut-Bonnici, T. (2017). Pareto analysis. In P. C. Cooper (Ed.), *Wiley Encyclopedia of Management.* John Wiley & Sons, Ltd.

Pujawan, I. N., & Geraldin, L. H. (2009). House of risk: a model for proactive supply chain risk management. *Jurnal Business Process Management (JBPM), 15*(6), 935-967. doi:10.1108/14637150911003801

Qadeer, A., Zia-Ul-Haq, Butt, S. J., Haidree, S. R., Mehmood, T., Nawaz, M. K., & Asam, H. M. (2020). Prospects of lettuce production in hydroponic agriculture: A review. *International Journal of Biosciences (IJB)*, 608-626. Retrieved from http://www.innspub.net

Ramadhina, S., & Trimo, L. (2022). Faktor internal dan eksternal pengembangan agribisnis hortikultura petani muda. *SEPA (Jurnal Sosial Ekonomi Pertanian dan Agribisnis), 18*(2), 185 – 194. Retrieved from https://doi.org/10.20961/sepa.v18i2.49644

Rozudin, M., & Mahbubah, N. A. (2021). Implementasi metode house of risk pada pengelolaan risiko rantai pasokan hijau produk Bogie (studi kasus: PT Barata Indonesia). *Jisi: Jurnal Integrasi Sistem Industri, 8*(1), 1-11. Retrieved from http://jurnal.umj.ac.id/index.php/jisi

Utami, N. M., Endaryanto, T., & Adawiyah, R. (2023). Analisis rantai pasok sayuran hidroponik di Kota Bandar Lampung. *Jurnal Ilmu Ilmu Agribisnis: Journal Of Agribussiness Science, 11*(3), 173-180.

Velazquez-Gonzalez, R. S., Garcia-Garcia, A. L., Ventura-Zapata, E., Barceinas-Sanchez, J. D., & Sosa-Savedra, J. C. (2022). A review on hydroponics and the technologies associated for medium- and small-scale operations. *Agriculture, 12*(5), 646. Retrieved from https://doi.org/10.3390/agriculture 12050646

Wahyudin, N. E., & Santoso, I. (2016). Modelling of Risk Management for Product Development of Yogurt Drink Using House of Risk (HOR) Method. *The Asian Journal of Technology Management (AJTM), 9*(2), 98-108. doi:10.12695/ajtm.2016.9.2.4

Wahyuni, D., Nazaruddin, Muharrami, T. A., & Budiman, I. (2021). Identification of halal risk in risoles production using house of risk method. *E3S Web of Conferences 332*, 04003. Retrieved from https://doi.org/10.1051/e3sconf/202133204003

Wastra, A. R., & Mahmubi, A. (2013). *Risiko Agribisnis.* Jakarta: Gaung Persada Press Group.