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Risk Detection of Curly Red Chili (*Capsicum annum* L) Production with House of Risk

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ABSTRACT

Purpose: *In the phenomena and constraints faced by red chili farmers that result in unsustainable production, an interesting research question raised is how to detect production risks in curly red chili, the impact of risks caused by the source of risk and mitigation of priorities that must be done in managing risks which occurred in one of the red chili production centers in Majalengka Regency, West Java Province.*

Research Method : *Research to mitigate production risk is carried out using the House of Risk method at the red chili production center with 30 respondents. Respondents were determined purposively. Observed responses include risk events, risk agents to identify problems. The risk status grouping is determined based on the aggregate risk potential (ARP) value.*

Findings : *The results showed that curly red chili farming had 17 risk events with 7 risk agents. The risk agent for climate change and erratic weather produces the highest ARP value of around 3469 or around 30.33% so that this agent is considered to be the main priority in risk mitigation. Priority mitigation strategies can be carried out through the creation of green houses, training and application of standard operating procedures.*

Limitations : *Detecting event and sources on the risk red chili production.*

Value : *With detection of events and sources of risk it can produce priority potency for handling of risk or mitigation of risk.*

Keywords: *Production Risk, Curly Red Chili Farming, Risk Mitigation*

INTRODUCTION

Climate change has caused various problems in various lives including agriculture. The climate in Indonesia has experienced changes associated with the occurrence of El-Nino Southem Oscillation (ENSO), and this affects and even hinders the performance of the agricultural sector (Boer *et al.,* 2014). Supari *et al.,* explained that changes in weather patterns during the warm ENSO period, prolonged drought, and the delay in the rainy season resulted in higher and more vulnerable agricultural risks (Supari *et al.,* 2017). Climate change and pest attacks have a negative impact on the agricultural sector (Mashiza, 2019), especially horticulture such as red chili and shallots (Zuhriyah, 2012). The unsustainable supply of red chili from production centers to the market fluctuates quite high and influences inflation (Andayani, 2016). On the other hand red chili including curly red chili has the potential to be developed because it has high economic value (The Ministry of Agriculture of the Republic of Indonesia (MoA), 2015). The same thing was explained by Bank Indonesia because red chili tends not to know the season. Bank Indonesia has initiated to develop a red chili cluster in Indonesia since 2011 but until now it has not been optimal and still leaves problems including the large number of risks that occur (Bank Indonesia, 2015).

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Andayani explained in his research that the red chili agribusiness cluster in Garut Regency, West Java indicated production risks, market risks, and institutional risks that accumulated into financial risks (Andayani, 2015). In their research, Anwarudin *et al.,* explained that there are strategies in dealing with the fluctuations in the price of red chili, such as by increasing the area of planting and production in the rainy and dry seasons, stabilizing prices, and developing reliable and sustainable partnership institutions (Anwarudin *et al.,* 2015). Research by Wijaya *et al.,* highlights chili in terms of post-harvest. Anticipating the deteriorating performance of the handling of the post-harvest chili, they proposed a quality plan through the selection of harvest time, adequate equipment in the presence of protective, packaging, transportation, and storage (Wijaya *et al,*2013). Conditions in the red chili cluster in handling post-harvest red chillies are still experiencing problems. Productivity to maintain the continuity of supply of red chili in addition to the technical aspects of cultivation that refers to standard operating procedures (SOP), can also be increased by taking into account the human resources they have, the level of independence of young agribusiness actors (PMA) which is relatively weak, especially in terms of quality and power competitiveness, as well as suggesting several collaborative strategies (Setiawan *et al., 2015)*. Not only vegetables are affected by climate change but fruit producers in various countries often experience various risks associated with climate change and weather (Tsyr-Shuay, 2018). To reduce the negative impact of agricultural risk and reduce risk, small farmers are willing to pay insurance for agricultural production. In anticipation of climate change, the government implemented insurance of production costs in 2015 (a large number of subsidies have been allocated by the government) but the level of farmer participation is still very low (Mutaqin *et al.,* 2019). Types of risk-prone agriculture due to climate change have very large variations (Arbuckle, 2015). Farmers around the world face and manage various risks caused by various factors (Duong *et al.,* 2019*)*. In the agricultural sector, not only is the weather climate a risk agent but there are also many opportunities related to plant disease pests and there are many risk-free opportunities in improving pest control by managing ecosystem services (Roos, *et al.,* 2018).

Based on the phenomena and constraints faced by red chili farmers that result in unsustainable production, an interesting research question raises is how to detect production risks in curly red chili, the impact of risks caused by the source of risk and mitigation of priorities that must be done in managing risks which occurred in one of the red chili production centers in Majalengka Regency, West Java Province.

METHOD

The study was designed in a descriptive quantitative and qualitative manner with a case study method designed to describe the risks and sources of risk that are the problem. The steps taken are to explore the causes of production discontinuity and offer alternative solutions to mitigate the risk. The used analysis in analyzing the level and impact of risk on curly red chilli farming is the House of Risk (HOR) Method. HOR is a modification of the development of the Failure Mode and Effect Analysis (FMEA) and adapts the House of Quality (HOQ) to be able to prioritize which risks are handled first so that they can choose the most effective actions in managing risks.

The HOR method can be used to proactively manage risk. Risk agents identified as causes of risk events can be managed by ranking them on the basis of the magnitude of the impact that is likely to occur. The stages in the HOR method, namely, HOR 1 and HOR 2. The framework in the HOR1 stage is carried out to determine the choice of risk agents as a priority in subsequent risk prevention (Rizqiah, 2017). The stages of the HOR model are: HOR 1 (a). Identify the occurrence of risk (risk event, Ej) and assess the severity (severity, SJ), (b). Identify the risk agent (Aj) and assess the level of frequency (Oj) for the likelihood to occur, (c). Providing a correlation value (Rij) between risk events and risk (d). Calculating the aggregate risk potential (ARPj) determined by the likelihood of the occurrence of risk agents and the aggregate impact of the risk events incurred (e). Making risk agent priorities based on potential aggregate risks. HOR 2 gives priority proactive steps that effectively reduce the risk based on financial capabilities and other resources. HOR 2 can also be used to facilitate management in prioritizing risk management that has been identified and calculated the level of risk in HOR (Rizqiah, 2017). HOR steps 2 (a). Determine several risk agents with top ranking to be the cause of the risk that will be prioritized to be addressed (b). Identify relevant proactive action (PAk) steps to prevent risk agents (c). Determine the level of relationship between each PA and risk agent (Ejk) (d). Calculate the total effectiveness of each proactive action $TE_K = \sum ARP_j.E_{jk}$ (e). Assess the level of difficulty (Dk) in implementing PA (f). Calculate the ratio of total effectiveness to the level of difficulty $ETD_k = TE_k/D_k$ (g). Give priority to the list of proactive actions that are most effective in reducing the occurrence of risk according to ability.

RESULTS AND DISCUSSIONS

Risks in curly red chili plants

Table 01 provides data on risk events ranging from seeding, cultivation, harvesting, post-harvesting as well as marketing to be marked with a code to facilitate the detection process.

Risk agents can be said to be the cause of a risk event. Table 02 is a list of risk agents as a possible cause of the risk of crop failure in curly red chilli farming. Selection of the seeds, climate change, and erratic weather are likely to fail in the high red chili farming.

Table 01: List of Production Risk Events

Curly Red Chili Farming Process	Event Risk	Code
Nursery	Sprout sprouts	E1
	Grow not synchronously	E2
	Pests in the ground	E3
	Growing media	E4
	Treatment	E5
Cultivation	Planting	E6
	Maintenance	E7
	Falling flower	E8
	die of withering	E9
	attacked by pests	E10
	stricken with disease	E11
	low flowering	E12
Harvest and post harvest	Crop failure	E13
	Sorting	E14
	Processing yield	E15
Marketing	sell directly to the market	E16
	sell to merchant collectors	E17

Table 02: List of Agents and Possible Risk

Code	Risk Agent	Occurrence	Possibility of Failure
A1	Seed selection	8	Very high
A2	Climate change and erratic weather	8	Very high
A3	Postharvest without technology	7	High
A4	Nature of chili that is easily damaged	7	High
A5	Price unable to compete	6	Medium
A6	Lack of manpower	6	Medium
A7	HR negligence in maintenance	7	High

Table 03: Risk Agent ARP Value and Mitigation Priority Ranking Sequence

No.	Code	ARP	Level	% ARP	% ARP Cumulative	Category
1	A2	3469	1	30,33	30,71	Priority
2	A7	3208	2	28,05	58,76	
3	A1	1960	3	17,14	75,90	Non Priority
4	A4	1118	4	9,78	85,68	
5	A3	667	5	5,83	91,51	
6	A5	570	6	4,98	96,49	
7	A6	444	7	3,88	100,38	

The influence or impact of the greatest risk agent on the activity of curly red chilli farming can be seen from its ARP value. A risk agent that has a high ARP value means it has a large impact on farming activities of curly red chili and vice versa. The results of calculation of all ARP values can be seen in Table 03.

Climate change and erratic weather are risk agents that have a big influence and become the main priority in handling. This is not much different from the results of Tan *et al.,*'s research that in the agricultural sector the risks are related to weather (55%), risks related to human resources (35%), the rest are related to other factors.

The determination of priority risk agent categories is done using the Pareto law or the 80:20 law. Determination of priority risk agent categories can be seen in Figure 01. Figure 01 explains that the main priority to get treatment is the risk agent for climate change and erratic weather (A2), negligence risk agent for human resources in maintenance (A7), and the agent seed selection risk (A1). That is because the ARP value of each risk agent has the greatest value among the other risk agent ARP values.

The results of the calculation of ARP value of risk agents in curly red chilli farming is shown in the Table 04.

Mitigation Strategies Used for Handling Occurring Risks

Measurements for mitigation strategies for risk agents can be analyzed by HOR 2. At this stage, identification of appropriate and accurate treatment strategies to reduce priority risk agents is proposed. The priority risk agents for handling or mitigating are climate change and erratic weather, negligence of human resources in maintaining and selecting seedlings. Mitigation actions are: (1). climate and weather adjustments (PA1), (2). making green houses (PA2), (3). improving farmers' skills (PA3), (4). training related to Good Agriculture Practices (GAP) (PA4), (5). application of Operational Standards for Curly Red Chili Farming Procedure (PA5), (6). selection of quality red chili superior seeds (PA6).

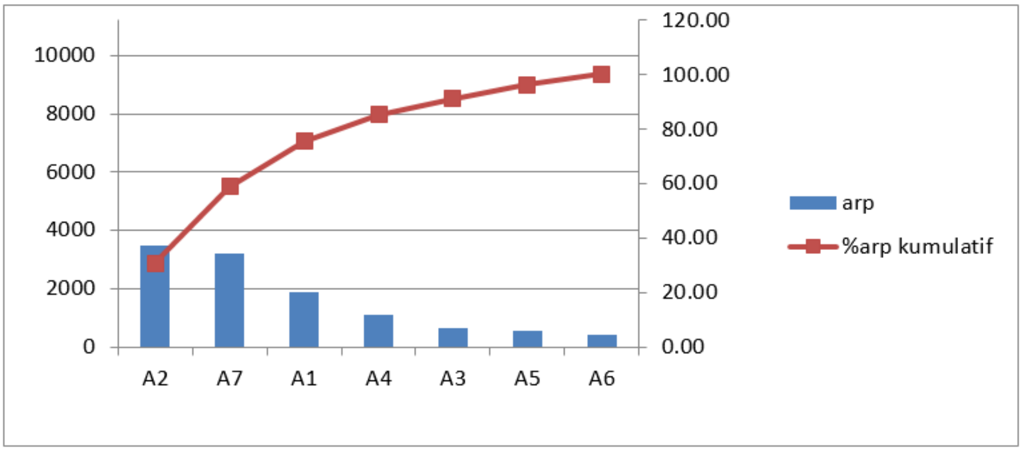

Figure 01: Pareto Diagram of Risk Agents in Curly Red Chili Farms

Table 04: Results of Correlation Values and ARP Values in Curly Red Chili Farms

Code	A1	A2	A3	A4	A5	A6	A7	Sj
E1	9	3		1		1	3	7
E2	9	3			1		9	5
E3	1	3					3	5
E4	1							5
E5		3		1		1	3	7
E6	3	3			3		3	6
E7	1	9				3	9	6
E8	3	9					3	5
E9	3	9					9	6
E10	3	9		3	1		9	8
E11	3	9		3	1			8
E12	3	3					9	5
E13	1	3		3	3	3	9	9
E14			3	3	3		3	5
E15			9		3	3	1	5
E16			3	9				3
Code	A1	A2	A3	A4	A5	A6	A7	Sj
E17			9	9				3
Oj	8	8	7	7	6	6	7	
ARP	1960	3469	667	1118	570	444	3208	
Pj	3	1	5	4	6	7	2	

Mitigation actions are identified, then Total Effectiveness (TE) and Difficulty level (D) calculations are calculated. The final stage in the House of Risk (HOR2) is determining priority mitigation actions that can be implemented. Priority mitigation actions must be determined by calculating the ratio between the value of effectiveness and the value of the level of difficulty. A TE PA1 value of 40578 means that PA1 (climate and weather adjustments) has a high level of difficulty in handling or mitigating actions. The greater the TE value, the more difficult it is to handle risk agents and vice versa. The calculation results explain that the value obtained is the highest value of the mitigation action ratio because the higher the value of the mitigation action ratio, the more effective the mitigation action to be implemented. PA1 ETD value is 8116, so it can be said that mitigation actions are more effective to be implemented (because the value of the mitigation action ratio is the greatest value compared to the others). The results of the calculation of mitigation actions can be seen in Table 05.

Table 05 Mitigation Action Calculation Results

Code	Risk Agent Description	PA1	PA2	PA3	PA4	PA5	PA6	ARP
A2	Climate Change and Erratic Weather	9	9					3475
A7	HR Negligence in Maintenance	3		9	9	3	1	3101
A1	Seed Selection				1	3	3	1907
	TE	40578	31275	27909	29816	15024	8822	
	D	H(5)	M(4)	M(4)	M(4)	L(3)	L(3)	
	ETD	8116	7819	6977	7454	5008	2941	

In the Table 05, it is found that the highest value of mitigation actions is found in the PA1 variable of 40578 with a value of 5. The calculation results show that the costs required for mitigation actions tend to be quite high or difficult to implement. Counseling to increase a better understanding of farmers' perspectives on climate change and weather needs to be done (Arbuckle *et al.,* 2014). In a research in China's Anhui Suzhan City in avoiding risk, farmers made the decision to buy weather-based crop insurance. This can provide useful insights for local policy makers and insurance companies and can increase farmer participation in insurance (Jin *et al., 2016)*.

CONCLUSIONS

From the survey results of the 30 farmers, there were 17 risk events with 7 risk agents. The results of the HOR analysis show that the highest ARP value was 3469 or around 30.33% which occurred in climate change and erratic weather. The results of this analysis will have a major effect and become the main priority in risk mitigation in red chili. The priority mitigation strategies can be created through the creation of green houses, training and application of operational standard procedures.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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