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ANALYSIS OF CASSAVA FARMING BUSINESS RISK USING ANALYTIC NETWORK PROCESS

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Abstract

It is important to develop research to support food and energy sustainability. This includes managing existing risks, because risk is the core of the paradigm underlying risk management initiatives. This research is aimed at analyzing priority risks in the on-farm aspects of cassava. The research location is in Serdang Bedagai Regency, which is a cassava production center in North Sumatra. This research uses the analytic network process method with the help of superdecision software. We involved three experts in the field of cassava farming who we chose based on experience, knowledge and interests in cassava cultivation in the research area. The identification results in this research found five stages carried out in cassava farming and each stage has potential risks. We also identified three risk criteria and eleven risk sub-criteria. Through analysis using the analytic network process method, we have found that the three priority risks in this research are the risk of low market prices, fertilizer costs and flood risk. Based on the results of this research, we have also explained the managerial implications intended for the future progress of cassava farming.

Keywords: Analytic Network Process, Cassava, Farming, Price, Risk

1. INTRODUCTION

Food and energy crises are two problems facing the world today (Fauziah & Mema Parandy, 2024; Hartati et al., 2021). Therefore, developing research in supporting food and energy sustainability is an important thing to do. The agricultural sector supports food supply and industry in this sector often faces challenges and many risks (Zandi et al., 2020). Meanwhile, the risk aspect is important in the article (Komarek et al., 2020) argues that risk is at the heart of new paradigms and approaches underlying risk management initiatives and shaping investment in many countries. In our opinion, this is one of the reasons why implementing risk management in commodity agribusiness is very important.

Cassava (*manihot esculenta*) is a commodity that is a source of local food and an alternative source of carbohydrates for the Indonesian people (Hartati et al., 2021; Pu'u, 2019). As a food commodity, cassava certainly must receive attention from various groups, including scientific researchers. In the 2020 Cassava Outlook published by the Center for Agricultural Data and Information Systems, Ministry of Agriculture, it is stated that cassava is currently an important food crop commodity in Indonesia after rice, corn, soybeans, peanuts and green beans, namely as a food ingredient, feed and industrial raw materials both upstream and downstream.

Based on data from the Central Statistics Agency (Indonesia Statistic Centre) that the provinces that are the largest cassava production centers on Sumatra Island are Lampung and North Sumatra. Lampung is the region with the highest area and production of cassava and of course this is supported by active scientific research activities to develop agribusiness for this commodity. (Suryani et al., 2023) who studied risks in the cassava value chain in Lampung and found that priority risks in the on-farm aspect of cassava include uncertain climate change, fertilizer scarcity and lack of agricultural standards, these tend to be production risks. Previously (Zulkarnain et al., 2021) studied the risk of cassava in Lampung using the Co-variance method and found that the risk of income and production of cassava on agricultural land was high. (Sari et al., 2024) found that the risk in cassava farming in Central Lampung was low. Even though it is low, based on the coefficient of variationn, the sequence of risks prioritized in cassava farming is income risk, production risk, and then price risk. Several studies in other areas also found that priority risks in cassava farming include cost risk, production risk and income risk and found cost risk as the highest risk (Ekaria & Muhammad, 2018). Risk analysis on cassava farming in the Wonogiri area using coefficient of variation analysis shows that the risk to cassava farmers' income is relatively low (Rahayu et al., 2021).

Meanwhile, in North Sumatra, one of the highest cassava production centers is Serdang Bedagai Regency, there is still little research related to risks in cassava's agribusiness. The previous research we found was (Saragi et al., 2022) which analyzed production risks, costs and income from cassava farming. Then (Panggabean, 2023) where he found that the risk of cassava farming in one area in North Sumatra was relatively low. Other research related to cassava discusses the economic feasibility aspect of the on-farm aspect (Thamrin et al., 2013), biological aspects of cassava (Fauzi et.al, 2015). This is what prompted us to conduct research on the risks of cassava farming in production centers in North Sumatra province. We conducted this research using the Analytic Network Process (ANP) method as a manifestation of the importance of developing risk analysis methods (Zandi et al., 2020). Meanwhile, several previous studies regarding cassava risk were carried out using the House of Risk method and coefficient of variation analysis (Ekaria & Muhammad, 2018; Rahayu et al., 2021; Sari et al., 2024; Suryani et al., 2023; Zulkarnain et al., 2021).

2. IMPLEMENTATION METHOD

This research was conducted by applying qualitative and quantitative approaches to obtain good decision options in risk management for cassava farming in Serdang Bedagai Regency, especially Dolok Masihul District as the largest producer. The data in this research is dominated by primary data collected through discussions with respondents (experts). The number of respondents in this study were three respondents who came from cassava farmers with more than 10 years of experience, heads of farmer groups and combined cassava farmer groups as well as local agricultural assistants or instructors.

2.1 Data Collection and Analysis

The data used is scaled data resulting from expert assessments of the research matrix. Data collection was carried out using a questionnaire and then summarized in digital form. We do this to make calculations easier. We analyzed the data using the Analytic Network Process (ANP) method supported by superdecision software. To obtain data that represents the opinions of all respondents, the geometric mean (geo-mean) of the respondents' opinions contained in the questionnaire we provided was taken. The use of the geometric mean refers to the ANP superdecision guidelines (Saaty, 1999). The ANP method is used because it can analyze more complex problems and generalize previous models (Gu et al., 2018). According to Saaty, this method is also independent of the assumptions used and so do of each level of elements used (Nugroho et al., 2020); (Cooper & Liu, 2017). Several previous studies used the House of Risk (HOR) method and coefficient variation analysis (Ekaria & Muhammad, 2018; Rahayu et al., 2021; Sari et al., 2024; Suryani et al., 2023; Zulkarnain et al., 2021). We intend to develop risk analysis with other methods to make it more useful in the scientific world. In using the ANP method, things that are done include creating a model and defining the problem by creating a pairwise comparison matrix, then assigning weights to the matrix based on expert opinion, inputting the weights into superdecision software, analyzing the consistency index and getting the results. (Syafei et al., 2016; Tanjung et al., 2019);

(Cooper & Liu, 2017). Weighting is carried out using a comparison scale with the provisions in Table 1.

Table 1. Scale used for matrix weighting

Scale	Definition	Description
1	Equal value	Two requirements of equal value
3	Slightly more value	Experience slightly favouring one requirement over another
5	Essential or strong value	Experience strongly favouring one requirement over another
7	Very strong value	A requirement is strongly favoured and its dominance is demonstrated in practice
9	Extreme value	The evidence favouring one over another is of the highest possible order off affirmation
2,4, 6,8	Intermediate values between two adjacent judgements	When compromise is needed

Reference: (Farhana T, 2018)

The scale in Table 1 is used reciprocally for the inverse comparison (Farhana T, 2018).

3. RESULTS AND DISCUSSION

3.1 Defining The Problem

This research aims to examine risk priorities in cassava farming to make it more profitable, and we see it not only in production risks. Because we consider the points presented to be important (Komarek et al., 2020), that 66% of 3,283 studies focused only on production risks, and only 15% considered more than one type of risk. Without a more detailed analysis of the different types of risks farmers face, farmers and policymakers will lack the information necessary to design relevant risk management strategies and policies. Literature related to risks in cassava farming used to create the model studied is as follows (Suryani et al., 2023) about the risks of cassava production due to climate, fertilizer shortages and lack of agricultural standards. Then (Zulkarnain et al., 2021) which examines income and production risks in cassava farming. Then (Sari et al., 2024) which identifies production, price and income risks. The article of (Ekaria & Muhammad, 2018) which identifies costs, production and income risks and (Rahayu et al., 2021) regarding income risks.

Based on the information we obtained from respondents, risks in cassava farming exist in every process carried out. The process includes the following activities:

1. Land processing stage (P1)
2. Stage of providing seeds (P2)
3. Planting stage (P3)
4. Maintenance stage (P4)
5. Harvesting stage (P5)

The aim of this research is to determine risk priorities in cassava farming in the research area (we give the code G1). Based on our goals, literature and confirmation from respondents (experts) and validated, the risk identification results used in this research analysis are displayed in Table 2.

Table 2. Identification of Risk Criteria and Sub-Criteria

Risk Criteria	Code	Risk Sub Criteria	Code
Risk of Cost	R1	Pesticide cost	SR1
		Fertilizer cost	SR2
		Labor costs	SR3
		Loan interest	SR4
Risk of Production	R2	Seedlings Are Not Superior	SR5
		Flood	SR6
		Drought	SR7

Risk Criteria	Code	Risk Sub Criteria	Code
		Pest Attack	SR8
		Incorrect Cultivation Techniques	SR9
Risk of Income	R3	Low Selling Price	SR10
		Low Market Price	SR11

Table 2 was then modeled into superdecision software to obtain a network visualization like Figure 1.

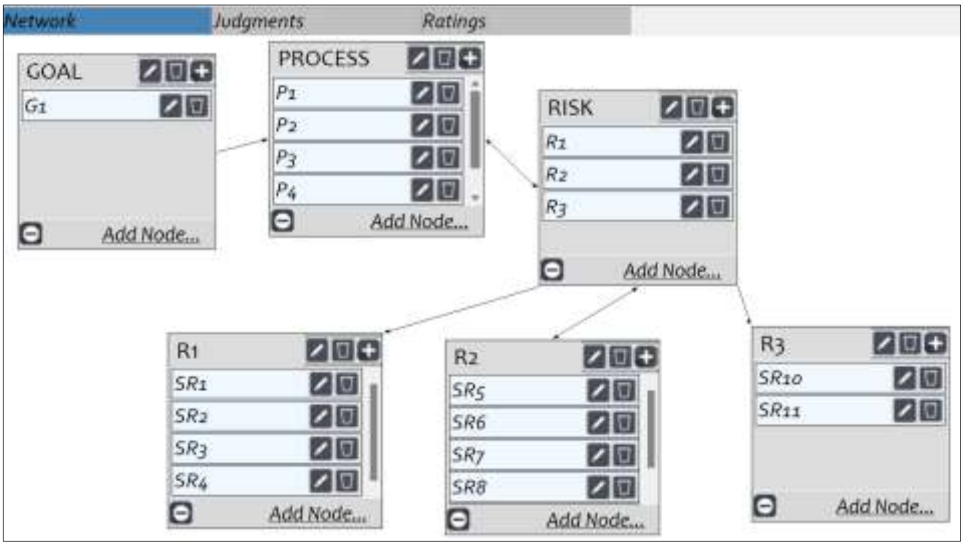

Figure 1. ANP network in Superdecision

3.2 Matrix Weighting

After we compiled a network of connections between all the elements used in this research, each matrix was given a weight which is presented on the judgment superdecision tab. The numbers used are the result of calculating the geometric mean (geomean) of expert answers to the questionnaire that we provided. Because the data we use is available in digital form, we calculate the geomean value using the geomean formula and round it off, as in the following formula in Microsoft Excel.

=(ROUND(GEOMEAN(Expert1;Expert2;Expert3);0)

Table 3. Superdecision Comparison Matrix Values

Comparison with respect to G1 node in Process cluster							
Geomean				Rounded			
P1		3,00	P2	P1		3	P2
P1		1,26	P3	P1		1	P3
P1		4,22	P4	P1		4	P4
P1	4,22		P5	P1	4		P5
P2	2,62		P3	P2	3		P3
P2		2,62	P4	P2		3	P4
P2	6,65		P5	P2	7		P5
P3		6,95	P4	P3		7	P4
P3	5,59		P5	P3	6		P5
P4	6,26		P5	P4	6		P5
Comparison with respect to P1 node in Risk cluster							
Geomean				Rounded			
R1	3,00		R2	R1	3		R2
R1	8,28		R3	R1	8		R3
R2	3,30		R3	R2	3		R3
Comparison with respect to P2 node in Risk cluster							
Geomean				Rounded			

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Table 3. Superdecision Comparison Matrix Values

R1		3,30	R2	R1		3	R2
R1	3,17		R3	R1	3		R3
R2	4,72		R3	R2	5		R3
Comparison with respect to P3 node in Risk cluster							
Geomean				Rounded			
R1	4,22		R2	R1	4		R2
R1	5,19		R3	R1	5		R3
R2	3,11		R3	R2	3		R3
Comparison with respect to P4 node in Risk cluster							
Geomean				Rounded			
R1	2,62		R2	R1	3		R2
R1	4,72		R3	R1	5		R3
R2	3,56		R3	R2	4		R3
Comparison with respect to P5 node in Risk cluster							
Geomean				Rounded			
R1	3,30		R2	R1	3		R2
R1		3,30	R3	R1		3	R3
R2		4,72	R3	R2		5	R3
Comparison with respect to R1 node in Process cluster							
Geomean				Rounded			
P1	4,72		P2	P1	5		P2
P1	7,00		P3	P1	7		P3
P1		3,30	P4	P1		3	P4
P1	3,11		P5	P1	3		P5
P2	3,30		P3	P2	3		P3
P2		6,26	P4	P2		6	P4
P2		3,00	P5	P2		3	P5
P3		7,32	P4	P3		7	P4
P3		3,30	P5	P3		3	P5
P4	6,26		P5	P4	6		P5
Comparison with respect to R2 node in Process cluster							
Geomean				Rounded			
P1	3,00		P2	P1	3		P2
P1	2,62		P3	P1	3		P3
P1		3,30	P4	P1		3	P4
P1	4,72		P5	P1	5		P5
P2	3,30		P3	P2	3		P3
P2		3,56	P4	P2		4	P4
P2	3,11		P5	P2	3		P5
P3		4,72	P4	P3		5	P4
P3	3,00		P5	P3	3		P5
P4	4,72		P5	P4	5		P5
Comparison with respect to R3 node in Process cluster							
Geomean				Rounded			
P1	1,00		P2	P1	1		P2
P1		1,82	P3	P1		2	P3
P1		1,82	P4	P1		2	P4
P1		3,00	P5	P1		3	P5
P2		3,00	P3	P2		3	P3
P2		1,82	P4	P2		2	P4
P2		4,72	P5	P2		5	P5
P3		2,88	P4	P3		3	P4
P3		3,56	P5	P3		4	P5
P4		4,72	P5	P4		5	P5
Comparison with respect to R1 node in R1 cluster							
Geomean				Rounded			
SR1		3,00	SR2	SR1		3	SR2
SR1	4,82		SR3	SR1	5		SR3
SR1	3,11		SR4	SR1	3		SR4
SR2	5,00		SR3	SR2	5		SR3
SR2	3,98		SR4	SR2	4		SR4
SR3		3,11	SR4	SR3		3	SR4
Comparison with respect to R2 node in R2 cluster							
Geomean				Rounded			
SR5		4,72	SR6	SR5		5	SR6

Table 3. Superdecision Comparison Matrix Values

SR5	2,62		SR7	SR5	3		SR7
SR5		3,00	SR8	SR5		3	SR8
SR5		4,72	SR9	SR5		5	SR9
SR6	6,54		SR7	SR6	7		SR7
SR6	5,19		SR8	SR6	5		SR8
SR6	3,00		SR9	SR6	3		SR9
SR7		2,88	SR8	SR7		3	SR8
SR7		4,72	SR9	SR7		5	SR9
SR8		2,52	SR9	SR8		3	SR9
Comparison with respect to R3 node in R3 cluster							
Geomean				Rounded			
SR10		2,62	SR11	SR11		3	SR12
Comparison with respect to SR5 node in Risk cluster							
Geomean				Rounded			
R1		3,00	R2	R1		3	R2
R1	3,30		R3	R1	3		R3
R2	6,80		R3	R2	7		R3
Comparison with respect to SR6 node in Risk cluster							
Geomean				Rounded			
R1		3,00	R2	R1		3	R2
R1	3,30		R3	R1	3		R3
R2	6,80		R3	R2	7		R3
Comparison with respect to SR7 node in Risk cluster							
Geomean				Rounded			
R1		2,62	R2	R1		3	R2
R1	3,00		R3	R1	3		R3
R2	3,56		R3	R2	4		R3
Comparison with respect to SR8 node in Risk cluster							
Geomean				Rounded			
R1	3,30		R2	R1	3		R2
R1	4,72		R3	R1	5		R3
R2	3,00		R3	R2	3		R3
Comparison with respect to SR9 node in Risk cluster							
Geomean				Rounded			
R1		2,52	R2	R1		3	R2
R1	3,00		R3	R1	3		R3
R2	4,72		R3	R2	5		R3

Then we enter these numbers into the superdecision matrix with the condition that the maximum inconsistency index is less than 0.1 (Farhana T, 2018; Saaty, 1999).

Figure 2. Example of weighting in the Superdecision Matrix

3.3 Limit Matrix

After all the data has been input, one of the things you need to pay attention to is whether the matrix limit has been reached. According to the guideline (Saaty, 1999), If the values of all columns are the same, then the limit has been reached and the matrix multiplication is stopped. The resulting limit matrix is shown in Figure 3.

Clusters	Nodes	G1	P1	P2	P3	P4	P5	SR1	SR2	SR3	SR4	SR5	SR6	SR7	SR8	SR9	SR10	SR11	R1	R2
GOAL	G1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.
PROCESS	P1	0.058152	0.058152	0.058152	0.058152	0.058152	0.058152	0.000000	0.000000	0.000000	0.000000	0.058152	0.058152	0.058152	0.058152	0.058152	0.000000	0.000000	0.058152	0.
	P2	0.023651	0.023651	0.023651	0.023651	0.023651	0.023651	0.000000	0.000000	0.000000	0.000000	0.023651	0.023651	0.023651	0.023651	0.023651	0.000000	0.000000	0.023651	0.
	P3	0.018018	0.018018	0.018018	0.018018	0.018018	0.018018	0.000000	0.000000	0.000000	0.000000	0.018018	0.018018	0.018018	0.018018	0.018018	0.000000	0.000000	0.018018	0.
	P4	0.112023	0.112023	0.112023	0.112023	0.112023	0.112023	0.000000	0.000000	0.000000	0.000000	0.112023	0.112023	0.112023	0.112023	0.112023	0.000000	0.000000	0.112023	0.
	P5	0.038156	0.038156	0.038156	0.038156	0.038156	0.038156	0.000000	0.000000	0.000000	0.000000	0.038156	0.038156	0.038156	0.038156	0.038156	0.000000	0.000000	0.038156	0.
R1	SR1	0.034110	0.034110	0.034110	0.034110	0.034110	0.034110	0.000000	0.000000	0.000000	0.000000	0.034110	0.034110	0.034110	0.034110	0.034110	0.000000	0.000000	0.034110	0.
	SR2	0.064476	0.064476	0.064476	0.064476	0.064476	0.064476	0.000000	0.000000	0.000000	0.000000	0.064476	0.064476	0.064476	0.064476	0.064476	0.000000	0.000000	0.064476	0.
	SR3	0.007855	0.007855	0.007855	0.007855	0.007855	0.007855	0.000000	0.000000	0.000000	0.000000	0.007855	0.007855	0.007855	0.007855	0.007855	0.000000	0.000000	0.007855	0.
	SR4	0.016008	0.016008	0.016008	0.016008	0.016008	0.016008	0.000000	0.000000	0.000000	0.000000	0.016008	0.016008	0.016008	0.016008	0.016008	0.000000	0.000000	0.016008	0.
R2	SR5	0.006649	0.006649	0.006649	0.006649	0.006649	0.006649	0.000000	0.000000	0.000000	0.000000	0.006649	0.006649	0.006649	0.006649	0.006649	0.000000	0.000000	0.006649	0.
	SR6	0.043154	0.043154	0.043154	0.043154	0.043154	0.043154	0.000000	0.000000	0.000000	0.000000	0.043154	0.043154	0.043154	0.043154	0.043154	0.000000	0.000000	0.043154	0.
	SR7	0.003886	0.003886	0.003886	0.003886	0.003886	0.003886	0.000000	0.000000	0.000000	0.000000	0.003886	0.003886	0.003886	0.003886	0.003886	0.000000	0.000000	0.003886	0.
	SR8	0.011135	0.011135	0.011135	0.011135	0.011135	0.011135	0.000000	0.000000	0.000000	0.000000	0.011135	0.011135	0.011135	0.011135	0.011135	0.000000	0.000000	0.011135	0.
	SR9	0.023304	0.023304	0.023304	0.023304	0.023304	0.023304	0.000000	0.000000	0.000000	0.000000	0.023304	0.023304	0.023304	0.023304	0.023304	0.000000	0.000000	0.023304	0.
R3	SR10	0.009856	0.009856	0.009856	0.009856	0.009856	0.009856	0.000000	0.000000	0.000000	0.000000	0.009856	0.009856	0.009856	0.009856	0.009856	0.000000	0.000000	0.009856	0.
	SR11	0.029567	0.029567	0.029567	0.029567	0.029567	0.029567	0.000000	0.000000	0.000000	0.000000	0.029567	0.029567	0.029567	0.029567	0.029567	0.000000	0.000000	0.029567	0.
RISK	R1	0.244898	0.244898	0.244898	0.244898	0.244898	0.244898	0.000000	0.000000	0.000000	0.000000	0.244898	0.244898	0.244898	0.244898	0.244898	0.000000	0.000000	0.244898	0.
	R2	0.176258	0.176258	0.176258	0.176258	0.176258	0.176257	0.000000	0.000000	0.000000	0.000000	0.176258	0.176258	0.176258	0.176258	0.176258	0.000000	0.000000	0.176258	0.
	R3	0.078844	0.078844	0.078844	0.078844	0.078844	0.078844	0.000000	0.000000	0.000000	0.000000	0.078844	0.078844	0.078844	0.078844	0.078844	0.000000	0.000000	0.078844	0.

Figure 3. Limit Matrix

Meanwhile, the results of risk priority calculations obtained are as follows:

Main Network: ANP Analysis.sdmod: formulai...

Here are the priorities.

Icon	Name	Normalized by Cluster	Limiting
No Icon	G1	0.00000	0.000000
No Icon	P1	0.23261	0.058152
No Icon	P2	0.09460	0.023651
No Icon	P3	0.07207	0.018018
No Icon	P4	0.44809	0.112023
No Icon	P5	0.15262	0.038156
No Icon	SR1	0.27856	0.034110
No Icon	SR2	0.52655	0.064476
No Icon	SR3	0.06415	0.007855
No Icon	SR4	0.13073	0.016008
No Icon	SR5	0.07545	0.006649
No Icon	SR6	0.48967	0.043154
No Icon	SR7	0.04409	0.003886
No Icon	SR8	0.12635	0.011135
No Icon	SR9	0.26443	0.023304
No Icon	SR10	0.25001	0.009856
No Icon	SR11	0.74999	0.029567
No Icon	R1	0.48980	0.244898
No Icon	R2	0.35252	0.176258
No Icon	R3	0.15769	0.078844

Figure 4. Superdecision Output Risk Priority

Based on Figure 4 above, information can be taken that in an effort to achieve the goal (G1) in the research area, the three highest priorities of all criteria and sub-criteria are SR11, then SR2 and SR 6. Based on the process criteria, the three main priorities in the cassava cultivation business are maintenance (P4); land preparation (P1); and harvesting (P5). The priority level of P4 is 1.9 times compared to P1 and 2.9 times compared to P5. Meanwhile, the priority level of P1 is 1.5 times higher than P5. Based on the risk criteria, the first risk priority is cost risk (R1), production risk (R2), and income risk (R3). The priority of R1 is 1.3 times R2 and 3.1 times R3. Meanwhile, the priority of R2 is 2.2 times R3. In terms of sub-risks, of all the sub-risks studied, the three main priorities are SR11, SR2, and SR6 (low market prices, fertilizer costs, and threat of flooding). We have not found risk research on cassava farming that analyzes the process, but rather the rice commodity that is carried out (Sang et al., 2018), they analyzed environmental, health and safety perspectives in the rice farming process. Based on risk criteria, the main priority is cost risk. Meanwhile, previous literature found that income risk and cassava production risk are priorities (Zulkarnain et al., 2021). Added by (Suryani et al., 2023) that fertilizer scarcity is one of the priority risks in cassava production and this is in line with the findings of this research.

3.4 Managerial Implication

The implementation of risk management in cassava farming certainly cannot be done by one party alone. To achieve sustainable development and overcome the food and energy crisis, a joint commitment to policy reform is needed (Fauziah & Mema Parandy, 2024). Overall, the greatest weight is on the sub-risks of low market prices, fertilizer costs and the threat of flooding. These three risk priorities certainly cannot be managed by one party alone. Let's start with farmers who, based on this research, have a lot of work to do. First, start thinking about efforts to increase the added value of cassava, such as processing it into derivative ingredients. Second, pay great attention when carrying out maintenance (pruning, fertilizing, pest control) and ensuring that the land's water channels function optimally. However, farmers cannot do this alone, the government's role is very decisive in this effort. Extension agents from related agencies and other assistants can encourage the growth of cassava farmer groups, this is of course very beneficial for farmers. The relevant government can provide a forum and access to how to increase the added value of cassava, then guarantee an adequate supply of fertilizer for farmers so that it can be accessed properly. Based on information in the field, fertilizer prices are often uncertain due to fertilizer scarcity. Meanwhile, flood management is carried out with good cooperation to obtain a quality irrigation system (water channels).

4. CONCLUSION

We conducted this research as an effort to support the development of science. Through this research, we found that there are five main processes carried out in cassava farming in the research area which include land processing, seed procurement, planting, maintenance and harvesting. The findings in this research are that in each process there is a cost risk, production risk, income risk and the prioritized risk is cost risk. In more detail, this research found 11 sub-risks (sources of risk), namely five cost sub-risks, four production sub-risks and two income sub-risks. Overall, the greatest weight is on the sub-risk of low market prices, then fertilizer costs and the threat of flooding..

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REFERENCES

Cooper, O., & Liu, G. (2017). Achieving The Desired Level Of Dependency In Anp Decision Models. *International Journal of the Analytic Hierarchy Process*, *9*(1). https://doi.org/10.13033/ijahp.v9i1.450

Ekaria, E., & Muhammad, M. (2018). Analisis Risiko Usahatani Ubi Kayu di Desa Gorua Kecamatan Tobelo Utara. *Agrikan: Jurnal Agribisnis Perikanan*, *11*(2), 9. https://doi.org/10.29239/j.agrikan.11.2.9-14

Farhana T, A. M. (2018). Development Of Integrated Analytic Network Process (Anp) And Theory Of Inventive Problem Solving (Triz) In The Conceptual Design SELECTION. In *Journal of Engineering Science and Technology* (Vol. 13, Issue 9).

Fauziah, L., & Mema Parandy, L. (2024). Addressing the Global Food Security Crisis and Energy Shortages: Innovative Solutions and Policy Interventions for Sustainable Development. In *International Journal of Science and Society* (Vol. 6, Issue 1). http://ijsoc.goacademica.com

Gu, W., Saaty, T. L., & Wei, L. (2018). Evaluating and Optimizing Technological Innovation Efficiency of Industrial Enterprises Based on Both Data and Judgments. *International Journal of Information Technology and Decision Making*, *17*(1), 9–43. https://doi.org/10.1142/S0219622017500390

Hartati, T. M., Roini, C., & Rodianawati, I. (2021). Growth Response of Local Cassava to Cutting Models and the Number of Buds. *Caraka Tani: Journal of Sustainable Agriculture*, *36*(2), 379. https://doi.org/10.20961/carakatani.v36i2.37746

Komarek, A. M., De Pinto, A., & Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. In *Agricultural Systems* (Vol. 178). Elsevier Ltd. https://doi.org/10.1016/j.agsy.2019.102738

Nugroho, S. H., Bandono, A., Suharyo, O. S., & Novianto, R. 2014.). *The Selection Of Alternatives Training Ship To Substitute Kri Dewaruci For Naval Academy Cadets Using The Analytic Network Process (Anp) Method*.

Pu'u, Y. M. S. W. (2019). Relationship between Population and Intensity of Cassava Mealybug (Phenacoccus manihoti) Attack on Flores Island. *Caraka Tani: Journal of Sustainable Agriculture*, *34*(1), 61–66. https://doi.org/10.20961/carakatani.v34i1.25974

Rahayu, E. S., Setyowati, & Rahwadwiati, R. (2021). Risk analysis and revenue distribution of cassava farming as an impact of climate change in Wonogiri Regency. *IOP Conference Series: Earth and Environmental Science*, *824*(1). https://doi.org/10.1088/1755-1315/824/1/012108

Saaty, T. L. . (1999). *Decision making for the new millenium : ANP software for dependence and feedback*. [Katz Graduate School of Business, University of Pittsburgh].

Sang, A. J., Tay, K. M., Lim, C. P., & Nahavandi, S. (2018). Application of a genetic-fuzzy FMEA to rainfed lowland rice production in sarawak: Environmental, health, and safety perspectives. *IEEE Access*, *6*, 74628–74647. https://doi.org/10.1109/ACCESS.2018.2883115

Saragi, C. P. H., Nainggolan, M. F., Aulia, M. R., & Sinaga, D. (2022). Analysis of Income and Risk of Cassava Farming Business in Bosar Galugur, Simalungun, Indonesia. *The International Journal of Business & Management*, *10*(6). https://doi.org/10.24940/theijbm/2022/v10/i6/bm2206-021

Sari, D. M., Zakaria, W. A., Arifin, B., Endaryanto, T., & Indah, L. S. M. (2024). *Risk Analysis of Cassava Farming in Central Lampung Regency* (pp. 81–92). https://doi.org/10.2991/978-94-6463-510-2_8

Suryani, A., Masyhuri, Waluyati, L. R., & Utami, A. W. (2023). Risk Analysis on the Cassava Value Chain in Central Lampung Regency. *Agraris*, *9*(2), 150–173. https://doi.org/10.18196/agraris.v9i2.333

Syafei, W. A., Kusnadi, K., & Surarso, B. (2016). Penentuan Priorita Perbaikan Jalan Berbasis Metode Analytic Network Process Sebagai Komponen Menuju Kota Cerdas. *JURNAL SISTEM INFORMASI BISNIS*, *6*(2), 105. https://doi.org/10.21456/vol6iss2pp105-113

Tanjung, W. N., Atikah, S. A., Hidayat, S., Ripmiatin, E., Asti, S. S., & Khodijah, R. S. (2019). Risk Management Analysis Using FMECA and ANP Methods in the Supply Chain of Wooden Toy Industry. *IOP Conference Series: Materials Science and Engineering*, *528*(1). https://doi.org/10.1088/1757-899X/528/1/012007

Thamrin, M., Mardhiyah, A., Samsul, D., & Marpaung, E. (2013s2013s). *ANALISIS USAHATANI UBI KAYU (Manihot utilissima)*.

Zandi, P., Rahmani, M., Khanian, M., & Mosavi, A. (2020). Agricultural risk management using fuzzy topsis analytical hierarchy process (Ahp) and failure mode and effects analysis (fmea). *Agriculture (Switzerland)*, *10*(11), 1–28. https://doi.org/10.3390/agriculture10110504

Zulkarnain, Z., Zakaria, W. A., Haryono, D., & Murniati, K. (2021). Economic efficiency and risk of cassava farming in Lampung province. *International Journal of Financial, Accounting, and Management*, *3*(2), 129–148. https://doi.org/10.35912/ijfam.v3i2.433