

Farmer's perceptions on risk and determinants of risk management strategy in integrated cattle and crops farming systems

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ABSTRACT

The research was conducted to analyze farmers' risk perceptions and factors that influence farmers' decisions in implementing risk management strategies to integrated farming of cattle and crops. This study used a survey method by conducting interviews to 150 respondents who were divided into two patterns based on the composition of the farming practice. Pattern I practice cattle-rice-corn-rice business and Pattern II practices cattle-rice-corn-soybean in Grobogan District, Central Java, Indonesia. Data were collected in January - May 2019 and were analyzed using probit model on the risk management strategies adopted consisting of credit, insurance, partnerships, and off-farm income. The results showed that 59.15 percent of pattern I farmers and 47.06 percent of pattern II farmers perceived the risk of farming due to climate, market, biological and financial in the high category. Farmers' decisions in implementing risk management strategies were influenced by farmers' perceptions of climate, market, biological and financial risks.

Keywords: Crop-cattle, Insurance, Integration, Management, Risk.

INTRODUCTION

Smallholder agriculture is the key to local and global food security and it is the engine for development and economic growth for most developing countries. The majority of Indonesian farmers are small farmers with less than one hectare of agriculture (Hemas *et al.*, 2019). Rearing cattle per household farmer is relatively in a small scale which is integrated with crops, plantation crops and horticulture (Rusdiana *et al.*, 2019; Widarni *et al.*, 2020). They produce a large number of basic crops by relying on natural

processes, agricultural biodiversity, local resources and local knowledge for farming.

The increasing intensity of extreme climate happens in recent years has led to an increase in drought and flooding in many parts of Indonesia (Sumastuti and Pradono, 2016). Climate variability is a major source of risk to smallholder farmers and pastoralists, particularly in dryland regions, affecting the long-term economic viability of rainfed agriculture (Hansen *et al.*, 2019). Grobogan Regency-Central Java experiences hydrometeorological drought almost every year (Pemerintah Kabupaten Grobogan, 2016; Hastuti

et al., 2017). The price fluctuation and high dependence on natural environmental conditions such as temperature, rainfall, pollution, pests, and diseases give a major impact on agricultural production. These economic and biophysical environmental variables cause agricultural activities to face various risks and uncertainties.

Some risk management strategies are carried out by farmers in managing their farms. Risk management strategy is an important part of farmer decision making to minimize losses from farming practices (Magsakay *et al.*, 2014; and Munandar *et al.*, 2015). The common risk management strategies in Indonesia are adoption of agriculture credit, insurance, precautionary savings diversification, and integration (Akhtar *et al.*, 2019; Saqib *et al.*, 2016). However, the choice of the risk management system is usually based on farmers' perceptions of the source and impact of losses (Mase *et al.*, 2017), farmers' right attitude (Iqbal *et al.*, 2016). Farmers' perceptions and responses to risk are important in understanding their behaviour. Farmers' adoption of risk management strategies is, to a large extent, influenced by their socio-economic characteristics. In this context, the article aimed to analyze farmers' risk perceptions and factors that influence farmers' decisions in implementing risk management strategies to integrated farming of cattle and crops. These findings will guide the government in taking policy initiatives to help farmers manage risk.

MATERIALS AND METHODS

A cross-sectional quantitative study was conducted in Grobogan Regency, Central Java from January to May 2019. Based on 2018 Agricultural and Animal Husbandry Statistics data, it is known that Grobogan is a Regency with potential for beef cattle and crop farming (rice, corn, soybean) which has reached the highest production in Central Java in 2019 (Dinas Pertanian Grobogan, 2020). This study used a survey method. There were 5 districts selected purposively where two villages were taken in each district namely Nambuhan and Ngraji Village in Purwodadi District, Sulursari and Banjarejo Village in Gabus District, Panunggalan and Sidorejo Village in Pulokulon District, Pilangpayung and Krangganharjo Village in Toroh District and Karangasem and Sambirejo Village in Wirosari District. Furthermore, in each district, 30 farmers were assigned, so that the total respondents were

150 farmers. Survey farmers are grouped into two groups: farmers with a cattle-rice-corn-rice pattern (pattern I) and a cattle-rice-corn-soybean pattern (pattern II). A total of 150 farmers were surveyed consisting of 82 pattern I farmers and 68 pattern II farmers selected purposively. Farmer characteristics were tested using independent sample t-test.

The farmers were asked to provide their perceptions of the main sources of risk affecting their agricultural activities, i.e. crops and cattle. The four types of risks that farmers are known to face are climate, market, biological and financial risks. Farmers are asked to assess the incidence and severity of this risk. Climate risks are associated with losses arising from drought, heavy rain, flooding, temperature fluctuations that result in losses to livestock and crops. Market risk is related to the fluctuation of input and output prices, below average profit. Biological risks related to pests and diseases in cattle and crops. Financial risks related to fluctuations in working capital interest rates, unavailability of production loans. Ratings on a Likert scale from 1 (very low) to 5 (very high) based on their understanding of each source of risk. Akhtar *et al.* (2018) stated that the given scores are then aggregated in a risk matrix and classified as low if the scores are 2 to 5 and high if they range from 6 to 10. Figure 1 shows the risk matrix. Thus, the variable of risk perceptions is a binary variable 1 if farmers considered a risk as high, and 0 otherwise (Ullah and Shivakoti, 2014).

Probit Model

This model was to estimate the probability

5	6	7	8	9	10
4	5	6	7	8	9
3	4	5	6	High 7	8
2	3	4 Low	5	6	7
1	2	3	4	5	6
	1	2	3	4	5
			Severity		

Figure 1. Matrix of risk

Table 1. Variables Description

Variables	Description of used variables	
Farmer age	Continuous	Age of head of household in years
Farmer education	Continuous	Number of schooling years
Farm experience	Continuous	Number of farming years
Family size	Continuous	The number of members in the family in person
Number cattle	Continuous	Number of cattle owned in Animal Units (AU)
Land ownership	Continuous	Total land that managed by farmer in hectare
Gender	Dummy	1 if male and, otherwise 0
Farmer groups	Dummy	1 if the farmer actively participates in group, otherwise 0
Farm income	Continuous	All farmers' income from farming in IDR year ⁻¹
Perception of Risk		
Climate risk	Dummy	1 if climate risk value more than 5, otherwise 0
Biological risk	Dummy	1 if biological risk value more than 5, otherwise 0
Price risk	Dummy	1 if price risk value more than 5, otherwise 0
Financial risk	Dummy	1 if financial risk value more than 5, otherwise 0
Strategy Management Risk		
Insurance	Dummy	1 if have insurance, otherwise 0
Credit	Dummy	1 if have agricultural credit, otherwise 0
Partnership	Dummy	1 if have partnership, otherwise 0
Off-farm income	Dummy	1 if have off-farm income, otherwise 0

that observation with specific characteristics will fall into one particular category. This study used a probit model because the dependent variable as a risk management strategy adopted by farmers was dichotomous. Confirmation regarding the risk management strategy that has been adopted by the farmer, the set of alternatives is obtained four possibilities. Risk management strategy (1) credit, (2) insurance, (3) partnership, and (4) off-farm income. The role of agricultural credit has a significant effect on farmers' income, especially for those prone to disasters as financing can increase production (Saqib *et al.*, 2016). Insurance is a risk mitigation strategy by transferring risk to a third party (An-nisa *et al.*, 2015). The partnership program effectively increases income (Suardika *et al.*, 2015; Harjanto *et al.*, 2018). Off-farm income as income diversification has been a basic approach in managing risk (Fahad *et al.*, 2020). The probit model is given as (Akhtar *et al.*, 2018):

$$y_{ij} = x_{ij}\beta_j + \varepsilon_{ij}$$

Where y_{ij} , in this case, is binary variable for the risk management parameter ($j = 1, \dots, m$) chosen by the farmer ($i = 1, \dots, n$), x_{ij} is a 1xk as the observed variable vector that affects the chosen risk management strategies (Table 1), β_j is the kx1 vector of the unknown parameter which are to be estimated, and ε_i is the unobserved error term. In

this condition, each y_j is a binary variable for risk management strategies (credit, insurance, partnership and off-farm income), and thus eq. (2) is a system of m equations ($m=4$) to be estimated as:

RESULTS AND DISCUSSION

$$y_1^* = \alpha_1 + x\beta_1 + \varepsilon_1$$

$$y_2^* = \alpha_2 + x\beta_2 + \varepsilon_2$$

$$y_3^* = \alpha_3 + x\beta_3 + \varepsilon_3.$$

and

$$y_4^* = \alpha_4 + x\beta_4 + \varepsilon_4$$

Characteristics of Respondents

Respondent farmer households were classified into farmers with cattle-rice-corn-rice as pattern I, and cattle-rice-corn-soybean as pattern II. The respondents' characteristics in Table 2 showed that the average age of pattern II is 52.24 relatively higher farmer pattern I, but not in a significant difference. Farmers in both patterns are categorized as productive age. Data on education indicate that respondents completed their primary education (65.33 percent), and only 29,33 percent and 4 percent have attained junior and high school. It is believed that higher educa-

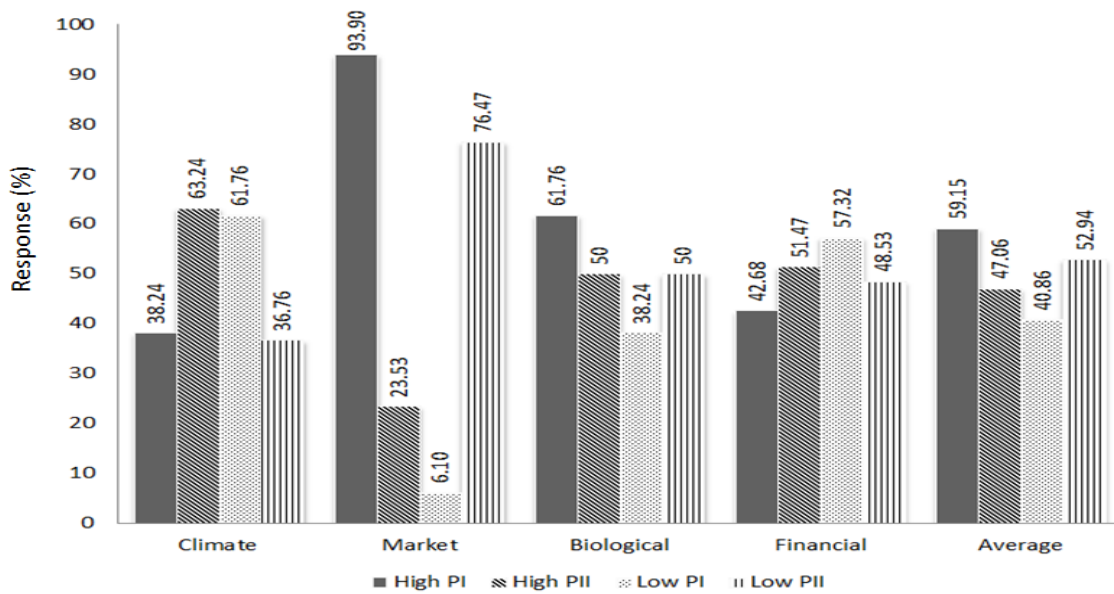


Figure 2. Composition in percent of farmers' risk perception in pattern I and pattern II

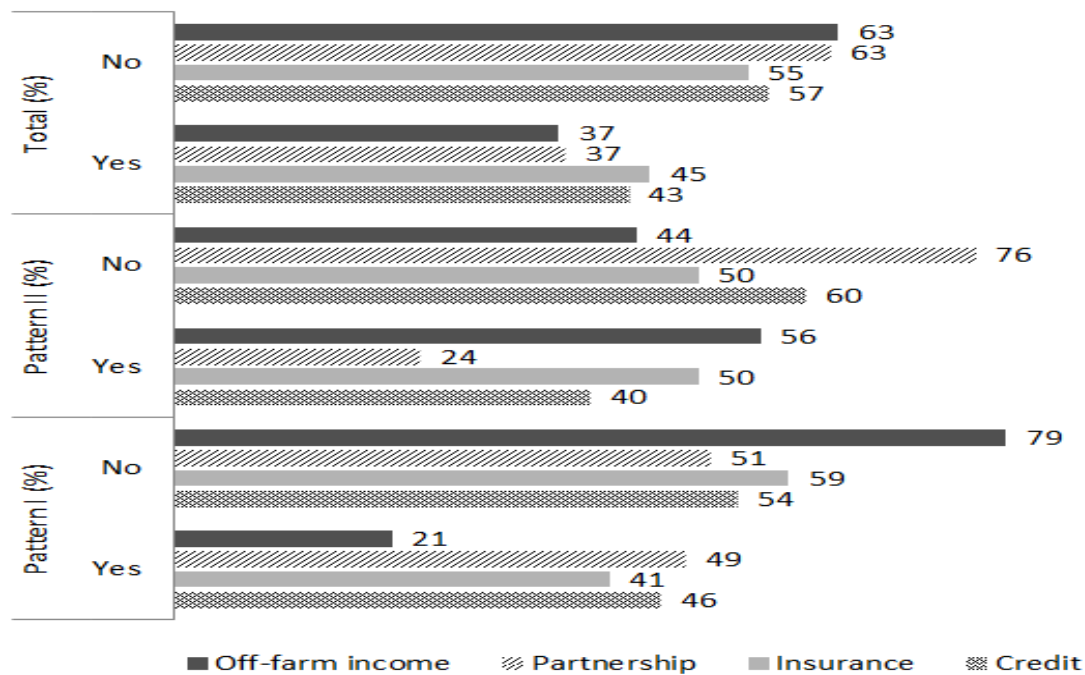


Figure 3. Adoption of risk management strategies in farming patterns I and II

tion possibly facilitates better access to information and often hypothesized to increase the probability of adopting new technologies (Amare and Simane, 2017). Household members ranged from 3 to 7 members with an average of 4 members. The average household land tenure was

0.29 hectares (0.28 hectares for Pattern I and 0.30 hectares for Pattern II). Cattle farming is a diversification of the business that can generate relatively large income per year. The contribution of income from cattle in farming was 51.99 and 66.56 percent in the pattern I and pattern II,

Table 2. Descriptive Statistics of Variables in Pattern I and Pattern II

Variables	Pattern I (n=82)		Pattern II (n=68)		p value
	Mean	Std.dev	Mean	Std.dev	
Farmer age	50.99	10.71	52.24	10.18	0.643 ^{ns}
Farmer Education	6.7	1.93	6.48	2.1	0.517 ^{ns}
Farm Experience	31.7	11.72	32.49	10.07	0.655 ^{ns}
Family size	4.19	0.92	4.04	1.19	0.756 ^{ns}
Number Cattle	1.41	0.65	1.34	0.55	0.475 ^{ns}
Land size	0.28	0.23	0.3	0.22	0.588 ^{ns}
Gender	0.93	0.26	0.91	0.29	0.737 ^{ns}
Farmer groups	0.97	0.17	0.8	0.43	0.451 ^{ns}
Farm income ^a	8,932	5,580	11,077	6,036	0.002 ^{***}
Cattle income (%)	52	12.8	66.56	17.7	0.000 ^{***}

Note: ^a) in thousands IDR year⁻¹; ns non significant; *** significant at 1%

respectively, showing a significant difference of $p < 0.00$.

Farm-level perception of risk

In the descriptive analysis, farmers' perceptions of farm risk was assessed as an independent variable. Farmers' knowledge of the probability of events and their impact is illustrated in Figure 2. The study found that as many as 59.15 percent of farmers in a pattern I and 47.06 percent of pattern II farmers perceive that the risks they face in farming practices are in a high category. Farmers' perceptions of the risks of farming practices based on climate, market, biology and finance in the two patterns have different compositions. In pattern I, the percentages assessing high category risk are market, biological risks, while in pattern II were climate, biological and financial risks. Habiba *et al.* (2012) confirm that farmers have different perceptions regarding climate change based on the physical environment, type and level of involvement in agricultural activities, which affect their financial well-being. Perception can be said to be a cognitive process as Tripathi and Mishra (2017) mentioned that even though they have correct perceptions, sometimes people cannot respond to climate change due to lack of resources, lack of information or lack of capacity.

Market or price risks reflect variations in agricultural output and input prices. However, these risks affect income variability in agriculture. Depicted in Figure 2 as much as 93.9 percent in pattern I and 23.53 percent in pattern II have a high perception of market risk. Rice farmers have a high level of dependence on subsidized fertilizers than soybean farmers. Concerns over the price fluctuations of subsidized fertiliz-

ers have led to higher perceptions of rice farmers towards risk.

There are variations in the perception of biological risk among respondents in pattern I compared to pattern II. Overall, the perception of biological risk was higher in pattern I (61.76 percent). Diseases that generally occur due to parasites in livestock (73.3 percent) and flatulence (12 percent), while rats and leafhoppers on rice plants. The ex-ante strategy through disease control in livestock and the Movement for Control of Plant Pest Organisms (Gerdal Pests) on plants is a risk management strategy implemented by farmers.

Financial risk occurred when money borrowed to finance agricultural businesses and small farmers who borrow money experiencing debt repayment difficulties (Kahan, 2013). As many as 57.32 percent in pattern I and 48.53 percent in pattern II have a low category of financial risk perceptions.

Factors affecting Risk Management Strategy

The results of the analysis of the application of risk management are presented in Figure 3. In the study location, there are several risk mitigation options and measures to protect against income volatility. For example, the credit package for the procurement of production factors was adopted as much as 43 percent, of which 70.27 percent obtained access from commercial institutions, while the rest came from farmer groups and family or relatives. Accessing credit for cattle or plants has a requirement to join a farmer group. Farmers prefer access to credit at informal institutions because the requirements for obtaining it are not complicated. Informal institutions that play a role include agricultural input traders,

Table 3. Parameter Estimates of the Probit Model

Variables	Credit	Insurance	Partnership	Off-Farm Income
Intercept	1.6225 (1.3427)	3.5325** (1.7251)	0.4120 (1.3646)	1.3464 (1.4382)
Age	-0.0048 (0.0291)	0.0161 (0.0357)	0.0115 (0.0288)	-0.0140 (0.0301)
Education	-0.0275* (0.0592)	0.0247 (0.0735)	0.0348 (0.0601)	-0.1070* (0.0641)
Experience	-0.0118 (0.0288)	-0.0458 (0.0365)	-0.0252 (0.0286)	-0.0171 (0.0297)
Family member	0.0919 (0.1171)	0.0813 (0.1510)	0.1153 (0.1169)	0.1092 (0.1309)
Land	0.9556 (0.7662)	0.2786 (0.9545)	0.5148 (0.7751)	1.2997 (0.8771)
Cattle	-0.3791 (0.2665)	-0.2406 (0.3457)	-0.1994 (0.2699)	-0.6654** (0.3174)
Gender	-0.0236 (0.4813)	0.6154 (0.5786)	0.6117 (0.4852)	0.6113 (0.5222)
Participation FG	-0.0086 (0.0084)	-0.0093 (0.0103)	-0.0130 (0.0085)	0.0249** (0.0095)
Income	0.2701 (0.4714)	-0.3684 (0.6477)	-0.9027* (0.5059)	0.4042 (0.4930)
Perception of risk ^a				
Climate	-1.1657*** (0.3450)	-2.1449*** (0.4884)	-0.6449** (0.3276)	-1.0836*** (0.3348)
Market	0.8052* (0.4614)	0.4241 (0.5719)	1.2937** (0.5203)	-0.4448 (0.5032)
Biological	-1.2272*** (0.2890)	-2.5236*** (0.4163)	-1.4220*** (0.3022)	-1.5855*** (0.3230)
Financial	0.3424 (0.2805)	0.5431* (0.3305)	0.3801 (0.2919)	0.3547 (0.3192)
Log likelihood	-75.7640	-48.0096	-72.8236	-64.1760
LR χ^2 (13)	53.7415***	110.6163***	54.5229***	68.7953***
Pseudo R ²	0.2618	0.5353	0.2724	0.3490

^adummy variable 1 for high criteria and 0 otherwise.

Standard errors are in parenthesis. *, ** and *** represent significant at 10%, 5% and 1% probability level respectively.

agricultural product traders or traders who both function (Pratiwi *et al.*, 2019).

Since the release of an insurance program by the government in 2015, it aims to protect the risk of crop failure in rice farming insurance. Then, in 2016 the cattle insurance was released as a risk protection for the death and loss of cattles. These programs can be accessed through farmer groups as a requirement for participants. Insurance participants in the study lo-

cations were 45 percent, both rice insurance and cattle insurance. A study reported by Ambarawati *et al.* (2018) reveals that most farmers ask for full subsidies from the government, not a 20 percent premium payment. In fact, in terms of rice insurance, the government subsidizes 80 percent, and 20 percent is the farmers' duty to pay premiums, guarantees, and claims.

Partnership in agricultural midwives is a concept of cooperation between two or more par-

ties in certain farming activities. Farmers in the study locations generally collaborate with production factor distributors and village collector, also known as "middlemen". As many as 40 percent collaborated in the form of supply of production factors, especially seeds and fertilizers from partners, and calculated with agricultural production after harvest. Pasaribu (2015) states that farmers involved in a partnership pattern get social and economic benefits.

Off-farm income is mostly done by farmers and their families, especially their wives and adult. As many as 37 percent of farmers get off-farm income opportunities, such as casual construction workers and farm laborers. Between the two patterns, farmers in pattern II (44 percent) have a higher chance than farmers in pattern I (21 percent) because the working time of soybean farmers in the fields is less than rice farmers (Figure 3). This activity is mostly carried out by farmers in other developing countries, as Loison (2015) reported that rural farmer households in SSA-Southern Sahara Africa diversify their livelihoods in non-agricultural activities, including migration, especially to minimize risks and increase their income.

The probit model used in the study to assess the impact of socio-economic factors and their perceptions of risk is shown in Table 3. The equation results for risk management strategies show that lower levels of education and their perceptions of climate, market, and biological risks influence credit strategies' adoption. The higher their perception of climate and biological risks, they are not interested in adopting farm credit. This consideration is based on the ability to repay their credit if the farm yield is unpredictable. On the other hand, the higher their perception of market risk follows the credit adoption decision. Tawaf (2018) found that the beef cattle partnership model between farmers and feedlot companies still finds financing problems when it is done intensively. They still experience obstacles related to product distribution and payment, in contrast to implementing a partnership pattern between rice farmers and companies that have felt economic and technical benefits (Priandika *et al.*, 2015).

The results show that the decision to adopt insurance is more influenced by their perception of climate risk, biological in an inverse relationship, where the higher their perception of climate risk and biological, the less interested in adopting insurance. When facing this risk, farmers

prefer to take care of their own risk by using their money to buy pesticides and medicines rather than paying for insurance premiums. However, the higher their perception of financial risk, the higher it is for insurance adoption. Agricultural insurance is one way of managing risk; however, insurance has a similarly out-of-reach history for those in rural areas like most financial services. Some insurance products are not yet accessible to rural communities due to a lack of distribution networks and high premium costs (Ardiana and Agusta, 2018).

The analysis results show that the smaller income, the higher the perception of climate risk and the biological risk, so they are less interested in engaging in partnerships. Conversely, the more their perception of market risk increases, the more considered partnership adoption. The analysis of off-farm income shows that those with less education do not implement this risk management strategy, fewer cattle raised, and their perceptions of climate and biological risks. Meanwhile, farmers who actively participate in farmer groups open opportunities to earn off-farm income. In contrast to farm-level adjustments, farmers employ various adaptation practices outside of agriculture to address underproduction.

CONCLUSION

The characteristics of respondent farmers in both patterns are relatively the same except for pattern II farm income, which is significantly higher than pattern I. Farmers' perception of farming risks includes climate, market, biological and financial risks. In pattern I (cattle-rice-corn-rice), the risk of farming they face is higher than in pattern II (cattle-rice-corn-soybean). The ranking of risk management strategies adopted by farmers in pattern I is a partnership, credit, insurance, and off-farm income. In pattern II, respectively, are off-farm income, partnership, credit, and insurance. The adoption of risk management strategies is influenced by farmers' perceptions of the farming risks they face. Perceptions of climate, market, biological and financial risks are significant factors that form the basis for decisions on adopting credit, insurance, partnerships, and off-farm income strategies.

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