Research article

Factors affecting risk tolerance among small-scale seasonal commodity farmers and strategies for its improvement

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ABSTRACT

In developing countries, farming businesses are dominated by small-scale farmers with limited resources. Such farmers are subjected to high risks, influencing the success rate of their agricultural endeavors. This study, conducted in Aceh Province, Indonesia, measured the risk tolerance among six groups of farmers with businesses based on the following seasonal commodities: paddy, corn, soy, chili, potato, and tomato. A total of 360 respondents were surveyed and 54 key respondents interviewed. A Likert scale was used to assess the risk tolerance levels of the farmers, and ordinal regression analysis to analyze the factors influencing risk tolerance. Paddy, chili, and potato farmers had a relatively high tolerance to farming risks, whereas corn and tomato farmers showed a moderate tolerance. Soy farmers were classified into the low risk tolerance category. Ordinal analysis indicated that the risk tolerance of farmers in each commodity group was influenced by specific factors. Overall, it was found that the farmers' attitudes to risk tolerance were significantly affected by the following factors: experience, education, farming income, capital, land status, and land size. An intervention strategy including improvements in the curriculum, actors, network, scope of clusters, and technology are among the strategies required to positively improve farmers' perceptions and increase their tolerance to farming risks.

1. Introduction

Research on risk in various business sectors has gained attention in the last decades, including in the agricultural sector. Climate change, economic globalization, and technological developments are among the factors causing uncertainty in farming businesses (Jianjun et al., 2015). In addition, agricultural sectors are subjected to higher risks than non-agricultural sectors (Roe 2014). Risks in agriculture depend on geographical location, legislation and policies, presence of risk management tools, type of commodity, production, markets, personal and institutional risks, and disaster-related factors (Ullah et al., 2016).

Risk is defined as any situation in which the outcome of one or more events is not known with certainty or not known for sure, ahead of time (Chavas 2004). Risk could cause hesitation in farmers regarding the application of treatments to their businesses owing to the possibility of failure, despite probable high incomes accruing from such actions. Farmers’ risk tolerance can be defined as the courage to apply various innovations to increase agricultural productivity in the midst of uncertain situations in the future. Risk tolerance is affected by various factors, including age and education level, monthly income outside farming, status of land ownership, informal funding access, experience in farming, size of land, and perception of climate change (Jianjun et al., 2015; Ullah et al. 2015). It has also been found that gender affects the risk tolerance among farmers in Yongqiao, China, where women tend to be less willing to take risks than men (Jianjun et al., 2015).

Because the factors affecting farmers’ risk tolerance differ according to the type of farming business and the farmers’ perception of risk, management strategies should be farmer-specific so that applied strategies can address the needs and motives of specific farmers. For example, disease reduction, financial management, diversification, and market networks are considered effective risk management strategies for dairy farmers in Tigray, Ethiopia (Gebreegziabher and Tadesse 2014). In another study, hedging modeling was found to be effective as a risk management strategy for wheat farmers (Rusnáková et al. 2015).

To motivate farmers to have higher risk tolerance, it is important to increase their awareness about the possible effects of potential risks. This can be achieved by improving their skills and knowledge, providing up-to-date information, and increasing their adaptive capacity (Zeweld...
Farmers who receive capacity-building training tend to have a positive attitude toward new technology and innovations and are more risk tolerant.

In previous studies, assessments of risk tolerance have mainly focused on specific farming businesses. However, assessments that compare the risks among groups that farm various commodities at specific times and locations are still few in number, especially in developing countries where farmers face a variety of shortages and limitations in their businesses. In a tropical region where cultivation is not restricted by climate, farmers may choose different commodities according to their individual experiences and preferences. Therefore, various commodities can be cultivated at the same time in the same region, which may influence the risk. These farmers may face different risks according to their chosen commodity, but they may also share common ones. Thus, it is necessary to investigate the various factors that affect risk and how risk is shared among groups of farmers who farm different commodities at the same time in the same location.

Indonesia is one of the world’s developing countries located in a tropical region, where the majority of farmers have small-scale businesses based on seasonal commodities with an average land ownership of 0.6 ha and an annual crop production revenue of USD 573 (Glance 2018). Since these farmers have limited resources, such as land, capital, and labor, it is important for them to apply farming innovations to increase the productivity of their businesses. In this study, risk tolerance is defined as the attitude of small-scale farmers to the acceptance and application of various business innovations. An assessment of risk tolerance was conducted by identifying and comparing the perceptions and attitudes toward farming innovations among farmers of six seasonal commodities. A common region was chosen to determine whether common factors affecting risk tolerance are shared among groups farming different commodities. The assessment results were used to formulate an intervention strategy to improve the farmers’ attitudes and increase their tolerance to farming risks.

2. Materials and methods

This study followed several steps: selection of the study area, design of the survey instruments, collection of primary data, analysis, and evaluation. An intervention strategy aimed at improving farmers’ attitudes and increasing their tolerance to farming risks was proposed, based on the results of the evaluation.

The study was conducted in five districts in Aceh Province, Indonesia (Figure 1). Based on 2019 data obtained from the Aceh Province Statistics Office (Aceh Province Statistical Office, 2019), these districts were chosen because of the relatively high productivity of the six commodities: paddy, soy, chili, potato, corn, and tomato farmed in these districts. In the study region, farmers tend to select commodities based on subjective preferences during particular cultivation seasons. Therefore, the commodities chosen from one season to the next could be different. Because of this, respondents were selected only if they could be classified into a selected commodity group and had experienced at least one cultivation season so that they could share their experiences and perceptions about farming the commodity. It was found that, of the six commodities included in the study, soy was the least farmed, with an estimated seasonal so that they could share their experiences and perceptions about selected commodity group and had experienced at least one cultivation

The chosen respondents were considered small-scale farmers or smallholders based on several criteria, including the size of land in their possession and the amount of annual revenue they earned. “Smallholders are defined as producers with less than 5 ha, 5 tropical livestock units (TLUs) and 8405 USD of revenues” (Khalil et al., 2017, page 29). In Indonesia, the average land ownership of small farmers is 0.6 ha, and the annual crop production revenue is USD 573 (Glance 2018). For the respondents selected in this study, the mean land ownership for the six commodities ranged between 0.31 and 1.12 ha, and the mean value of annual farming income ranged between USD 778 and USD 1496.

The primary data were collected using a survey and interview process. The survey was conducted with all 360 respondents from the six commodity groups to determine the attitude of the farmers toward farming risk tolerance and its influencing factors. After the data from the survey were collected and analyzed, the results were validated by interviewing 54 key respondents. The interview group consisted of nine respondents from each commodity group selected using the criteria: experience, and leadership (leaders of farming groups), and through nomination (by other farmers). The key respondents were asked to perform a self-assessment of their perceptions and expectations of the selected commodity (S1). The results of the survey and interview were used to formulate an intervention strategy aimed at increasing the risk tolerance levels of the farmers. Such methods have been used previously to investigate farmers’ perceptions of the risks, risk attitudes, and benefits accrued from a risk management strategy (Wauters et al., 2014). In this study, information was initially collected from 54 key informants, followed by the completion of the Flemish Farm accountancy data network survey by 614 respondents. The self-assessment approach was also used in a study of Polish farmers’ risk attitudes (Sulewski et al., 2020).

The data acquired from the survey were quantified using a Likert scale based on the criteria presented in Table 1. A risk-averse attitude was classified at a low level, while a fully prepared to take risks attitude was classified at a high level. As most respondents had a low level of education, it was assumed that they might face difficulties differentiating the risk attitude levels among the scale points. Therefore, to gain a more accurate measurement of risk attitudes, farmer risk tolerance was measured based on the farmers’ survey (S2) answers regarding the courage and effort they made when dealing with risk. The respondents were asked about their attitude when facing various risks associated with

![Figure 1. Location of the five districts in Aceh Province, Indonesia, from which 360 small-scale seasonal commodities farmers were randomly selected to participate in survey of farming risk assessment.](image-url)
The ordinal logistic regression model used the logit equation

\[
\logit(Y_j) = \theta_j + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p.
\]  

(2)

where \(\theta_j\) is the intercept vector parameter of \(\logit(Y_j)\), and \(\beta_k\) is the slope vector parameter \(X_k\) \((k = 1, 2, \ldots, p)\), and \(p\) is the number of variables.

In this model, the ordinal property of response \(Y\) is manifested in cumulative opportunity so that a logit cumulative model is a model achieved by comparing the cumulative opportunity, which is less than or equal to the category of the \(j\)-th response at the \(p\) predictor variable defined by vector \(X\), \(P(Y \leq j|X)\), to the larger opportunity than the response category of the \(j\)-th; \(P(Y > j|X)\) (Hosmer and Lemeshow 2005).

The cumulative opportunity \(P(Y \leq j|X)\) is defined as

\[
P(X \leq j|X) = \frac{\exp(\beta_0 + \sum_{k=1}^{p} \beta_k X_k)}{1 + \exp(\beta_0 + \sum_{k=1}^{p} \beta_k X_k)}
\]  

(3)

where \(j\) is the response category of \(j = 1\) to \(n\) with \(n = \) number of category levels.

If there are \(j\) response categories, the logistic ordinal model obtained is as follows:

\[
\logit(Y_1) = \ln\left(\frac{Y_1}{1 - Y_1}\right) = \theta_1 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p,
\]  

(4)

\[
\logit(Y_2) = \ln\left(\frac{Y_2}{1 - Y_2}\right) = \theta_2 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p,
\]  

(5)

\[
\logit(Y_{n-1}) = \ln\left(\frac{Y_{n-1}}{1 - Y_{n-1}}\right) = \theta_{n-1} + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p.
\]  

(6)

In this study, the values for \(p\) and \(n\) are 7 and 11, referring to the seven variables (Table 2) and the 11 scale levels (Table 1).

3. Results and discussion

Farmer risk tolerance is defined as the extent to which a farmer is willing to apply various innovations or treatments to increase the productivity of, or profit from, a chosen commodity. Based on the levels of risk tolerance described in Table 1, the percentile distribution of the farmers’ risk tolerance of the six commodities (paddy, corn, soy, tomato, chili, and potato) are shown in Figure 2. The risk tolerance of paddy,
chili, and potato farmers was categorized as high because these commodity groups had at least one percentile that reached risk tolerance level 8. Corn and tomato farmers were categorized as having a moderate level of risk tolerance because only the 50th and 75th percentiles reached level 7. Farmers in the soy group were categorized as having low risk tolerance because the level was lower than 4 for all percentiles (25, 50, and 75).

Descriptive statistics of the farmers in each of the six commodity groups (Table 3) indicated that all farmers in this study had small-scale farming businesses with mean values of farming incomes between USD 351 (soy) and USD 1496 (tomato), and mean land areas between 0.31 and 1.12 Ha. Chili farmers had the most capital (mean: USD 1495), whereas the least capital was associated with soy farming (mean: USD 48).

The ordinal regression analysis of the factors influencing the farmers’ risk tolerance for all commodity groups indicated a relatively small R² value (less than 0.4) for each commodity group (Table 4). However, these values were larger than those reported by Aditto et al. (2012) and Asravor (2018). A lower R² value in the regression model indicates a larger diversity in the respondent’s perception of risk. Therefore, the larger R² values in our analysis than those in prior studies indicated a less diverse perception of risk among the farmers as the regression was conducted separately for each commodity group. Data in brief concerning the farmers’ risk tolerance among the six seasonal farmed commodities is provided (S3).

Table 4 shows that four significant factors influenced the paddy farmers’ risk tolerance: age (0.114), experience (−0.229), education level (0.440), and land ownership (2.057). However, experience affected risk tolerance in a negative way. In this study, the mean age of farmers in the paddy commodity group was 38 years, suggesting that this group had relatively more stable psychological behavior toward managing risk. Such a relationship has been used by Meraner and Finger (2019) to explain the risk behavior of farmers. Older farmers tended to be more selective when choosing seeds, especially ones with which they have had prior experience. However, farmers with more experience tended to be less susceptible to newly introduced innovations, such as new superior seeds and improved cultivation techniques. Interviews conducted with key respondents revealed that this hesitancy was related to their inability to foresee the production results of new innovations; they were worried about failure. These farmers indicated that they would rather use proven techniques than take the risk of using new techniques. This explains why, in this case, experience affected risk tolerance in a negative way. The experience factor also had a negative influence on risk tolerance of tomato farmers (with a significant value of −0.229). Similar to the paddy group of farmers, the mean age and experience of tomato farmers was 38 and 10 years, respectively. In addition to experience, the reluctance of tomato farmers to take risks was caused by market price risk, which is highly variable owing to the lack of post-production processes. In contrast to rice and tomato farmers, experience affected the risk tolerance of corn farmers in a positive way. This could be because corn farmers (mean years of experience: 5.6 years) were relatively less experienced than paddy and tomato farmers. This result is comparable to that of a previous study in which less experienced farmers tended to be more susceptible to risks (García-Pabon 2011).

Education affected the risk tolerance of paddy farmers in a positive way because educated farmers tended to have a higher awareness, and the knowledge necessary to increase their capacity to adopt innovations in their businesses. Farmers with higher education levels and experience tended to have a better initiative, causing them to be more tolerant to business risks (García-Pabón 2011; Miyata 2010). Other researchers have reported that education level is proportionally related to willingness to take risks (Ullah et al., 2016). More educated households were found to have a better understanding of risk than those with lower education levels (Asravor 2018). Other than paddy farmers, education also had a significant influence on corn and tomato farmers (0.175 and 0.424, respectively). In this study, the mean value of education for paddy and tomato farmers was 11.52 years, whereas for corn farmers, it was 9.32 years. However, despite the relatively high mean values, the level of education did not significantly affect the risk tolerance of chili and potato farmers (mean values: 11.07 and 10.47 years, respectively). This may be
Table 3. Descriptive statistics showing the mean value of the farmer characteristics (variables) in this study.

| Variable               | Main Agricultural Commodities |
|------------------------|------------------------------|
|                        | Paddy | Corn | Soy  | Chili | Potato | Tomato |
| Risk tolerance level   | 7.17 [7; 8] | 6.97 [6; 8] | 4.45 [1; 8] | 7.58 [7; 10] | 7.30 [6; 10] | 7.17 [7; 8] |
| Age (years)            | 38.03 [20; 60] | 43.30 [24; 78] | 46.63 [28; 72] | 39.20 [20; 60] | 37.90 [23; 65] | 38.03 [20; 60] |
| Experience (years)     | 10.05 [1; 33] | 5.60 [0.25; 58] | 4.67 [0.25; 40] | 8.02 [0.25; 28] | 10.31 [1; 50] | 10.03 [1; 33] |
| Education (years)      | 11.52 [6; 16] | 9.32 [0; 16] | 8.75 [0; 15] | 10.42 [6; 16] | 11.07 [0; 16] | 11.52 [6; 16] |
| Farming income (USD)   | 1228.92 [207.31; 4837.18] | 778.44 [41.46; 4837.18] | 351.89 [9.67; 1036.54] | 1496.19 [103.65; 11056.40] | 1375.89 [96.74; 6910.25] | 1128.91 [103.65; 6910.25] |
| Capital (USD)          | 470.36 [103.65; 1727.56] | 258.70 [8.29; 1382.05] | 177.10 [25.57; 1382.05] | 472.04 [55.28; 2764.10] | 1495.61 [186.58; 6219.23] | 474.85 [27.64; 2073.08] |

Land ownership status:

| Owned (%)             | 58.33 |
| Rented (%)            | 41.67 |
| Land area (Ha)        | 0.31 [0; 0.6; 1] |

Table 4. Results of ordinal regression of factors that influence farmers’ risk tolerance.

| Variable     | Commodity |
|--------------|-----------|
|              | Paddy | Corn | Soy  | Chili | Potato | Tomato | Overall commodities |
| Age (X1)     | 0.114** | 0.001 | –0.001 | 0.003 | 0.020 | 0.098 | –0.007 |
| Experience (X2) | –0.229** | 0.140** | 0.001 | –0.012 | 0.029 | –0.207** | 0.099*** |
| Education level (X3) | 0.440* | 0.175* | 0.076 | 0.193 | –0.030 | 0.424* | 0.130*** |
| Farming income (X4) | 0.031 | 0.064 | 0.281*** | 0.022* | 0.000 | 0.030 | 0.050*** |
| Capital (X5)   | 0.193 | 0.408** | –0.231** | 0.075* | 0.002 | 0.086 | 0.033*** |
| Land ownership status (X6) | 2.057** | 0.146 | –2.579*** | 0.519 | –1.156* | 2.075** | –0.591** |
| Size of land area (X7) | –4.213 | –2.046* | –0.4400** | –0.467 | 0.017 | –2.336 | –0.529*** |
| Log likelihood  | 54.067 | 61.530 | 189.432 | 115.478 | 90.526 | 54.067 | 781.518 |
| LR Chi-square  | 42.511 | 144.760 | 384.519 | 164.475 | 182.801 | 43.818 | 2201.413 |
| Pseudo R²      | 0.218 | 0.219 | 0.388 | 0.239 | 0.086 | 0.273 | 0.70 |

Note: ***, **, and * show statistical significance with confidence levels of 99%, 95%, and 90%, respectively.

related to a greater effect of other factors such as the high market price of chili products and the low availability of farming input for potato cultivation.

With rice being the staple food in the region, paddy cultivation has become a way of life for farmers. In the paddy cultivation season, all farmers opt for paddy cultivation, regardless of how promising the market prospects of other commodities are. Therefore, farmers will use all available land to cultivate paddy. This was reflected in the significant positive relationship between the land ownership status factor and risk tolerance of paddy farmers. Similar to paddy farmers, the land ownership status factor also had a significant positive influence (2.076) on tomato cultivation.

As mentioned by Chaudhry (2009), capital is very important for obtaining high-quality production input to increase productivity. Available capital affects farmers’ decisions to purchase high-quality seed as well as to adopt innovations to optimize production. Capital tends to drive farmers to be more tolerant to business risk (Faruq and Telaroli 2011). However, in this study it was found that corn farmers had little confidence in the quality of seed provided by the government, because it did not always result in high productivity. Therefore, those who had capital were willing to acquire their own superior seed and, thus, take more risks, whereas farmers with little capital were less willing to increase the area of land for corn cultivation. In some cases, they even switched the available land to other commodities requiring less capital. For this reason, the size of land factor had a negative influence on the corn farmers’ risk tolerance, as reflected in this study.
The capital factor also significantly influenced farmers’ risk tolerance with respect to chili (0.075) and soy (−0.252) production. Chili farmers commonly expected a high income due to chili’s relatively high market demand and price all year-round. Since chili is a commodity excluded from government subsidies, farmers must use their own capital to obtain high-quality input. Therefore, farmers willing to spend more capital showed higher risk tolerance. This was related to another significant factor affecting the risk tolerance of chili farmers, farming income (0.022). This finding is supported by Jankelova et al. (2017) who reported that farmers in Slovakia considered the price risk and production or income risk as important risk factors. Farmers with higher incomes also tend to be more selective in their commodity choice (Schluter and Mount 1976). Moreover, farmers that have more access to capital are more amenable to production risk (Asravor 2018). The expectation of receiving a high income can also increase farmers’ risk tolerance (Roe 2014).

The negative effect of the capital factor on farmers of soy was caused by the low market value of soybeans, which tended to make farmers avoid investing their capital in soy production. Besides the price risk, soy is also prone to pests and diseases, thus, requiring higher capital to manage production. To decrease the hesitancy among farmers, the government has been providing various farming input subsidies to increase local soybean production and decrease imports of this commodity. Therefore, although the market price of soybeans is relatively low, the farming income of soybean farmers is relatively high owing to low investment capital needs. This explains why farming income had a significant influence on the risk tolerance of soy farmers (0.269). Farmers with little capital were willing to take more risks in the soy business because of the government subsidies available. However, farmers with more capital tended to choose other commodities, such as chili, because of the higher income potential.

From the above discussion, it can be summarized that age had a significant influence on level of risk tolerance in only one group (paddy farmers), whereas experience significantly influenced three farmer groups (paddy, corn, and tomato). Education level significantly affected the same three groups as experience (paddy, corn, and tomato), whereas farming income significantly influenced the risk tolerance levels of two farmer groups (soy and chili). The capital factor significantly affected three farmer groups (corn, soy, and chili), whereas the land ownership factor significantly influenced four farmer groups (paddy, soy, tomato, and potato). The size of the land significantly affected only one group of farmers (corn). Regression analysis of overall respondents for all commodities indicated four factors with a significant positive influence on farmers’ risk tolerance: experience, education, farming income, and capital, and two factors with a significant negative influence: land ownership status and size of land.

The findings of this study showed that, in terms of socioeconomic characteristics, the significant factors influencing farmers’ risk perception depended on the commodity or farming business. Certain factors, such as experience and education, were found to be significant for several commodity groups (paddy, corn, and tomato), whereas other factors, such as age and land size, significantly influenced only certain farmer groups (paddy and corn, respectively). In prior studies of smallholder farmers, age and education were found to significantly influence the risk attitude among crop farmers in South Africa (Kisaka-Lwayo and Obi 2012). Besides age and education, farm size, experience, farming income, and capital were found to be significant among crop farmers in Ghana (Aditto et al. 2012). In another study, age, farm size, and farm income were found to be significant for risk perception of fish farmers in Thailand (Aditto et al., 2012).

Furthermore, according to the results of our study, farmers of paddy, chili, and potato were grouped into the high risk tolerance category, indicating that these farmers had already implemented at least one innovation to improve the productivity of their commodities. Farmers in these commodity groups were considered to have a good attitude toward farming risks and to be ready to accept new techniques or innovations in their businesses. However, the risk tolerance levels of these farmers could be further increased by improving their attitudes and capacity in relation to the significant factors affecting the risk tolerance level of the respective groups and/or by providing solutions to the problems they faced. From the interviews of key respondents in these groups, it was noted that the common problems faced by these particular farmers (paddy, chili, and potato) were availability and access to high-quality seed and market price fluctuations. Therefore, to increase the capacity of these farmers, for example, by reducing the hesitancy to adopt new innovations among experienced paddy farmers, it is necessary to improve the content of counseling to include not only technical aspects but also capacity building toward behavioral change. The risk tolerance levels of the farmers in these groups could be increased by providing them with the necessary skills to implement farming techniques or innovations related to high-quality seed production and agro-industry and post-production processes. Furthermore, a cluster scope approach is considered crucial for small-scale farmers because it will enable farmers to have high crop productivity, increased market orientation, and high value-added production (Galvaet-Nogales 2010). This strategy should be supported by capacity building through curriculum improvement as well as institutional strengthening and development of networking, technology, and marketing partnerships.

The tolerance to risk of tomato and corn farmers was within the moderate category. Farmers in this category tended to avoid implementing new techniques or farming innovations in their farming businesses, even though they may have had some skills or knowledge about these innovations. This reticence to innovate associated with the tomato farmers’ group could be related to the speculative behavior of these farmers owing to the less predictable market price of tomatoes. Although the demand for fresh tomato products in the region is quite stable, there is instability in product availability. Market prices usually decrease at the peak harvest time, but at other times, the farming income from one season can reach three times the production costs. Because of this unpredictability, farmers tended to avoid implementing innovations that required additional capital because of the possibility of higher losses if the market price declined. To increase the risk tolerance of farmers in the tomato group, it is necessary to provide them with post-production process access or skills. The cluster scope approach could also improve the stability of tomato production capacity to achieve a more stable market price, thus, increasing the farmers’ tolerance to risks.

Farmers in the corn commodity group, although having a moderate risk tolerance level, shared common problems with farmers in the soy commodity group, classified in the low risk tolerance category. Farmers of both these commodities received seed and fertilizer subsidies from the government to increase the national production of corn and soybean. Spicka et al. (2009) found that subsidies can decrease the variability of a farmer’s income and provide suitable supplementary tools for risk management. However, despite the subsidies, the risk tolerance level of these farmers was still low, which could be attributed to problems associated with low seed quality, pest and disease control, and low market prices. As both these commodities can be cultivated in similar soils, soy farmers sometimes opted for corn cultivation owing to the perception of obtaining better farming income from corn. As a consequence of these problems, the majority of soy farmers in this study had not considered any innovation in an effort to increase productivity because of a concern that implementing cultivation innovations would add more cost and further decrease the income margin.

The findings of this study showed that not all variables significantly influenced the risk tolerance levels of the respondents. Overall, the age factor did not have a significant relationship with the farmers’ tolerance attitude, a result supported by the findings of Hawley and Fujii (1993). Their study also found that richer respondents are less likely to take financial risks, whereas those with higher education levels are more likely to take financial risks. This supports the findings of our study that the capital factor, in general, did not significantly influence farmers’ risk
tolerance levels, whereas the education factor did have a significant influence.

Because of differences in the nature of research and characteristics of people in various types of businesses, it is possible to have a different trend concerning the influence of similar parameters in various studies. For example, Roe (2014) found that age has a significant effect on the risk tolerance of all farming commodities in the United States. However, this finding does not agree with that of Hawley and Fujii (1993) or with findings in our study. This discrepancy could be caused by differences in the farmers’ sociocultural characteristics as well as the related risk management policies in the region.

The relationship between risk tolerance and productivity of farmers is also debatable because the application of various innovations in farming businesses has implications for farming expenditures (Vigani and Kathage 2019). In our study, there was inadequate data to determine whether productivity was positively related to a farmer’s level of risk tolerance. Nevertheless, improvement in farmers’ attitudes toward risk tolerance is considered important for small-scale farmers because of their limited access to other resources such as land, farming capital, and labor.

The findings of this study suggest that improvement in the attitudes of the farmer groups toward accepting and applying innovations in their businesses (i.e., increasing the risk tolerance level) could be accomplished using an intervention strategy, as shown in Figure 3. The strategy involves improving the following aspects: 1) curriculum, 2) actors, 3) network, 4) cluster scope, and 5) technology. Curriculum improvement is necessary to increase the human capacity of farmers aiming to change their behavior toward technology and innovations. The counseling content should consist not only of new techniques or innovations but also hands-on skills development and evidence-based learning. For this purpose, actors (agents of change) are necessary. These actors should not only be government instructors but also experts from universities and NGOs. This will provide an integrated system as well as innovation exchange opportunities among the stakeholders (the network) to promote a suitable environment that will result in behavioral change and risk tolerance increase. The network should cover not only the primary groups of farmers (according to their current practice) but should also include marketing partner groups to assist with improving the problems associated with high fluctuations in market prices.

To create a conducive environment for implementation of the intervention strategy, a cluster approach based on commodities is necessary. Such a cluster approach has advantages, including creating an enabling environment for inter-farmer cooperation, facilitating the diffusion of innovations, and providing a means to efficiently channel public support (Gálvez-Nogales 2010). Farmers and the market can benefit from participating in the cluster as they enjoy mutual advantages. The fifth aspect, technology, is also important because a strategy related to technology could enable farmers to cope with various uncertainties in their farming businesses.

The implementation of this intervention strategy requires strong support from the policy-makers and other relevant stakeholders. The respondents themselves had a positive attitude toward this strategy. The interview with key respondents revealed a common perception among farmers that improvement in counseling subjects, better understanding of post-production technology, value-added processes, and seed production techniques are factors required for a higher tolerance toward risk as well as support from industry.

4. Conclusion

It can be concluded from our study that paddy, chili, and potato farmers can be grouped into the high risk tolerance category, farmers of corn and tomato into the moderate risk category, and soy farmers into the low risk tolerance category. A significant influence of the experience factor on risk tolerance level was common among groups that farmed paddy, corn, and tomato. Education had a significant effect on the risk tolerance level of paddy, corn, chili, and tomato farmers, whereas the significant influence of the capital factor was common among the groups that farmed corn, soy, and chili. The land ownership factor was found to
be significant to the risk tolerance level of paddy, soy, potato, and tomato farmers. However, the age factor influenced only paddy farmers. To increase risk tolerance among the smallholder farmer groups, it is necessary to improve the curriculum by including subjects aimed at increasing the capacity of farmers to change their behavior toward technology and innovations and to provide evidence-based learning. The success of this curriculum requires the role of actors (agents of change) not only from government institutions but also experts from universities and NGOs. Furthermore, to create a controllable environment for implementation of an intervention strategy, a cluster scope approach is necessary, which will potentially create a suitable environment to facilitate the diffusion of innovations, promote inter-farmer cooperation and capacity building, and provide a mutual advantage to farmers and markets. Policies and support from stakeholders are required for the success of the cluster scope implementation.

Declarations

Author contribution statement

Agussabti Agussabti: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.
Romano Romano: Performed the experiments; Analyzed and interpreted the data.
Rahmaddiansyah Rahmaddiansyah: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.
Rohayati Mohd Isa: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data included in article supplementary material/referenced in article.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

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