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Perceptions of farmers on risk management strategies in Son La province, Vietnam

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Abstract:

Commercial fruit farmers in Son La province of Vietnam face substantial risks and they often struggle to implement appropriate risk management responses. A field survey was conducted to achieve a comprehensive view of the risk perception and risk management practices of fruit farmers in Son La province. Our findings indicated that there were 14 sources of risks, which were grouped into production, market, human, and finance categories. Among the risk sources, production was the most serious source of risk, which included seedling quality, unfavourable weather conditions, and disease risk as single risks. Risk management strategies were also categorised, namely, diversification, product quality, human resource, and consultancy. Within these categories, quality regulation, disease prevention, and product preservation were perceived as the most important risk management strategies. In addition, a number of socio-economic variables had significant effects on farmers' perceptions of sources of risk and management responses. Technical support and or information sharing via extension services, and production conversion toward VietGAP would be useful for fruit farmers to manage various risks.

Keywords: **fruit farms, risk management, risk perception, Son La province, Vietnam.**

Classification number: **4.1**

1. Introduction

In general, agricultural production is a risky activity because it is linked to biological processes and natural surroundings in which farming operates [1]. These relationships easily affect outputs of agricultural production. Moreover, risk sources farmers face are changing due to various factors such as increasing market liberalisation and industrialisation of the sector [2]. Risks are closely linked to vulnerability of production output. Therefore, it also affects farm households by keeping them in poverty or falling into poverty, especially in developing countries [3]. Under risks of failure, farmers must consider any activities or investments that have higher expected outcomes [4]. In agriculture, farmers are confronted with a variety of risks and uncertainty that force them to make decisions in a risky production environment. These risks are mainly due to climate variability and change, the complexity of biological processes, the seasonality of production, and the geographical separation of production area and product consumers [5]. Increased frequency of natural disasters, variability of yield and prices of farm products, imperfect markets of input and outputs, and absence of financial assets along with limited extent and design of risk mitigation tools are also risk sources affecting agricultural production [6]. Classification of risk sources in agriculture is very meaningful to cope with these risks. There are many ways of classifying the sources of risks.

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According to M.D. Boehlje, et al. (1994) [7], these risks are categorized into production management, marketing, and finance. They could also be categorized into production risk, price risk, disaster risk, and technological risk [8]. Risks of agricultural production have been grouped into production risk, marketing risk, financial risk, legal and environmental risk, human resource risk [9].

Horticultural production makes up an important proportion in agriculture of Vietnam, especially in the fruit sector. In 2018, the total export value of horticultural products reached 3.8 billion USD - an increase of 47.3% compared with those in 2017. Overall, fruit export value accounts for more than 80% of total export value of vegetable and fruit products. In Vietnam, the Son La province has been considered as a central area of commercial fruit production in the north region. The farming system in Son La province is highly intensive and diversified with a majority of the farmlands growing a variety of fruit trees such as mango, longan, lichi, and climbing lemon, etc. Mango production in the Son La province accounts for 58% of total mango production in the Northern Vietnam. Total longan planting area of the province also is twice the size of that in Hung Yen province - a traditional and famous longan planting area in the northern region [10]. Although there are several risk sources in commercial fruit production, risk perceptions that affect farmers' choices and decisions are still unknown. A comprehensive understanding of farmers' risk perception is essential in designing suitable risk management strategies that remove or reduce negative effects of factors creating risks in agricultural sector. This also means that good risk management strategies will offer farmers maximum benefits. The various risk management strategies have different effects on farming operation, but none of those strategies can deal with all types of risk [11]. Therefore, sufficient understanding on farmers' risk perception and their response is an important demand in creating policies to improve not only agricultural production but also a farmer's ability to manage risk.

2. Literature review

Agricultural production is inherently risky. Outputs of farms heavily depend on weather and biological process over which farmers have little chance to control. Moreover, competition in domestic and international markets exposes farmers to unanticipated price fluctuations [12]. However, negative impacts of risk can be minimized if farmers identify them early and have good preparation with suitable measurements.

A number of studies on farmer's perceptions of agricultural risks and risk management strategies were found in the existing literature. According to a global review article by T.T. Duong, et al. (2019) [13], about 200 published articles were on the topic of risk perception and management in agriculture. Among these studies, more than half of the studies aimed at agricultural risks in the crop sector, while studies in the animal sector and mixed production sectors (both crop and animal) made up 27 and 19%, respectively. Surprisingly, of about 200 studies, there was no study category in the horticultural sector - an important production sector to the world.

Although there exists a multitude of studies on risk perception and management, only few prior studies explore risk management of horticultural farms [14-17]. Three out of four studies were targeted toward risk management of fruit production, but all those studies were conducted in developed countries. This is in contrast with the global review of studies on farmer's perceptions of agricultural risks and their management response [13], which

stated they were predominantly conducted in Asia (29%), followed by America (25%) and Europe (22%). Few studies also indicated that geographic location, farm type, institutional structures, and other factors affecting the farming operation of farmers influenced their risk perceptions and management responses [2, 18].

There are substantial differences between horticultural (e.g., fruit and vegetables) and agricultural production (e.g., crop, dairy). The difference comes from less political support and less impact from direct subsidies, lower equity ratio, and different product marketing channels. This would result in existing agricultural risk perceptions and management responses that are often not applied to horticultural production [17]. Moreover, fruit plants are often perennial crops. This implies that the decision to plant perennial trees is comparable to a long-term investment decision. Thus, flexibility is more limited compared with vegetable and cash crop productions. Despite the importance of risk perceptions and management decisions, similar studies in a Vietnamese context are not available. Therefore, this study is an attempt to provide empirical insight into: (1) fruit farmers' risk perceptions and risk management and (2) characteristics of a fruit farm and/or farmer that relate to these farmers' perceptions.

3. Analytical framework

Economists have traditionally used an expected utility theory to serve both normative and descriptive purposes in studies of risky choice [19]. However, many studies criticized that the expected utility theory fails to describe observed behaviour [20, 21]. To describe decision-making behaviour, understanding the individual's frame of reference for evaluating choices is very necessary because the basis for his or her choices and a decision maker's perceptual view is affected by the person's reality [22, 23]. Thus, in the study, a descriptive approach was used to characterize how fruit farmers perceive and manage sources of risk. Moreover, farm and farmer characteristics were also expected to have influences on their risk perceptions and management responses [24, 25]. The relationship between farm and farmer characteristics, risk perceptions, and management response could be illustrated by the model of the decision-making environment for the firm [26, 27]. Fig. 1 summarizes the groups of variables used in the study. Specifically, P→E/P describes how farm and individual characteristics (P) influence farmers' perceptions of risk types (E/P). The relationship P→E/P→B reflects how the farm/individual characteristics impact farmers' risk management strategies (B).

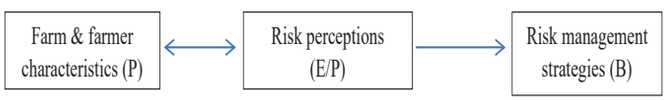

Fig. 1. Adapted from the model of a firm's decision-making environment [26].

4. Materials and methods

4.1. Study area, sampling, and data collection

Son La is located in the northwest region of Vietnam and has an advantage of commercial agriculture with more than 147,272 ha of which fruit production land including longan, mango, and citrus trees accounts for the most proportion. Fruit tree farms have been continuously increasing due to provincial agriculture policy working to transition low-value crops into high-value crops [10].

The present study was conducted in Son La province from July to October 2020. Both primary and secondary data were used in the study. Secondary data was used to select the study site for primary data collection, which was information gathered using a multi-stage sampling technique. At the first stage, three communes of each district (Mai Son and Van Ho districts) were chosen. In the next stage, all fruit farmers from those communes

were numbered on a list. Then, 30 fruit farmers from each commune were randomly selected for data gathering through direct interviews via a semi-structured questionnaire set. The questionnaire consists of three main parts including: (1) basic information of household and farm characteristics, (2) farmers' perception of risk sources, and (3) their risk management responses. The 5-level Likert scale is widely applied to measure farmers' risk perception and risk management [28]. After deleting invalid and missing observations, the remaining data from the 172 fruit farmers were used to analyse the study results.

Determination of sample size plays an important in any study and it heavily rely on field of study, applied econometric model, and analysis technique and so on. In the study, data was analysed by using principal component analysis (PCA) technique and multiple linear regressions, further described in Subsection 4.2. For PCA, there are a few explicit guidelines for determining suitable sample size. E. Guadagnoli, et al. (1988) [29] reviewed several studies that concluded absolute minimum sample sizes ranging from an N of 50 [30] to 400 [31]. In general, a larger sample size is always better [32].

4.2. Statistical analysis

Risk perceptions and management of fruit farmers were first studied using descriptive analyses. The PCA technique was employed to summarize the information because the number of variables was quite large. The PCA technique is popularly used to analyse data in which its relationships could be described by inter-correlated quantitative dependent variables [33]. The objective of the technique is that the most important information is extracted from the dataset, called components. The criterion of eigenvalue >1 was used as a guideline to determine how many components to extract. In this study, there were 14 risk sources and 10 risk management strategies that were perceived and managed by farmers, respectively. The PCA has a strong advantage of reducing the dimension of the variables without losing much information. Standardised factor scores for each farmer and factor were saved for multivariate analyses in the next step. Multiple linear regressions are popular models to explore associations between farm and farmer characteristics and risk management strategies [24, 28], as outlined in Fig. 1. The linear regression equation is given as:

$$Y_i=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots+\beta_{ji}X_{ji}+\varepsilon_i$$

where Y_i are scores obtained from i^{th} farmer's risk management (i=1, 2,..., n). These scores are automatically generated by predict syntax after PCA procedure; X is exploratory variables to be included in the analysis (j=1, 2,..., n) as described in Table 1. β_0 is constant; β_{ji} is estimated coefficients in the regression models; and ε_i is random error.

The correlation matrix indicated that its coefficients between all pairs of independent variables were low. The variance inflation factor (VIF) equals 1.19, indicating no multicollinearity problems. The value (d-statistic) of Durbin-Watson test were very close to 2, implying no autocorrelation. No heteroskedasticity was detected using the Breusch-Pagan test.

4.3. Description of variables used in the regression model

The dependent variables were farmers' risk management responses, based on which four components were extracted from PCA analyses. Exploratory variables in the regression were chosen on basis of economic theories, references to findings of previous studies, and actual statuses of agricultural production in the study area. Many studies indicated that farmers' risk perceptions and risk management strategies were affected by characteristics of household and farming condition, including age, ethnic minority, educated level, main occupation, agricultural labours, planting area, accessing to extension service, and credit access [3, 24, 25]. Definitions of the variables are shown in Appendix 1, while their descriptive statistics are presented in Table 1.

Table 1. Descriptive statistics of variables used in the regression.

Exploratory variables	Unit	Mean	Std.err	Min	Max
Age	years	44.5	11.2	22	75
Ethnicity	dummy	0.7	0.5	0	1
Education	years	9.2	2.8	1	12
Occupation	dummy	0.8	0.4	0	1
Agr-labor	person	2.3	0.8	0	5
VietGAP	dummy	0.6	0.5	0	1
Farmland	ha	0.83	0.9	0.02	6
Extension	dummy	0.67	0.5	0	1
Credit	dummy	0.6	0.5	0	1

Source: Estimation from author's surveyed data, 2020.

Descriptive statistics of all variables in Table 1 indicated that the fruit planting area of households ranged from 0.02 to 6.0 ha. Average fruit land was quite small with about 0.83 ha per household. Average age of the head of household was 44.5 years old, and 70.0% of households belonged to the Kinh ethnic group. Agricultural production is the main livelihood source of all the families accounting for 80.0% total surveyed respondents. The heads of household had a formal education level of secondary school. In the study area, farmers producing fruit under Vietnamese Good Agriculture Practices (VietGAP) accounted for 60.0% in 2020. Accessed level of extension and credit services were 67.0 and 60.0% of interviewed respondents, respectively.

5. Results and discussion

5.1. Perception of risk sources

Fruit farmers' perception on main sources of risk is presented in Table 2. The second column of the table indicates the ranking of risk sources based on the average scores in the third column. Average scores of farmers' risk sources vary from 4.18 to 3.09, where the higher values implied more risk than lower ones. Next columns include the four main components, which were selected on the basis of loadings scores greater than 0.3 and their close relationship among risk sources.

Table 2. Mean score and varimax rotated factor loadings for sources of risk.

Sources of risk	Rank	Mean	Most important components			
			Production	*Market*	*Human*	*Finance*
Seedling quality	1	4.18	**0.4085**	0.1380	0.0287	0.2223
Pest and disease	3	3.86	**0.3821**	-0.1243	0.2283	0.1709
Unfavourable weather	2	4.05	**0.5324**	-0.0355	0.1616	0.1650
Product preservation	8	3.03	**-0.3931**	0.2120	0.2839	0.1610
Unstable yield	4	3.22	**-0.3146**	-0.2393	0.1505	0.2900
Selling price instability	6	3.11	-0.0490	**-0.3819**	0.2020	0.2955
Preference change	10	2.96	0.2141	**0.5784**	0.3265	0.0755
Quality regulation	14	2.55	-0.1870	**0.3640**	0.0661	0.2219
VietGAP criteria	11	2.95	0.0045	**-0.4256**	0.2351	0.2843
Capital shortage	12	2.89	0.0454	0.0762	-0.1664	**0.3734**
Interest rate of credit	13	2.89	-0.2421	0.2205	0.0485	**0.3577**
Indebted credit	9	3.02	0.0360	-0.0914	-0.0390	**0.3226**
Health of household head	5	3.16	0.0511	0.0717	**-0.5462**	0.2217
Lack of labour	7	3.09	0.0493	-0.0046	**-0.5298**	0.2932

Note: Extraction method: Principal Component Analysis using Varimax rotation. Loadings of ≥0.31 are in bold. Adequacy measurement: Kaiser-Mayer-Olkin criteria (KMO)=0.71
Source: Estimation from author's surveyed data, 2020.

According to the study, there were 14 sources of risk perceived by fruit farmers that also cover all aspects of production process in the area. In general, output of fruit production would be affected by seedling quality, weather conditions, pests and disease, and yield, which are sources of perceived risk with the highest rankings. Seedling quality obviously has a strong impact on yield and fruit quality. Good seedling quality will be a very advantageous base for plant care and creates potential for good output in the coming years. The seedling quality of perennial trees becomes more

important than annual crops because perennial trees have a longer basic construction phase without any income earnings in this stage. Interviews indicated that farmers bought seedlings from different sources based on their experience rather than choosing certified seedling providers. Thus, it is easy to understand that farmers are very worried about seedling quality. In addition to seedling quality, weather conditions also have very strong impacts on agricultural production because of the nature of agriculture. Climate variability or unfavourable weather will have negative impacts on output and influence the development of pests and diseases. In turn, pests and diseases will damage crops and reduce agricultural yield. The next source of risk that may have an impact on production output is the health of the head of household. The head of household plays an important role in decision making for all production processes. The next five sources of risk that may have a significant impact on output of fruit production based on the farmers' perceptions are the selling price of fresh fruit, shortage of labour, product preservation, and debt, which were ranked from 6th to 9th, respectively. The five sources of risk that have lowest rankings include quality regulation by the government, credit interest rates, shortage of investment capital, VietGAP criteria, and customer preference changes.

Before applying PCA, the KMO index was estimated to measure the adequacy of the sampling. The KMO index varies from 0 to 1, and an overall value equal to or greater than 0.5 is considered an acceptable condition. In this study, the overall KMO of the dataset was 0.71, suggesting that the data is sufficient for principal component analysis. Table 2 presents the risk source loadings, which were grouped into four main components with eigenvalues greater than 1, accounting for 63.6% total variance. On the basis of the loading scores and their relationship to single risk sources, components 1-4 are labelled as production, market, human, and finance, respectively. Component 1 has the highest loading of unfavourable weather conditions that comes from the farmers' concerns about unusual climate variability. This worry is completely suited to characteristics of agricultural production, which heavily relies on the surrounding environment and climate conditions. Seedling quality is also a single source of risk grouped into this component together with pests, product preservation, and unstable yield. Component 2 has the highest loading score of customer preference change. The loading scores of VietGAP criteria, market price, and related government regulation are ranked in order. These factors have impacts on selling price, thus farmers' income, and is out of the control of fruit farmers. Therefore, they were grouped into the market component as mentioned above. Component 3 consists of head of household health and agricultural labour with high loading scores of 0.5462 and 0.5298, respectively. This risk source reflects the change in the number of farming labourers due to health problems and participating in off-farm work. Finally, component 4 includes capital shortage, interest rates, and debt with loading scores of 0.3734, 0.3577, and 0.3226, respectively.

5.2. Perception of risk sources

More than 15 risk management strategies were given for fruit farmers' consideration. Farmers indicated their perceived importance of each management strategy on a Likert scale from 1 (not important) to 5 (very important). Farmer's perceptions of the 10 risk management responses are presented in Table 3.

Strategies generally perceived as very important were to obey quality regulation, prevent and reduce fruit disease, fresh fruit preservation, produce fruits under VietGAP standards, and hire labourers. Other management strategies include diversifying marketing channels, reduction of production cost, income diversification, buying health insurance for family labourers, and market information, which had lower ranking orders and were considered as less important.

The overall MSA (measure of sampling adequacy) for the risk management variable was 0.65,

Table 3. Mean score and varimax rotated factor loadings for risk management.

Management responses	Mean	Rank	Most important components			
			Diversification	*Quality*	*Human resource*	*Consultancy*
Product preservation	4.16	3	0.0572	**0.4762**	0.1343	0.0635
Disease prevention	4.17	2	0.1617	0.0540	-0.2279	**0.8479**
Income diversification	3.09	8	**0.4405**	-0.1515	-0.0168	0.1094
Input cost reduction	3.12	7	**0.4115**	-0.1685	-0.3091	0.1248
Marketing channels	3.24	6	**0.4527**	-0.0603	-0.3063	-0.2313
Finding information	2.47	10	0.2431	-0.2701	-0.2421	**-0.3796**
Quality regulation	4.19	1	0.2560	**0.5499**	-0.0284	-0.1661
VietGAP production	4.15	4	0.2973	**0.5258**	0.0352	-0.1037
Health insurance	3.07	9	0.3097	-0.1147	**0.5442**	0.1153
Hiring labourers	3.53	5	0.3055	-0.2242	**0.6194**	-0.0186

Note: Loadings of ≥0.31 are in bold. Adequacy measurement: KMO=0.65. Source: Estimation from author's surveyed data, 2020.

suggesting that the matrix was suitable for factor analysis. Table 3 also presents the varimax rotated factor loading for risk management strategies. The number of management strategies was reduced from 10 to 4 components with eigenvalues greater than one, explaining 74.24% of the total variance.

Components 1-4 were labelled as diversification, product quality, human resource, and consultancy, respectively. To reduce financial risk, various single management responses that were applied by farmers were grouped into Component 1. This component was named diversification because it had high loadings for diversification of sale channels (target market, marketing channels), income diversification (off-farm income), and reduction of production cost (fertilizer, pesticide, other inputs). Component 2, product quality, had high loadings for obeying quality regulation, producing under VietGAP standards, and fresh fruit preservation. All these single management responses aimed at producing fruits with high quality and more safety, which are required more often now from domestic and foreign consumers. Component 3 had heavy loadings of hired labour and health insurance, and thus was accordingly labelled as human resource. Farming labour is very important for fruit production in the area. Commercial fruit farmers often have large areas of fruit farmlands. Often, family labour only is not enough to meet to a farmers' labour demand. Thus, lack of agricultural labourers was quite popular in the study area. Hiring labours and exchange of family labour were two strategies chosen to reduce shortage of farming labourers, especially during caring and harvesting time. Component 4, consultancy, includes disease prevention to minimise crop damage, and other technical information that is important for farmers' fruit production. To meet consumers' increasing requirements about fruit quality and safety, farmers have been converting fruit production toward VietGAP standards. Moreover, many high-breeding fruit varieties were introduced and planted in the study area. In addition, disease prevention and other related issues for fruit farms also needs support and consultancy from technical staff. Thus, technical consultancy or training courses and information sharing are very necessary for farmers.

5.3. Factors affecting risk management strategies

Multiple linear regressions were used to determine the relationship between information on socio-economic characteristics and management responses. The regression coefficients and the goodness-of-fit measures of the models are presented in Table 4. All four models were highly significant and all of them explained around 10% of total variance.

All socio-economic variables, except age and education, had significant effects. Farming owners who are of the Kinh ethnicity perceive consultancy as more important than other ethnic groups. Households with their main occupation in agriculture placed more emphasis on improving product quality because their main income source comes from fruit production and other crops. In turn, product quality and quantity had strong and direct impacts on their income. Families with more labourers were more likely to be associated with off-farm jobs and other activities for income diversification. Not surprisingly, they were significantly less concerned about diversification. Farmers producing fruits

Table 4. Estimation of multiple linear regressions for risk management.

Exploratory variables	Diversification	Quality	Human resource	Consultancy
Age	-0.008	-0.003	0.011	0.001
Ethnicity	0.240	-0.240	-0.283	**0.528*****
Education	-0.051	0.038	-0.030	0.043
Occupation	0.016	**0.165*****	0.242	-0.267
Agr-labour	**-0.333****	-0.105	0.112	0.009
VietGAP	-0.355	-0.045	0.090	**0.382****
Farmland	-0.150	0.086	**0.045****	-0.123
Extension	**0.533***	0.356	-0.085	0.109
Credit	**0.935*****	0.171	0.261	0.055
Constant	0.819	0.681	-0.691	-0.838
R^2	**0.1094****	**0.1076****	**0.0863***	**0.1479*****

Note: ***, **,and * denote significance at 1%, 5%, and 10% levels, respectively. Source: Estimation from author's surveyed data, 2020.

toward VietGAP standards considered technical consultancy and related information sharing as more important. Farmers with larger fruit farmlands were more likely to perceive human resources as very important. Farmers accessing extension services and credit found the diversification management response more important.

6. Conclusions

The present study provided insights into the risk perception and management strategies of fruit farmers in Northwest Vietnam, where fruit production plays an important role in a household's livelihood. Appropriate statistical techniques were applied to identify farmers' risk perceptions, risk management strategies, and factors affecting fruit farmers' risk perception and their responses, which included principal component analysis and multiple regression models. The findings of the study indicated that there were 14 sources of risk, which were categorised as production, market, human, and finance. Among the risk sources, seedling quality, unfavourable weather conditions, and disease risk were the most serious in fruit farmers' perception as single risks. Moreover, risk management strategies were categorized as diversification, product quality, human resource, and consultancy. Quality control regulation, disease prevention, and product preservation were perceived by fruit farmers as the most important risk management strategies. In addition, a number of socio-economic variables had significant effects on farmers' perceptions on sources of risk and management responses. Technical support and or information sharing via extension services, and production conversion toward VietGAP would be useful for fruit farmers to manage various risks.

Appendices

Appendix 1. Definition of variables and their expected signs in the regression.

Variables	Code	Definition	Sign
Age	X_1	Age of household head (years)	+/-
Ethnicity	X_2	Member of ethic group (1=Kinh; 0=otherwise)	+
Education	X_3	Educated level of household head (years)	+/-
Occupation	X_4	Main income of household (1=agriculture; 0=otherwise)	+
Agr-labour	X_5	Number of agricultural labours of household (person)	-
VietGAP	X_6	Fruit farming system (1=VietGAP; 0=otherwise)	+/-
Farmland	X_7	Fruit planted land measured in ha	+
Extension	X_8	Access to extension service (1=yes; 0=no)	-
Credit	X_9	Access to credit service (1=yes; 0=no)	-

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COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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