Thailand Vietnam Socio Economic Panel

Risk attitudes, knowledge, skills and agricultural productivity

Huong Dien Pham, Hermann Waibel

Leibniz Universität Hannover

2018

TVSEP Working Paper

WP-007

Gefördert durch DFG Deutsche Forschungsgemeinschaft

Leibniz Universität Hannover

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

The Thailand Vietnam Socio Economic Panel (TVSEP) is a long-term research project for data collection and scientific analysis funded by the Deutsche Forschungsgemeinschaft (DFG). The high quality panel data sets have been collected in rural areas of Thailand and Vietnam since 2007. The panels cover many important aspects of living standard measures, demography, geography, shocks, risks, expectations and behavioral traits of individuals. TVSEP data is available for scientific research purposes free of charge.

The TVSEP Working Papers disseminate the findings of work in progress of researchers who use the TVSEP database. Topics cover a broad range related to different fields of development economics. Papers are available online and can be downloaded at: https://www.tvsep.de/workingpapers

The findings, interpretations and views expressed in this series are entirely those of the author(s).

Thailand Vietnam Socio Economic Panel (TVSEP)
TVSEP Database Centre
Leibniz Universität Hannover
Königsworther Platz 1
30167 Hannover, Germany

Contact: lippe@ifgb.uni-hannover.de

Risk Attitudes, Knowledge, Skills and Agricultural Productivity

Huong Dien Pham (corresponding author) and Hermann Waibel
Institute of Agricultural and Development Economics, Leibniz Universität Hannover,
Königsworther Platz 1, 30167 Hannover; pham@ifgb.uni-hannover.de .

Abstract

Agriculture is a risky business contingent on risks and uncertainty. Without strong technical knowledge, farmers tend to rely heavily on heuristics and subjective judgments to deal with their daily business. It is crucial to understand farmers' practices to provide suitable supports. This study uses a rich data set from a long panel household survey to assess farmers' agricultural productivity in Hue province of Vietnam that we combine with data collected from special surveys conducted in 2014 and 2015 focusing on farmers' knowledge, skills and risk attitudes. It aims to provide an overview of the environment in which farmers do business under constraints. Particularly, we investigate the relations among risk attitudes, farmers' knowledge, management ability and agricultural productivity by using univariate and bivariate analyses. The results indicate a large variation in farmers' knowledge. Most of them have low degree of technical knowledge, but show higher subjective knowledge. Agricultural performance tends to be more dependent on subjective knowledge than technical knowledge. Accordingly, farmers received limited support from the extension institutions. While risk attitudes are significantly correlated with farmers' knowledge and decision-making ability in livestock production, it has no direct significant relation with agricultural performance. The previous outcome showed that livestock productivity is prone to fluctuation, risk-taking should be important for farmers to cope with shocks. This study suggests extension services to fill the gap between subjective knowledge and technical knowledge and to build a significant linkage between risk-taking and learning to improve farmers' abilities and consequently enhance agricultural productivity.

Keywords: Agriculture, Knowledge, Risk attitudes

JEL: D81, Q00, Q10

RePEc:tvs:wpaper:wp-007

1. Introduction

The famous T.W. Schultz hypothesis (Schultz, 1975) has established that farmers in developing countries are "poor but efficient". Farmers tend to find the best possible solutions based on experience and indigenous knowledge, which have emerged for specific farming environments for the conditions under which they operate. However, inefficiency can occur when conditions change. This can happen when the farming environment changes due to political, economic and environmental factors. One such example of political and economic change is the Doi Moi reforms in Vietnam during the nineteen eighties, which have led to an impressive increase in productivity and total output especially in Vietnam's rice economy. New technologies, access to yield increasing inputs and extension information has enabled farmers to quickly find new optima and produce efficiently. However, some regions in Vietnam such as the Northern and Central Highlands did not equally benefit from this development (e.g., Kyeyune, V., & Turner, S., 2016). Farmers in these regions often had to rely on own experience and subjective knowledge when adopting new technologies and adjusting their farming systems to altered environmental conditions such as climate change. Hence, farmers in these regions are confronted with higher costs of information and with higher risks.

The empirical basis of our study are long-term panel data from the Thailand Vietnam Socio economic panel (www.tvsep.de) which collected comprehensive socio-economic data from approximately 4,000 rural households in three provinces in Thailand and three provinces in Vietnam since 2007. The survey instrument includes detailed information on household and individual characteristics, shocks and risks, including individuals' (respondents') willingness to take risk; household assets, consumption expenditures, finance and insurance as well as all income generating activities including inputs and outputs of crop and livestock activities.

In this paper we use data from the province of Thua Thien Hue, where in addition to the household surveys; we have carried out two complementary surveys in 2014 and 2015 which were focused on knowledge and risk attitudes of the financial decision makers of the households in the panel. The survey also included questions on the productivity of crop and livestock activities and a detailed set of knowledge and behavioral questions together with survey measures of risk attitudes. In total, we have long-term panel data of 620 rural households in 70 villages in the province of Hue, covering the period from 2007 to 2015[1].

[1] The initial sample in 2007 was 700 or 10 households per village

The aim of this study is to investigate the relationship between knowledge, risk and the performance of farmers in the province of Thua Thien Hue. We want to answer three questions. First, do farmers with higher knowledge (both objective and subjective) and management skills show a better farming performance than those with lower capabilities? Second, we analyze whether farmers with better knowledge and skills are those who are willing to take more risks. Third, we want to find out if higher willingness to take risk is positively related to agricultural productivity of our farmers in the panel.

We undertake several steps to perform this analysis. First we provide a detailed description of our data. This covers annual yield and net revenues of major agricultural enterprises for the years 2007, 2008, 2010, 2011 and 2013 to 2015. We calculated the average annual yields and net revenues by activity and farm household. We report the results of the knowledge questions and management tests during the survey 2014 and 2015. Furthermore, we performed a number of tests on farmers' factual (objective) knowledge, their experience and indigenous (subjective) knowledge, their decision-making (management) abilities, their cognitive skills and their level of confidence in making decisions in farming and related businesses. We also provide the description of the results of two survey measures of risk attitudes.

The first analytical step is performing non-parametric tests for the association between risk and knowledge. Second we test separately to what extend knowledge is associated with farmer productivity and profitability and repeat the same for our risk measures. For the latter we apply Analysis of Variance (F-test) to find out if yield and net revenues differ across the knowledge and risk categories. The purpose of this analysis is twofold: first we undertake this as a validity test for our data and second we use the results of this explorative analysis as an orientation for formulating a model that can capture the relation between agricultural production and farmers' knowledge and management abilities and their attitudes towards risk. Such a model is subject to a follow-up paper.

In brief, we find that farmers in Hue province have little contacts with extension services. Not surprisingly they perform poorly in our knowledge tests which are based on factual and objective technical knowledge. This is also shown in their lack of good reasoning when confronted with management choices. On the other hand farmers do much better in subjective knowledge which is based on their experience in crop and livestock production.

In terms of risk attitudes our results indicate that famers tend to be moderately risk-taking. This holds for both survey risk items. The correlation, based on Chi-square tests, between agricultural performance and knowledge is insignificant when using the objective knowledge tests but shows significant differences for several performance variables when related to subjective knowledge. This result is confirmed when relating general cognitive (numerical) skills to crop productivity parameters. The relationship between our two risk measures and the various knowledge and management tests we mostly find a positive association between willingness to take risk and knowledge and decision-making skills in livestock production but less frequently in knowledge about crop production.

The paper proceeds as follows. In the next chapter, we briefly review the literature on knowledge and risk in farming in order to underpin our hypotheses. A description of the data and a univariate analyses for variables are included in chapter three. In chapter 4, we present the bivariate analyses and test results of the relations of knowledge, skills and management capacity with farm productivity parameters, on the one hand, and various parameters of individual risk attitude, on the other hand. Finally, in the fifth chapter, we summarize, and conclude the findings of the analysis so far and add a brief outline of a model that can identify the relationships between risk attitude and knowledge and their linkage to farmer performance.

2. Theoretical background and literature review

Knowledge and learning has long been recognized as a factor of production aside from the conventional inputs capital, land and labor. With the introduction of the endogenous growth theory (e.g. Romer, 1994) knowledge has been formally included in models of economic growth and in more recent economic researches (e.g. Helman, 2009), knowledge is being considered as the major input variable.

In development country agriculture the role of “learning-by-doing”, was established as an important factor that influences farmers’ technology choice decisions (Foster & Rosenzweig, 1995). Social scientists dealing with agriculture (e.g. Stone, 2016) have developed a theory of farmer learning taking into account multiple actors that shape farmers’ knowledge.

The approach of incorporating knowledge in models to explain productivity and efficiency in agriculture has been well documented in the literate on technology adoption (e.g. Jamison and Moock, 1984; Feder et al 1985, Stefanou & Saxena, 1988; Adesina & Djato, 1996). In these literature strands, variables such as education, experience, numeracy ability and the frequency

of extension contacts were considered as the major determinants of adoption and farm performance. More recently, with the introduction of information technology, for example precision agriculture (e.g. Fountas, et al., 2006) the importance of technical knowledge and management in the agricultural production process has increased.

Hence, as pointed out by Rougoor et al. (1998), more studies that include aspects of farmer's decision-making process are needed. In their paper, Rougoor et al. (1998) specified management capacity as a factor that could explain a considerable proportion of farm outcomes. The study confirmed management as the fourth production factor and concluded that the mechanisms are still poorly understood as mostly formal education has been used as the major explanatory variable.

Furthermore, the role of agricultural knowledge institutions where famers are not solely recipients of information but are part of an innovation system (e.g. Weyori et al., 2018) must be considered. Farmer participation has been well documented for example in the popular and widespread Farmer Field Schools (FFS) approach in developing countries. FFS was a method of experiential learning to generate in-depth knowledge, which is based on the understanding of the biological, technical and economic components in agriculture and thus facilitating judicious and reasoned decision-making. Tripp et al. (2005) in their study from Sri Lanka provided evidence for the generation of knowledge and understanding of the rice ecosystem and farmers' skills could help to lower uneconomical insecticide use.

In conclusion, a dearth of literature strongly underlines the importance of knowledge in explaining farm and farmer performance. Considering the advancement of information technology among small-scale farmers in Asia including smart phones (Hübler, 2016; Hübler & Hartje, 2016), the knowledge as a factor of production will grow relative to the traditional production factors like capital, labor and land.

While knowledge is an important factor in explaining technology adoption and efficiency in farming, another factor is risk behavior. In studies of technology adoption in developing countries risk attitude has often been a significant explanatory variable (e.g. Baidu-Forsen 1997; Liu 2013). However, little is known about the relationship between knowledge, decision-making ability and willingness to take risk. Thus, we briefly review the literature on risk in relation to the knowledge and decision-making. Marra et al. (2003) provided a useful state-of-the-art with their paper: "*the economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve"*. The authors

emphasize the importance of distinguishing between risk and learning for a correct understanding of technology adoption processes. They point out that aside from risk perception, farmer's attitude towards risk and the farmer's way of experimentation is relevant to understand technology adoption. A more recent example of the role of risk perception is given in a study about weather risks in apple production (Menapace et al., 2012). The authors confirm once again that famers are risk-averse decision makers. But they also show that risk attitude can affect subjective assessments of production losses due to weather events. Hence, the relationship between risk attitudes and subjective knowledge should be considered when analyzing farm outcomes. Willock et al (1999) also emphasized the need to integrate socio-economic, technical and psychological variables into a framework to analyze farmer decision making and outcomes.

In Vietnam, there have been prominent studies on farmer behaviors with regards to risk attitude and time preference (e.g. Tanaka et al., 2010). The authors found farmers to be generally risk averse and rather impatient. Furthermore, a number of studies have analyzed the role of agricultural extension services in Vietnam especially in the process of de-collectivization initiated by the Doi Moi policy (e.g. Castella et al., 2006). The study showed that large disparity exists within farmer communities concerning access to technical information and other agricultural services namely input subsidies. This was also confirmed in a recent study by Minh et al. (2015) although the prospects towards a more demand-driven and need-based extension approach were shown to slowly emerge. This tendency is confirmed in a recent paper by Do et al (2017) on the emergence of livestock. Both studies suggest that we can expect a considerable variation of farmer knowledge within our sample.

Following the literature review on the relationship between knowledge, farmers' capacity and risk attitude and farming performance, we derive three hypotheses for this study. Firstly, the fact that agricultural extension services in Vietnam may not be very effective in transmitting technical knowledge to farmers we expect low levels of technical knowledge especially in crop production and perhaps less so in technical knowledge about livestock production.. However we can expect that farmers have been relying on indigenous knowledge; experience and self-learning. Therefore, we expect to find higher levels and more variation in subjective knowledge. Second, based on the literature, we expect that farmers in our sample are generally risk averse. However, we expect those with better knowledge to show a higher willingness to take risk. Third, we expect both higher knowledge and higher willingness to take risk to be positively associated with farming performance.

3. Data and descriptive results

In the first part of this section we briefly describe the panel survey. In the second part we explain the knowledge, skills and farm performance tests as well as the risk items which were conducted in 2014 and 2015.

3.1 Description of long-term panel data

The data used in this project have been collected in the frame of the "Thailand Vietnam Socio Economic Panel" (see: www.TVSEP.de) and its predecessor projects. Under this frame, rural household and village surveys have been carried out among approximately 4,000 households and 440 villages in six provinces in Thailand and Vietnam since 2007 (Hardeweg et al. , 2013). The sample is representative for rural areas in Northeast Thailand and Central Vietnam. The sampling strategy consists of a 3-stage cluster sampling design. In the first stage, provinces were chosen purposively with criteria such as average per capita income, poverty headcount ratios, dependence on agriculture, remoteness and peripheral locations and poor infrastructure, i.e. overall provinces that had villages located in risky environments. In the second step, the sample was taken proportional to population size of all rural sub-districts (communes in Vietnam) in a province. From each sub district (commune), two villages were selected at random and within a village, ten households were chosen following a systematic-random sampling procedure by ordering households by their size. In Vietnam where the three provinces are heterogeneous regarding agro-ecological conditions and population density, e.g., lower densities in mountain areas and higher density in lowland areas additional strata was used. For two provinces namely Ha Tinh and Thua Thien Hue (Hue) the province was divided into coastal, lowland and upland areas while in Dak Lak province due to the absence of access to the sea only lowland and upland strata were defined. In order to allow meaningful analyses the sample size was fixed at a minimum of 160 households per location strata. Data for the local administrative units and household sample frames were taken from the Agricultural and Rural Census 2006, conducted by the Vietnam General Statistical Office (GSO).

In this paper, we use the data from the province of Thua Thien Hue that is located in the central part of Vietnam. The province of Hue ranges from the South China Sea in the east to the Laos boarder in the west and has three distinct zones, namely coastal, lowland and mountain zones. For our analysis, we have panel data from 620 households in 70 villages from seven survey waves, namely 2007, 2008, 2010, 2011, 2013, 2014 and 2015. The survey

waves 2007 until 2011 and 2013 were regular comprehensive household and village surveys. The survey instrument included information on household and individual characteristics, all income generating activities including farming, wage employment and non-farm self-employment, transfer income, debts, consumption expenditures and assets. Detailed data were collected on all agricultural activities of the household including yields, production costs and sales prices for crop and livestock products. Furthermore, subjective information on shocks and risks as well as individual risk attitudes had been elaborated.

3.2 Knowledge, skills and risk survey

In 2014 and 2015, special surveys were conducted in Hue province with the respondents of the panel. The surveys focused on risk, financial literacy, agricultural knowledge and decision-making skills and related business and only included some components of the income generating activities, i.e. input and output data for crop and livestock production.

Following the findings of the recent literature we go beyond the simple education variable to capture knowledge and management capacity in the design of this study. We therefore have incorporated a set of procedures that aimed at measuring knowledge and decision-making capacity, from both a technical-objective and a subjective perspective. First, we asked respondents a set of six standard cognitive skills questions related to simple calculus and logic with multiple-choice answers. Second, we included knowledge tests for technical knowledge in crop and livestock production as a set of ten knowledge questions respectively with a binary choice, i.e., right or wrong. This enabled us to establish a knowledge score ranging from zero to ten for every respondent. Third, we asked respondents to self-assess their knowledge in crops, livestock and business management based on a five point Likert-scale ranging from very poor to excellent. The question was asked as follows: “How would you rate your knowledge in crop, livestock and farm business?” This question is expected to indicate the level of subjective knowledge. Farmers own observations based on experiences in their agro-ecological and agro-economic environment, which may not necessarily correspond with the often highly partial and single-factorial knowledge packages generally promoted by agricultural extension services in combination with input subsidies. The fourth test we included in the surveys was a decision making test, again separated for crops and livestock production. Here we confronted famers with a management choice, i.e. two rice varieties and two livestock breeds that differed in output, product price and input costs. One alternative was clearly economically dominant in terms of net revenue. Farmers who made the right choice and gave a plausible reason, i.e., higher net revenue or profit, passed the test with 2 scores.

Respondents who made the correct choice but had no plausible reason for it received 1 score and the remainder of respondents zero score, i.e. they failed the test. Finally, we asked respondents to assess their confidence in making farm decisions. "Do you feel confident (i.e., you are sure that you always make a good decision) when you make a decision in agriculture (examples: given were: choice of variety, planting time, applying fertilizer, spraying pesticides, purchase of livestock)"? Again, a five point Likert- scale was used ranging from "never confident to always confident. The confidence score was interpreted as a subjective indicator of decision-making capacity (i.e. "to know what you are doing")[2]. In summary, the knowledge and skills tests included in our surveys are believed to provide a more advanced measure of human capital than the usual formal education questions common in most studies on farmer knowledge.

In addition, we included two measures of individual risk attitudes. First, we used the survey-based measure of Dohmen et al. (2011) in which respondents are asked to classify themselves on an eleven-point Likert scale. The survey question reads "*Are you generally a person who is fully prepared to take risks, or do you try to avoid taking risks? Please choose a number on a scale from zero (unwilling to take risks) to ten (fully prepared to take risks*)". Second, we included a hypothetical investment question and asked respondents about the sum of money they would be willing to invest in a high return but high risky investment. The question was as follows: "*Imagine you had just won 60 Mio. Dong in a lottery and you can invest this money in a business. It is equally likely that the business goes well or not. If it goes well you can double the amount invested after one year. If it does not go well you will lose half the amount. What fraction of the 60 million VND would you invest in the business*?"

The self-assessed question and the hypothetical investment were asked half-way through the interview. While we use identical households we did not constrain the analysis to be identical respondents. However respondents were always household heads or their representative involved in making financial decisions of the household.

3.2 Descriptive results

In this section we present a description of the main variables of the 2014 and 2015 surveys. This comprises farmers' exposure to extension services, their technical and subjective knowledge, their management capacity, their cognitive skills and their degree of confidence when making decisions. In addition, we present the results of the three risk measures. Finally,

[2] See Appendix 2 for excerpt of questionnaire.

using the data of all available seven survey waves, we show the annual average yields for rice and other crops as well for pig production which is the major livestock activity in the study area.

3.2.1 Extension services contacts

Extension services are a major source of farmers' technical knowledge enabling the adoption of new farming technologies and their efficient implementation. In the 2014 and 2015 surveys we asked about the frequency of extension contacts separately for crops and livestock production and we asked about participation in formal training courses on agricultural technologies

The results confirm the conditions described in the literature about agricultural extension in Vietnam. From Figure 1 (panel a) we can see that in 2014 only 51 (or less than 10 %) households had been in contact with a crop extension advisor and the majority reported only one contact per year. The intensity however was higher in 2015 (Figure 1, panel b) where almost one fourth of the farmers had been in contact with crop advisors although the majority only had only one or two contacts per year.

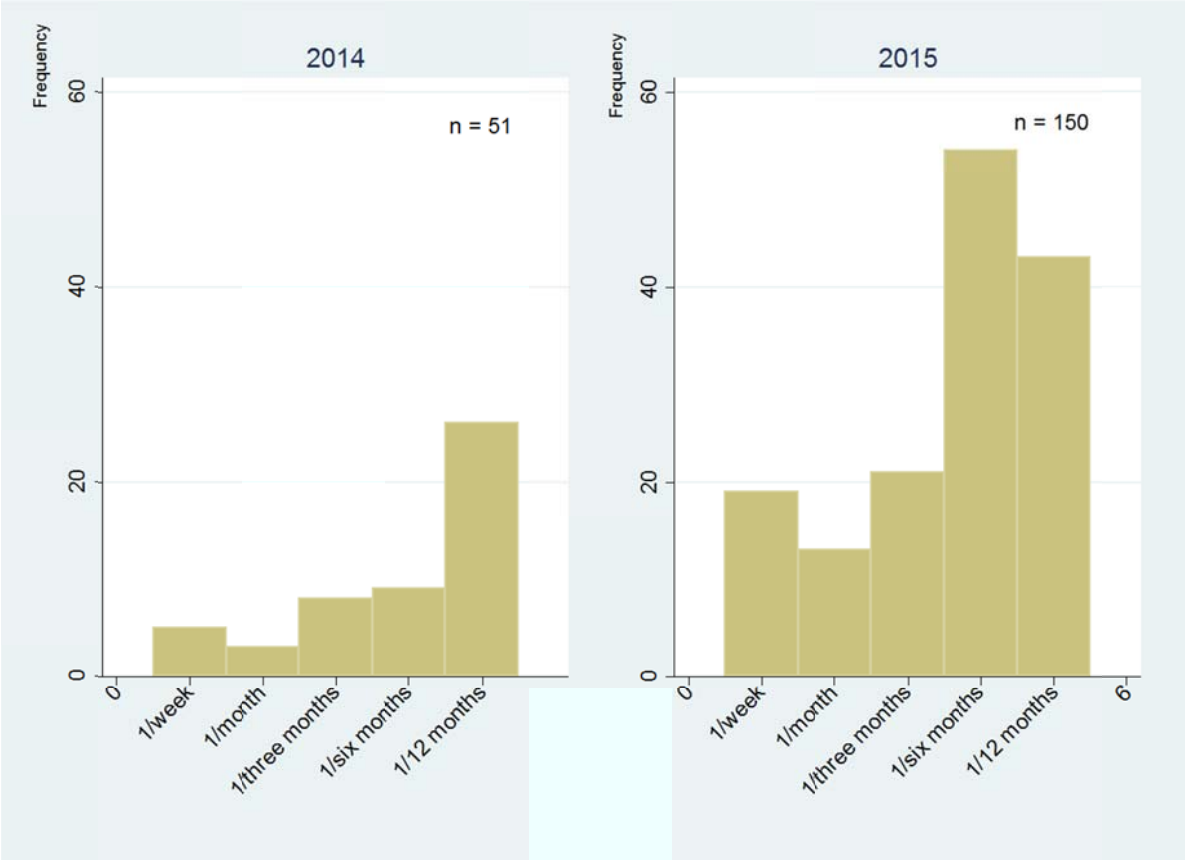

Figure 1a and b. Frequency of contacts with crop extension services

Source: Special surveys in 2014 and 2015, own calculations

The exposure to extension services is better in livestock production where in 2014 about 20 % of households (Figure 2a) and in 2015 about one third of the households received extension advice (Figure 2b). However the intensity of contacts remains low. Most farmers have only one or two contacts per year, less than 5 % have weekly or monthly contacts.

Figure 2a and b. Frequency of receiving livestock extension services

Source: Special surveys in 2014 and 2015, own calculations

We asked respondents if she (or any family member) participated in agricultural training courses in the past. The question did not refer to the reference period only but to any time before and therefore some overlap in the results between 2014 and 2015 is possible. In Figure 3a it is shown that about 16 % of households had attended a training course in the past while this number was almost three times as high in 2015 (Figure 3b). If we deduct the number of the 1st year then about 30 % of households attended an agricultural training in 2015. This would be a reasonably high number. However, once we've analyzed further information about the contents and the duration of the training a judgment about its quality and likely impact can be made[3].

In conclusion, the conditions about extension support for farmers in Hue province are rather poor and suggest that farmers agricultural knowledge may come from own experience rather than from external supply. Of course, exchange of information between farmers and information provide by input suppliers can add to farmers' knowledge but we did not include these information sources in the survey.

[3] We asked about topics of the training, duration and training supplier; unfortunately the information has not yet been processed.

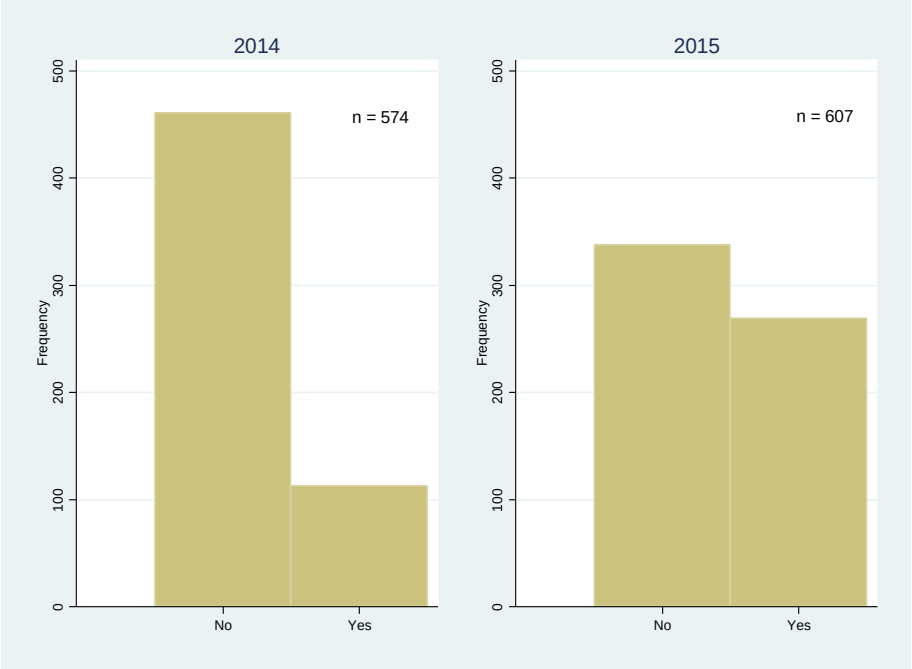

Figure 3a and b. Household members participated in training

Source: Special surveys in 2014 and 2015, own calculations

3.2.2 Technical and subjective knowledge

To measure the level of technical knowledge in agriculture of the farmers in Hue province, we performed a knowledge test with the respondents in the 2014 and 2015 surveys. The knowledge test consists of ten technical questions for crops and livestock production respectively (see Appendix 2 for further details). The answers were unambiguous so that respondents could give either a correct or a wrong answer and a knowledge scale from zero to ten could be derived.

Table 1 summarizes the results of the knowledge tests in both years. We organized the scores in four groups, namely no correct answer, 1 to 5, 6 to 8, and above 8 correct answers. The results show that in 2014 for crops, although there was no respondent with a zero score, the majority (almost 80 %) only answered half or less of the questions correctly. Results were better in the following year, where the majority of respondents were in the second highest knowledge category. Technical knowledge for livestock is, however, better. In 2014, the majority (almost 70 %) of respondents were in the score group 6 to 8. This remained about the same a year later. Clearly in 2015 technical knowledge had improved which could be seen in connection with better training supply (see Figure 3, panel b). However it is still low in crops

where over forty % of respondents could not answer more than half of the rather simple technical questions related to their agricultural enterprises.

Table 1: Technical knowledge in crop and livestock by test score in per cent

Year	**2014**		**2015**	
Score category	Crops	Livestock	Crop	Livestock
1-5	78.4	23.9	41.9	22.3
6- 8	21.2	69.8	52.8	70.3
9-10	0.4	6.3	5.3	7.4

Note: Scores were measured by counting the number of correct answers to a set of ten questions.

Source: Special surveys in 2014 and 2015, own calculations

Complementary to the objective knowledge we included a subjective knowledge question that was based on farmer's self-assessment of their knowledge. We assume that this question represents the indigenous knowledge of farmers which is based on experience whereby respondents were asked to assess their knowledge in crop, livestock and general farm management (including labor allocation and finance). The question was based on a Likert scale with five categories ranging from "very low" to "excellent". We complemented this question by asking how confident farmers feel about their farming decisions again using five categories like "never, often not, sometimes, mostly and always confident".

In Table 2, results of the subjective knowledge questions are presented. It is interesting to note that unlike with technical knowledge, results were quite consistent between the two survey years. Only for business decisions the difference is larger which could be due to variations in actual business success. However the difference between crop and livestock knowledge which is prominent in technical knowledge is not there in subjective knowledge. While one might assume that farmers may rather tend to be humble than overstating their knowledge the fact that less than 20 % of farmers judge their knowledge to be low or very low indicates the existence of indigenous knowledge and farming experience.

Table 2: Frequency distribution of subjective knowledge in crops, livestock and business

Year	**2014**			**2015**		
Field of Knowledge/category	Crop	Livestock	Business	Crop	Livestock	Business
Very Good	7	5	7	4	6	7
Good	86	74	131	147	104	97
Moderate	379	377	345	381	385	306
Low	68	84	72	52	73	88
Very Low	42	42	27	26	43	113
Number of respondents	582	582	582	610	611	611

Source: Special surveys in 2014 and 2015, own calculations

Table 3 shows respondents' confidence in agricultural decision making. Here in both years the majority is in the highest category (always confident) although the numbers dropped in 2015 where only slightly less wee in category "mostly confident". However taken the two upper categories together well over 80 % of the respondents are confident about their decisions in both years.

Table 3. Confidence in decision making in agricultural activities

Year/score	**2014**	**2015**
Always	327	247
Mostly	145	222
Sometimes	71	97
Mostly not	35	37
Never	2	8
Number of respondents	580	611

Source: Special surveys in 2014 and 2015, own calculations

3.2.3 Management capacity

To measure decision-making ability in both crops and livestock production, we confronted farmers with a management choice. Table 4 reports the results. It is shown clearly that only a minority of farmers reached the highest score of 2 points, i.e., gave the correct answer and the appropriate reason. A narrow majority could achieve at least 1 score for the correct answer (except for crop production in 2015). However, taking both years together farmers perform better in livestock production than in crop production.

Table 4: Decision making capacity for crops and livestock, per cent allocation to scores

Year	**2014**		**2015**	
Area/ Score category	**Crop (%)**	**Livestock (%)**	**Crop (%)**	**Livestock (%)**
2 (Correct answer and correct reason)	12.9	14.9	1.9	9.8
1 (Correct answer, incorrect reason)	38.8	44.0	34.9	44.0
0 (Failed both)	48.3	41.1	63.2	46.2

Source: Special surveys in 2014 and 2015, own calculations

Finally, a cognitive skill test was applied that included six general questions mostly related to numerical literacy and the ability to think logical. In Table 5 we can show that the majority of farmers were able to answer more than half of the questions in both years. On the other hand around 10 % were able to reach a full score and between 15 and 25 % the second highest score. This shows that farmers' cognitive abilities are quite good in general considering that the majority of respondents has only primary education.

Table 5: Cognitive skills scores of Hue farmers in 2014 and 2015

Year/score	**2014**	**2015**
6	68	51
5	152	102
4	212	176
3	125	178
2	44	67
1	23	42
0	1	4
Number of respondents	622	620

Source: Special surveys in 2014 and 2015, own calculations

To sum up at this stage, our 2014 and 2015 surveys contained a wealth of information that can give a good indication of the capabilities of Vietnamese farmers concerning knowledge, skills and confidence in making decisions in crop and livestock production. We also learn something about the extent of extension support that farmers in Hue province receive. The results show that while the technical knowledge of farmers may be low especially in crop production their subjective knowledge and their cognitive skills are better. The results are reasonable against the background of an underdeveloped and perhaps even dysfunctional agricultural extension system in the Central highlands which are outside the high potential agricultural areas of Vietnam like the red River and Mekong River Delta. Interestingly the

efforts of the Vietnamese government to develop the livestock industry seem to emerge from our results.

3.2.4 Risk attitudes

To assess the risk attitude of the respondents, two risk measures were included in the 2014 and 2015 studies. First, Dohmen et al.'s (2011) survey-based risk item, where respondents are asked to classify themselves on an eleven-point Likert scale has been carried out. Second, a hypothetical investment question, where respondents had to decide which fraction of an endowment of 60 million VND they would invest in a risky business was asked in the surveys.

Figure 4a and b show respondents' self-assessment of their willingness to take risk in 2014 and 2015. We can see that the majority of respondents choose a number between 6 and 8 (moderately risk-taking) while a much lower number of respondents chose a number below 5 (risk-averse).

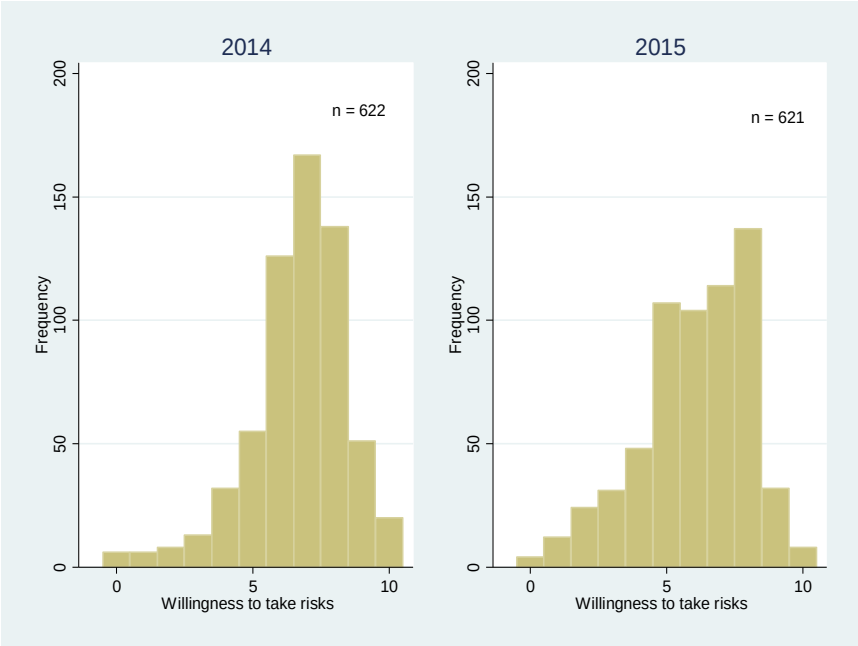

Figure 4a and b: Frequency distribution of the willingness to take risks (WTR)

Note: 2014 with 622 observations and 2015 with 621 observations. The willingness to take risk uses 11-Point Likert scale

Source: Special surveys in 2014 and 2015, own calculations

We find similar results from the second risk item of the hypothetical risky investment. In Figure 5, we show the frequency distributions of farmers' investment choices in steps of 10

million VND out of a total of 60 million VND. While the distributions show that both in 2014 and 2015 most respondents chose the middle column, a larger number of respondents chose the larger fractions of 50 or 60 million VND expressing a stronger willingness to take risk.

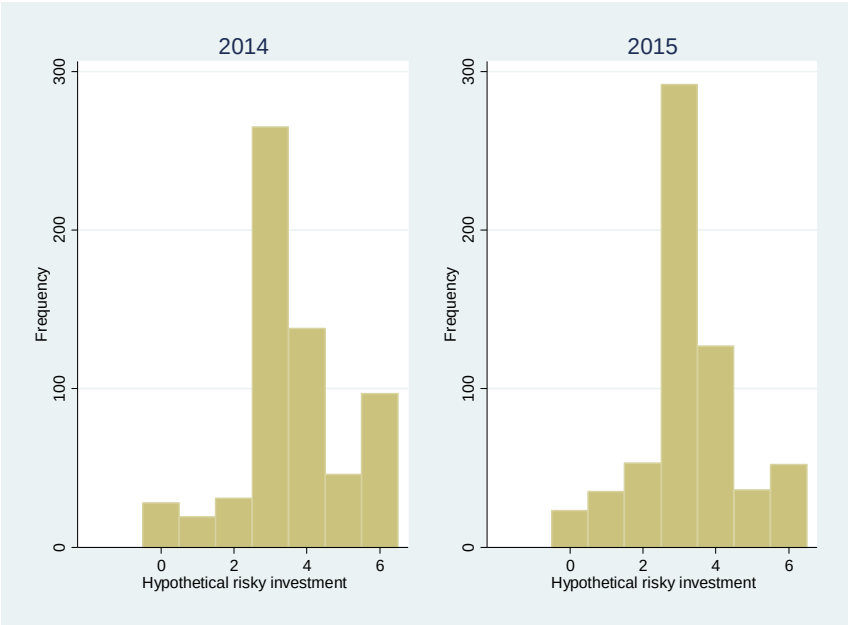

Figure 5a and b: Frequency distribution of the hypothetical risky investment

Note: investment amount in steps of 10 million VND. 2014 with 622 observations and 2015 with 621 observations

Source: Special surveys in 2014 and 2015, own calculations

3.2.5 Farmer performance

To obtain information about the performance of the farmers in our panel, we draw upon data from all survey waves, including the comprehensive household surveys conducted from 2007 to 2011 and 2013, as well as the special surveys in 2014 and 2015. In all seven waves, we collected information on yields and related measures of farm performance related to crops and livestock production. For crops, most observations we have is on rice production. Somewhat fewer observations we have in our sample grew cassava and maize. For livestock, two production enterprises are common in Hue, namely pig fattening and piglet production. While most farms who have chicken and ducks, majority of them are non-commercial and small-scale with the purpose for home production. Hence, we did not include these enterprises in the farm performance analysis.

We have seven time series observations for analyzing productivity and performance of farm enterprises. In Table 6, we report the results of annual average yields per farmer in kg per ha

for summer and winter rice, cassava and maize as well as the overall mean and standard deviations. For livestock we present annual average numbers of piglets per sow and the gross margins for pig fattening in the absence of a meaningful biological productivity measure.

Table 6 shows that rice yields are quite stable over the years in spite of flooding and storm events in the province of Hue which however are quite localized in selected communes or districts. This also holds for maize while for cassava variability is higher. This is due to the fact that cassava is in the mountain zone of the province which is prone to more weather shocks. For piglet production and pig fattening productivity is quite stable however data from only four years are available. However productivity on average is low compared to results achieved on farm trials in Northern Vietnam (Muth et al. 2017). The same is true for pig fattening with a gross margin (revenue less variable cash costs) of 15 – 20 $ per unit (pig).

Table 6: Productivity of Crop and Livestock over time

Year	Winter Rice	Summer Rice	Cassava	Maize	Piglets/sow/year	Gross margin/Pig Fattening (1000 VND)
2007	3819	3540	8767	3989	na	na
2008	4026	3704	11559	4151	14.38	33.72
2010	4042	3707	10866	4522	9.63	28.97
2011	3874	3419	11030	3602	10.57	46.70
2013	4108	3867	12296	3201	14.61	25.35
2014	3669	3017	12878	2965	na	na
2015	4399	4050	13458	4029	na	na
Mean	3991	3614.86	11550.57	3779.86	12.3	33.69
SD	234.85	334.36	1551.56	551.52	2.57	9.33

Note: na means no data available; in the 2014 and 2015 surveys no livestock balance sheets were elaborated.

Source: TVSEP survey from 2007 to 2013, special surveys in 2014 and 2015, own calculations

4. Bivariate analyses

So far the simple descriptive statistics have shown that farmers from Hue show relatively low technical knowledge, although their subjective knowledge and their cognitive skills are better. On average, farmers seem to be moderately risk-taking. However, their agricultural performance is relatively low. In this section we like to test the associations between the three

parameters, i.e., between (i) risk attitudes and knowledge, (ii) knowledge and agricultural productivity and (iii) risk attitudes and agricultural productivity.

4.1 Risk attitudes and knowledge

In table 7 we present the results of Chi2 test applied pairwise on willingness to take risk (WTR) and various objective and subjective knowledge parameters for 2014 and 2015. To perform the Chi2 tests we have discretized the 11 point Likert scale into risk averse, risk neutral and risk loving behavior.

Results show that farmers' willingness to take risk, elicited from Dohmen et al. (2011) survey question, is significantly related only to technical knowledge in livestock production in both survey years of 2014 and 2015. In 2014, we also obtain a significant association between WTR and livestock decision making and between WTR and cognitive skills. In both years, Table 7 shows a highly significant relationship between a farmer's WTR and her subjective knowledge.

This simple test indicates that we can to some first extent (without controlling for any confounding factors) confirm our hypothesis, i.e., those with better knowledge, in particular better technical livestock knowledge and higher subjective knowledge, also show a higher willingness to take risk.

Table 7. Risk attitudes and farmers' objective, subjective knowledge and cognitive skills

Year	2014			2015		
Chi Square Test	Pearson chi2(4)	Prob.	N	Pearson chi2(4)	Prob.	N
Willingness to take risks (WTR)						
Objective Crop knowledge	3.50	0.48	500	3.59	0.47	489
Objective Livestock knowledge	9.09	0.06	460	10.86	0.03	471
Crop decision making capacity	6.46	0.17	480	6.13	0.19	473
Livestock decision making capacity	12.97	0.01	450	7.81	0.10	461
Subjective knowledge in farm management	25.11	0.00	520	36.15	0.00	560
Cognitive skills	8.48	0.08	561	6.49	0.10	568

Source: Special surveys in 2014 and 2015, own calculations

4.2 Knowledge and farm productivity

Second, we test the association between our various knowledge indicators and agricultural performance. Here, we used ANOVA (F-test) to investigate the significance of productivity differences by knowledge scores.

Table 8 shows the results with respect to technical knowledge and management abilities, while Table 9 shows the results with respect to subjective knowledge, self-confidence and cognitive skills.

Table 8 shows that there are no significant differences in rice production but there are significant differences in livestock when tested against technical knowledge. This is plausible since rice production has a long tradition among farmers in Hue while commercial pig production has been promoted rather recently and hence technical knowledge is more important.

The results differ somewhat when testing farm performance against farmers' management capacity (lower panel of table 8). Here we find significant differences for rice yields in 2014 but not in the 2015 survey. In general however results are more ambiguous for this knowledge parameter.

Table 8: ANOVA results for technical knowledge and skill tests

Year	**2014**			**2015**		
ANOVA Results/No of observations (N)	F-value	Prob.	N	F-value	Prob.	N
Technical knowledge						
Winter Rice Yield	1.28	0.27	298	0.22	0.80	302
Summer Rice Yield	1.8	0.16	267	1.22	0.30	265
Piglet Production	1.1	0.36	94	2.50	0.09	104
Pig Fattening	2.45	0.09	111	4.12	0.02	131
Management (decision-making) ability						
Winter Rice Yield	2.31	0.10	288	1.42	0.24	291
Summer Rice Yield	3.95	0.02	256	0.11	0.90	258
Piglet Production	0.49	0.61	92	0.67	0.51	103
Pig Fattening	0.78	0.46	95	2.50	0.09	131

Note: ANOVA test (Analysis of Variance test). Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Source: TVSEP survey from 2007 to 2013 and special surveys in 2014 and 2015, own calculations

Table 9 however, shows a slightly different picture. With respect to subjective knowledge, there are significant differences in winter and summer rice yields in 2014. In 2015, we find significant differences in all four production activities, i.e., both in crop and in livestock (pig production). We can observe the same pattern for cognitive skills. With respect to self-confidence, Table 9 shows significant differences in winter and summer rice in 2015. The results demonstrate that subjective knowledge measures which capture experience and self-learning as well as basic education (cognitive skills) seem to be more important for farm performance than technical and formal agricultural knowledge.

Table 9: ANOVA result for subjective knowledge and skill tests

Year	**2014**			**2015**		
ANOVA Results/No of observations (N)	F-value	Prob.	N	F-value	Prob.	N
Subjective knowledge						
Winter Rice Yield	6.98	0.00	301	2.66	0.03	317
Summer Rice Yield	3.31	0.01	270	2.02	0.09	278
Piglet Production	1.70	0.19	97	3.08	0.02	107
Pig Fattening	1.84	0.14	117	4.08	0.00	138
Self-confidence in decision-making						
Winter Rice Yield	1.52	0.21	301	2.57	0.04	317
Summer Rice Yield	0.85	0.47	270	2.29	0.08	278
Piglet Production	0.07	0.93	97	2.06	0.11	107
Pig Fattening	1.92	0.13	117	1.84	.014	138
Cognitive skills						
Winter Rice Yield	6.51	0.00	308	9.90	0.00	317
Summer Rice Yield	7.15	0.00	273	8.68	0.00	278
Piglet Production	0.85	0.42	99	0.70	0.50	107
Pig Fattening	0.24	0.79	119	2.17	0.12	138

Note: ANOVA test (Analysis of Variance test). Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Source: TVSEP survey from 2007 to 2013 and special surveys in 2014 and 2015, own calculations

Following from these ANOVA tests, we can observe more significant differences in productivity from subjective knowledge than from technical knowledge. Average rice yields that are increasing in subjective knowledge scores and cognitive skills (as shown in the Appendix 3) indicate that knowledge (subjective knowledge in particular) is positively associated with farming performance.

4.3 Risk attitudes and farm productivity

Finally, we test the association between respondents' willingness to take risk and agricultural performance, where we use ANOVA (F-test) to identify significant differences between winter and summer rice yield the number of piglets per sow and net revenue of pig fattening. Table 10 shows that only piglet production in 2014 has significant mean differences by different categories of risk (risk averse, risk neutral and risk taker) derived from the Likert-scale.

Table 10: ANOVA result for willingness to take risk

Year	**2014**			**2015**		
ANOVA Results/No of observations (N)	F-value	Prob.	N	F-value	Prob.	N
Willingness to take risks						
Winter Rice Yield	0.56	0.57	307	0.23	0.79	317
Summer Rice Yield	0.92	0.40	272	0.21	0.81	278
Piglet Production	3.73	0.03	99	0.91	0.41	99
Pig Fattening	0.74	0.48	118	0.05	0.95	138

Note: ANOVA test (Analysis of Variance test). Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Source: TVSEP survey from 2007 to 2013 and special surveys in 2014 and 2015, own calculations

5. Conclusions and outlook

In this paper, we aimed to shed some light on the relationship between knowledge, risk attitudes and agricultural performance of farmers in the province of Thua Thien Hue in Vietnam. The descriptive analyses of rural farmers in Hue province has shown that farmers in our sample show relatively low technical knowledge, although their subjective knowledge and their cognitive skills are better. Accordingly, the rather poor extension services for farmers in Hue province contribute to the fact that farmers agricultural knowledge may come from own experience rather than from external supply. Furthermore, agricultural productivity is relatively low. The risk attitude measures have shown that on average, farmers seem to be moderately risk-taking.

We also tested the significance of relations between knowledge, risk attitudes and agricultural productivity. The test indicated that those with better knowledge, in particular better technical livestock knowledge and higher subjective knowledge also show a higher willingness to take risk. We also find a positive association between knowledge (subjective knowledge in

particular) and farming performance, but no significant link between risk taking behavior and farming performance.

This study suggests that extension services may fill the gap between subjective knowledge and technical knowledge and to build a significant linkage between risk-taking and learning to improve farmers' abilities and consequently enhance agricultural productivity.

To further develop the paper, in a next step, we aim to shed light on the causal relationships between farmers' subjective and objective knowledge, their management capabilities, their cognitive abilities, their individual risk attitudes and their economic performance in agricultural production. To explore these complex relationships we take a two-step regression approach. First, we test the be-directional relationship between the different knowledge measures and risk attitudes using a dynamic random-effect model. This model captures the dynamic interdependency and simultaneous causality between the two outcomes while controlling for unobserved heterogeneity (Devicienti & Poggi 2010). Second, we investigate how knowledge and risk attitude affect farmers' performance. We expect that a better understanding of these relationships will generate policy recommendations for the improvement of agricultural extension and services in Vietnam.

6. References

Adesina, A.A., Djato, K.K., 1996. Farm size, relative efficiency and agrarian policy in Cote dIvoire: profit function analysis of rice farms. *Agricultural Economics* 14, 93–102

Ambrasat, J., von Scheve, C., Conrad, M., Schauenburg, G., & Schröder, T. (2014). Consensus and stratification in the affective meaning of human sociality. *Proceedings of the National Academy of Sciences*, 111(22), 8001-8006.

Baidu-Forson. (1997). Factors influencing adoption of land-enhancing technology in the Sahel: lessons from a case study in Niger. *Agricultural Economics* 20 (1999) 231-239.)

Bergevoet, R.H.M., Ondersteijn, C.J.M., Saatkamp, H.W., van Woerkum, C.M.J., Huirne, R.B.M., (2004). Entrepreneurial behaviour of Dutch dairy farmers under a milk quota system: goals, objectives, and attitudes. *Agricultural Systems* 80, 1–21.

Castella, J. C., Slaats, J., Dinh Quang, D., Geay, F., Van Linh, N., & Thi Hanh Tho, P. (2006). Connecting marginal rice farmers to agricultural knowledge and information systems in Vietnam uplands. *Journal of Agricultural Education and Extension*, *12*(2), 109-125.

Charlotte Daydé, Stéphane Couture, Frédérick Garcia, and Roger Martin-Clouaire, "Investigating Operational Decision-Making in Agriculture" (June 17, 2014). *International Congress on Environmental Modelling and Software*. Paper 21. http://scholarsarchive.byu.edu/iemssconference/2014/Stream-H/21

Dalton, P. S., Ghosal, S., & Mani, A. (2016). Poverty and aspirations failure. *The Economic Journal*, 126(590), 165-188.

Devicienti, F., & Poggi, A. (2010). Poverty and social exclusion: two sides of the same coin or dynamically interrelated processes? Applied Economics, 43(25), 3549–3571.

Di Girolamo, A., Harrison, G. W., Lau, M. I., & Swarthout, J. T. (2015). Subjective belief distributions and the characterization of economic literacy. *Journal of Behavioral and Experimental Economics*, 59, 1-12.

Do, T. L., Nguyen, T. T., & Grote, U. (2017). Livestock Production, Rural Poverty, and Perceived Shocks: Evidence from Panel Data for Vietnam. The Journal of Development Studies, 1-21.

Feder, G., Just, R. E., & Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. Economic development and cultural change, 33(2), 255-298

Foster, A. and M. Rosenzweig. (1995). “Learning-by-Doing and Learning from Others: Human Capital and Technical Change in Agriculture,” *Journal of Political Economy* 103:6:1176-1209

Fountas, S., Wulfsohn, D., Blackmore, B. S., Jacobsen, H. L., & Pedersen, S. M. (2006). A model of decision-making and information flows for information-intensive agriculture. *Agricultural Systems*, 87(2), 192-210

Gladwin, C. H. (1989). *Ethnographic decision tree modeling* (Vol. 19). Sage.

Hardeweg, B., Klasen, S., & Waibel, H. (2013). Establishing a database for vulnerability assessment. In *Vulnerability to Poverty*(pp. 50-79). Palgrave Macmillan, London.

Helpman, E. (2009). *The mystery of economic growth*. Harvard University Press.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6, 1–55.

Hübler, Michael and Rebecca Hartje (2016). Are Smartphones Smart for Economic Development?, *Economics Letters* 141, 130-133.

Hübler, Michael. (2016). Does Migration Support Technology Diffusion in Developing Countries?, *World Development* 83, 148-162.

Jamison, D. T., & Moock, P. R. (1984). Farmer education and farm efficiency in Nepal: The role of schooling, extension services, and cognitive skills. *World Development*, 12(1), 67-86.

Kay, R. D., & Edwards, W. M. (1999). *Farm Management: Instructor's Manual*(No. 1373). Iowa State University, Department of Economics.

Kyeyune, V., & Turner, S. (2016). Yielding to high yields? Critiquing food security definitions and policy implications for ethnic minority livelihoods in upland Vietnam. *Geoforum*, *71*, 33-43.

Liu, E. M. 2013. Time to Change What to Sow: Risk Preferences and Technology Adoption Decisions of Cotton Farmers in China. *Review of Economics and Statistics* 95 (4): 1386–1403.

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, 1, 130-149.

Marra, M., Pannell, D. J., & Ghadim, A. A. (2003). The economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve?. *Agricultural systems*, *75*(2-3), 215-234.

McCown, R. L. (2012). A cognitive systems framework to inform delivery of analytic support for farmers' intuitive management under seasonal climatic variability. *Agricultural Systems*, *105*(1), 7-20.

Menapace, L., Colson, G., & Raffaelli, R. (2012). Risk aversion, subjective beliefs, and farmer risk management strategies. *American Journal of Agricultural Economics*, *95*(2), 384-389.

Muth P.C., Huyen L.T.T. & A. Valle Zárate (2017). Sow efficiency and early piglet mortality in two local pig breeds on smallholder farms in northern Vietnam-a longitudinal study. *Tropical Animal Health and Production*, 49(6), 1227-1234.

Öhlmer, B., Olson, K., & Brehmer, B. (2012). Behavioral Economics and Psychology of Incentives. *Annual Review of Economics*, 4(1), 427–452. http://doi.org/10.1146/annurev-economics-080511-110909

Reyna, V. F., Nelson, W. L., Han, P. K., & Dieckmann, N. F. (2009). How numeracy influences risk comprehension and medical decision making. *Psychological bulletin*, 135(6), 943.

Romer, Paul M. (1994). "The Origins of Endogenous Growth." *Journal of Economic Perspectives*, 8 (1): 3-22. DOI: 10.1257/jep.8.1.3

Rougoor, C. W., Trip, G., Huirne, R. B., & Renkema, J. A. (1998). How to define and study farmers' management capacity: theory and use in agricultural economics. *Agricultural economics*, *18*(3), 261-272.

Schultz, T. W. (1975). The value of the ability to deal with disequilibria. *Journal of economic literature*, *13*(3), 827-846.

Solano, C., León, H., Pérez, E., Tole, L., Fawcett, R. H., & Herrero, M. (2006). Using farmer decision-making profiles and managerial capacity as predictors of farm management and performance in Costa Rican dairy farms. *Agricultural Systems*, 88(2), 395-428.

Stefanou, S.E., Saxena, S., 1988. Education, experience, and allocative efficiency. A dual approach. *American Agricultural Economics Association* 70, 338–345

Stone, G. D. (2016). Towards a general theory of agricultural knowledge production: environmental, social, and didactic learning. *Culture, Agriculture, Food and Environment*, 38(1), 5-17.

Thai Thi Minh, R. Friederichsen A. Neef and V. Hoffmann. (2014). Niche action and system harmonization for institutional change: Prospects for demand-driven agricultural extension in Vietnam. *Journal of Rural Studies* 36 (2014) 273-284).

Tripp, R. Wijeratne, M and H. Piyadasa. (2005). What Should We Expect from Farmer Field Schools? A Sri Lanka Case Study. *World Development* Vol. 33, No. 10, pp. 1705–1720.

Van den Ban, A. W. (1998). Supporting farmers, decision making by agricultural extension. *Journal of Extension Systems*, 14, 55-67.

Wallace, M. T., & Moss, J. E. (2002). Farmer Decision-Making with Conflicting Goals: A Recursive Strategic Programming Analysis. *Journal of Agricultural Economics*, *53*(1), 82-100.

Weyori, A. E., Amare, M., Garming, H., & Waibel, H. (2018). Agricultural innovation systems and farm technology adoption: findings from a study of the Ghanaian plantain sector. *The Journal of Agricultural Education and Extension*, *24*(1), 65-87.

Willock, J., Deary, I. J., Edwards-Jones, G., Gibson, G. J., McGregor, M. J., Sutherland, A., ... & Grieve, R. (1999). The role of attitudes and objectives in farmer decision making: business and environmentally-oriented behaviour in Scotland. *Journal of agricultural economics*, *50*(2), 286-303.

Willock, J., Deary, I. J., McGregor, M. M., Sutherland, A., Edwards-Jones, G., Morgan, O., & Austin, E. (1999). Farmers' attitudes, objectives, behaviors, and personality traits: The Edinburgh study of decision making on farms. *Journal of Vocational Behavior*, 54(1), 5-36.

Appendices

Appendix 1
Risk Experiment

Do you prefer to play the 50:50-lottery (Option A) or to obtain a safe amount (Option B)? (Please show the show card to the respondent and ask him row by row which option he prefers. Tick the appropriate cell that corresponds to respondent's choice).

Row	Option A Lottery (1000 VND)	Please tick the option the respondent would prefer		Option B Safe Amount (1000 VND)
		Lottery	Safe amount	
1	200 : 0			0
2	200 : 0			10
3	200 : 0			20
4	200 : 0			30
5	200 : 0			40
6	200 : 0			50
7	200 : 0			60
8	200 : 0			70
9	200 : 0			80
10	200 : 0			90
11	200 : 0			100
12	200 : 0			110
13	200 : 0			120
14	200 : 0			130
15	200 : 0			140
16	200 : 0			150
17	200 : 0			160
18	200 : 0			170
19	200 : 0			180
20	200 : 0			190

Appendix 2

For the questionnaire that was used in 2015, we specified the questions on maize production for farmers who grow maize instead of rice and the questions on cattle production for farmers who raise other animals instead of pigs. In the results, nevertheless, we add them together for two variables of knowledge in crop and knowledge in livestock.

Question 5.1 Knowledge and Decision Making in Crop Production

(only if question 1 in Section 4.1 has "Yes" answer, otherwise go to Section 5.2)

5.1.1 Knowledge questions in rice production

1) Land preparation should be done one day before the rice transplanting.
   Correct _____ 01
   Wrong _____02
2) In a 50 kg bag of 16-20-0 fertilizer, there is 50 kg of nitrogen.
   Correct_____ 01
   Wrong_____02
3) The most important fertilizer for high rice yields is nitrogen.
   Correct_____01
   Wrong_____ 02
4) The more fertilizer one can apply the better for the rice yield.
   Correct_____ 01
   Wrong_____02
5) Transplanting method is good for weed control.
   Correct_____ 01
   Wrong_____02
6) Land preparation is not important for the water management during the cropping season in rice.
   Correct_____ 01
   Wrong_____02
7) The more water in the field is always better for growth of rice.
   Correct_____ 01
   Wrong_____ 02
8) All insects in the rice field are pests.
   Correct_____ 01
   Wrong_____ 02
9) The principle to apply pesticides is to spray only when you see the pests.
   Correct_____ 01
   Wrong_____02
10) Harvesting methods does not effect on the grain yield.
   Correct_____01
   Wrong_____02

Question 5.2 Knowledge and Decision Making in Livestock Production
(only if question 1 in Section 4.2 has "Yes" answer, otherwise go to Section 5.3)
5.2.1 Knowledge questions in pig farming

1) Pregnant period in pigs is 5 months
Correct _____ *01*
Wrong _____*02*
2) Growing pigs in a group makes them grow better than if a pig is alone:
Correct _____ *01*
Wrong _____*02*
3) A sow can give birth only once a year.
Correct _____ *01*
Wrong _____*02*
4) Foot-and-Mouth is the major disease in pigs.
Correct _____ *01*
Wrong _____*02*
5) Pigs are prone to sunburn and sun stroke.
Correct _____ *01*
Wrong _____*02*
6) Antibiotics should be provided to pigs on daily basis.
Correct _____ *01*
Wrong _____*02*
7) A sow reaches sexual maturity at 2 years of age.
Correct _____ *01*
Wrong _____*02*
8) Temperature influences the demand of water in pigs.
Correct _____ *01*
Wrong _____*02*
9) Crossbreeding is the method to improve the immune system in pigs.
Correct _____ *01*
Wrong _____*02*
10) Cassava is more nutritious feed than rice bran for pigs.
Correct _____ *01*
Wrong _____*02*

Subjective knowledge in crop, livestock, doing business
How would you rate your knowledge in:

a. Crop

Code H
1 excellent = 5
2 very good = 4
3 moderate = 3
4 quite low = 2
5 very low = 1

b. Livestock

Code H
1 excellent = 5
2 very good = 4
3 moderate = 3

4 quite low = 2
5 very low = 1

c. Doing business in agriculture

Code H

1 excellent = 5
2 very good = 4
3 moderate = 3
4 quite low = 2
5 very low = 1

Self-confidence in decision making

Do you feel confident (i.e. you are sure that you always make a good decision) when you make a decision in agriculture (e.g., Choice of variety, planting time, applying fertilizer, spraying pesticides, purchase of livestock, etc.)?

1 always confident
2 mostly confident
3 sometimes confident
4 often not confident
5 never confident

Decision-making tests

Crop production

The Agricultural Extension Center offers to introduce two new rice varieties (variety A and variety B). Variety A has lower input but also lower yield. Variety B has higher input cost but also higher yield. The center gives you the following information about the two varieties. Suppose that you could grow both varieties in your land, which Variety you choose? (You can use a calculator). Please, explain why do you choose that?

Options	Variety A	Variety B
Area	1 Sao	1 Sao
Cost per Sao	300 000 VND	600 000 VND
Yield per Sao (kg)	100 kg	200 kg
Price per kg	15 000 VND	10 000 VND

Pig production

The Agricultural Extension Center offers to introduce two breeds of pigs (Breed A and Breed B). Breed A has lower weight gain but also lower cost. Breed B has higher weight gain but also higher cost. The Center provides you following information about these two breeds.

Suppose that you could apply both options, which Breed do you choose? (You can use a calculator). Please, explain why do you choose that?

Options	Breed A	Breed B
Period	3 months	3 months
Cost	150 000 VND	180 000 VND
Weight	40 kg	60 kg
Price per kg	10 000 VND	8 000 VND

Questions regarding the frequency of extension visits

CROP PRODUCTION	**LIVESTOCK PRODUCTION**
1 Do you receive advice from agricultural extension worker?	**1 Do you receive advice from local veterinarian?**
Yes_____ _01 (go to question 2 below)	Yes_____01 (go to the question 2 below)
No_____ _02	No_____02
2 How often do they come?	
Code A	Code A
3 On which topics do they give you advice? *More than one answers possible*	
Code B1	Code B2
4 How are you satisfied with the advice you received?	
Code C	Code C
5 What do you do when crops (livestock) get diseases? *More than one answers possible*	
Code D	Code D

Code A

1	Once a week
2	Once a month
3	Every three months
4	Every six months
5	Once a year
90	Others (specific)

Code B1		Code B2	
1	Variety	1	Breeds
2	Fertilizers	2	Feeds
3	Pesticides management	3	Diseases management
4	Land preparation	4	Hygiene
5	Harvesting	5	Time of slaughter/sales
6	Market information	6	Market information
90	Others (specific)	90	Others (specific)

Code C		Code D	
1	Always satisfied	1	Throw away (leave it aside)
2	Mostly satisfied	2	Self-managing
3	Sometimes only	3	Consult the subject matter specialists
4	Mostly not satisfied	4	Consult the agricultural supplies stores
5	Never satisfied	5	Inform the local government
		90	Others (specific)

Cognitive skill questions

1 What is 54+67
Please fill in answer here or tick box to the right!
Do not know _____97
No answer _____98
2 If you have six friends and would like to give each of your friends three sweets, how many sweets do you need?
Do not know _____97
No answer _____98
3 What is 5% of 500?
Do not know _____97
No answer _____98
4 Suppose you want to buy a bag of rice that costs 230 000 VND. You only have one 500 000 VND note. How much change will you get?
Do not know _____97
No answer _____98
5 In a sale, a shop is selling all items at half price. Before the sale a mattress costs 600 000 VND. How much will the mattress cost in the sale?
300 000 VND
900 000 VND
1 200 000 VND
Do not know _____97
No answer _____98
6 A second-hand motorbike dealer is selling a motorbike for 6 Mio VND. This is two thirds of what it costs new.
How much did the motorbike cost new?
4 Mio VND
9 Mio VND
10 Mio VND
12 Mio VND
2400 20
Do not know _____97
No answer _____98

Appendix 3

ANOVA Test: SUBJECTIVE KNOWLEDGE AND WINTER RICE YIELD

Score	Mean	Std. Dev.	Freq.
1	4268.46	1648.88	3
2	4366.79	1373.47	94
3	4025.72	1421.62	195
4	3859.19	1548.02	22
5	2088.89	538.86	3
Total	4099.27	1428.81	317

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	21261331	4	5315333	2.66	0.0329
Within groups	623851824	312	1999525		
Total	645113155	316	2041497		

Bartlett's test for equal variances: chi2(4) = 2.5598 Prob>chi2 = 0.634

ANOVA Test: COGNITIVE SKILL AND WINTER RICE YIELD

Cognitive score	Mean	Std. Dev.	Freq.
1	3503.22	1382.55	66
2	4212.59	1395.14	238
3	5050.56	1332.26	13
Total	4099.27	1428.81	317

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	38268787	2	19134393	9.9	0.0001
Within groups	606844369	314	1932625		
Total	645113155	316	2041497		

Bartlett's test for equal variances: chi2(2) = 0.0514 Prob>chi2 = 0.975