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Demand for area crop insurance among litchi producers in northern Vietnam

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Abstract

This study examines the need for crop insurance for litchi production in northern Vietnam and how farmers might participate in such a program. Hypothetical insurance programs were developed which proposed all-risk coverage based on area yields. This coverage was offered to farmers to determine both their interest in the program and how insurance features and farmer characteristics affected their decision to buy insurance. Farmers were also surveyed regarding their production practices, price and yield expectations, and financial and personal characteristics. Even before considering other program costs and government budget constraints, there is not a strong case for establishing a crop insurance program here. Results indicate that while farmer participation would be significant, crop insurance is not needed to achieve policy goals like raising farmer income or guaranteeing subsistence levels of income. Crop insurance is not needed to promote litchi production, which is already expanding rapidly due to its high profitability relative to other farm enterprises. In their choice of coverages, farmers preferred higher yield guarantee levels and lower indemnity prices. Estimated premiums were quite low when expressed as a percent of expected revenue, and farmers were not responsive to changes in premiums. Econometric analysis indicated that high income farmers were more likely to participate, but other farmer characteristics seemed to matter little. Anecdotal evidence suggested that farmers believed the expected area yields used to set insurance coverage levels were too low. Because litchi productivity varies significantly by tree age and the litchi planted area is expanding rapidly, determining appropriate values for expected area yields and insurance coverage levels appeared to be the biggest challenge in program design. It is hypothesized that additional farmer education about the relationship between area and farm yields and other aspects of area insurance could improve such a program's operation. Published by Elsevier Science B.V.

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1. Introduction

Crop insurance has been used in a variety of forms and for a variety of purposes in more than 70 countries, according to an FAO survey published in 1991(FAO, 1991). In particular, developing countries have established crop insurance programs not only to provide farmers with another risk management tool but also to promote other goals, such as improving farmers' access to credit, promoting production of high-value crops that might also have higher yield risk, and providing more stability to agriculture and related industries. There have been quite varying degrees of success over the years, across countries and across several types of insurance programs (see Hazell et al., 1986; Hueth and Furtan, 1994; Mishra, 1996).

At this date, Vietnam has no formal agricultural insurance programs. As part of a pedagogical program related to risk analysis in agricultural production with

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the Faculty of Economics and Rural Development at Hanoi Agricultural University #1, a study was undertaken to evaluate farmers' interest in crop insurance for a crop in northern Vietnam. Several questions were important at the outset: could crop insurance be used to promote production of high-value, non-traditional crops; what types of insurance coverage would be appropriate for the particular conditions of northern Vietnam; would farmers' incomes be significantly stabilized by crop insurance; would farmers voluntarily participate in the program; and what factors appeared to affect farmers' insurance decisions.

Litchi (*Litchi chinensis*) was considered an appropriate crop for study because it appeared to be highly profitable, yet it could be considered a non-traditional crop that has not been widely adopted. In addition, the view commonly held among farmers was that litchi production was rather uncertain. The primary litchi growing area in northern Vietnam is near Hanoi, and local officials in one district there were willing to cooperate with surveys of litchi producers.

Two surveys were conducted to collect information addressing the issues mentioned above. A survey in May 1998 looked at farmers' production practices, costs, and expectations for prices and yields for all crop and livestock enterprises, along with farmers' personal characteristics such as age, education, and family size, and financial characteristics such as non-farm income and credit availability. A second survey in September 1998 evaluated farmers' responses to hypothetical crop insurance contracts on litchi production.

The following sections describe general conditions for litchi production and other farming practices in the surveyed area, the design of a hypothetical insurance program for litchi, farmer responses to this proposed coverage, and an econometric model of insurance demand. The final section summarizes the need for crop insurance for litchi production in northern Vietnam and some observations about insurance program design.

2. Litchi production in northern Vietnam

Litchi production in northern Vietnam occurs primarily in the mountainous region bordering the northern edge of the Red River delta. Luc Ngan district in Bac Giang province, located about 80 km northeast of Hanoi, was selected for the study, since it is an important center for litchi production in this area.

Luc Ngan district has about 1012 km^2 and is home to 173,000 people living in 31,100 households. Luc Ngan district's labor force works primarily in agriculture. Ethnic Vietnamese comprise about 54% of the local population, while 10 other ethnic groups living in the more mountainous areas of the district comprise the rest. Litchi production occurs mainly among the Vietnamese ethnic group.

The climate and topography of Luc Ngan district are well-suited for production of a tree crop like litchi. Annual rainfall is about 1800–2000 mm per year, average annual temperature is 18–23°C, and Luc Ngan is seldom affected by severe storms. Only about 18% of the district's land is considered suitable for rice and other field crops, while the area suitable for cultivating fruit trees, consisting of rolling hills, is quite large.

Litchi saplings are established by cutting and planting small branches from existing trees. The young trees begin to bear fruit in their third or fourth year, and they continue growing in size and productivity until perhaps the age of 15 years. They can remain productive indefinitely, with one tree in the area reportedly being more than 200 years old. The trees blossom in early spring (February and March), and the fruit is harvested over 1 month's period in late spring (May–June). However, a tree may not bear fruit every year; reportedly only about 60% of trees bear fruit in a given year. This may reflect weather conditions during the flowering period or other weather and disease-related conditions. A serious disease problem appeared in 1997 and 1998, apparently caused by a fungus that affects trees in heavy or poorly drained soils and which kills infected trees in a relatively short time. New management practices such as reducing planting depth, improving soil drainage, and greater tree pruning are being promoted to reduce this risk, and a chemical treatment has also been developed which saves about 60% of affected trees if they can be treated at an early stage of the disease.

Litchi was introduced into the area in the 1960s by farm families migrating from nearby Hai Duong province. Litchi production in Luc Ngan district has developed primarily since 1987, about the beginning of the *doi moi* economic renovation period in Vietnam. Table 1 shows litchi land area, total production, and

Table 1
Planted area, total production, and yields for litchi in Luc Ngan district, 1991–1998[a]

Year	Land area planted to litchi (ha)	Total output of litchi (t)	Litchi yield (t/ha)
1991	1500	1300	1.40
1992	1830	1400	1.40
1993	2050	1800	1.45
1994	2488	2000	1.62
1995	3000	2250	1.50
1996	4000	4599	1.70
1997	5278	4582	1.58
1998	7092	5000	1.25

[a] Note: Yields are calculated using land area with productive trees, not total planted area.

yields from 1991 to 1998 for Luc Ngan district. The most significant trend in this data seems to be the rapid growth in the planted area, growing from 1500 ha in 1991 to more than 7000 ha in 1998. Of these 7000 ha, about 4000 have trees old enough to produce fruit. Local officials hope to see this expansion continue, with a goal of 10,000 ha planted by the year 2005. Table 2 shows similar data for Tru Huu commune, the particular commune in Luc Ngan district visited for this study.

A survey in May 1998 collected information from Tru Huu farmers regarding their production practices for both crop and livestock enterprises, their income and credit situations, and other personal characteristics. One hundred households were interviewed. Several relevant results are reported here.

Table 2
Planted area, total production, and yields for litchi in Tru Huu commune, 1991–1998[a]

Year	Land area planted to litchi (ha)	Total output of litchi (t)	Litchi yield (t/ha)
1991	63	106	2.10
1992	65	115	2.20
1993	80	120	2.10
1994	85	144	2.40
1995	105	145	2.30
1996	114	215	2.76
1997	147	259	2.27
1998	160	245	2.15

[a] Note: Yields are calculated using land area with productive trees, not total planted area.

Average values for minimum, maximum, and most likely litchi yields were 4.1, 8.8, and 6.5 t/ha, respectively. This is significantly higher than the district average yield, 1.49 t/ha, or the commune average yield, 2.29 t/ha, over the 1991–1998 period. Further investigation revealed that Tru Huu commune had more early adopters of litchi production than elsewhere in the district, and the greater maturity of their trees accounts for at least some of the differences in yields.

Further litchi yield information was collected using a "visual impact method," where farmers placed counters into various yield ranges to assess their probabilities (see Hardaker et al., 1997). From this information, a yield distribution was derived for each farmer. The average yield across all 100 farms from these calculations was 6.22 t/ha, with a standard deviation of 1.44 t, or a coefficient of variation of about 26%. This suggests somewhat more variability than the minimum and modal yields reported above, where the minimum yield was 63% of the modal yield. Litchi yields on individual farms also seem more variable than the aggregate yields for the district and commune seen in Tables 1 and 2. The lowest district yield from 1991 to 1998 was 1.25 t/ha, about 84% of the average, while the lowest commune yield over this period was 2.10 t/ha, about 91% of average.

Farmers reported that the litchi price varies significantly by season, with a low of about 11,000 dong/kg at harvest and an off-season high of as much as 22,000 dong/kg (at that time, the exchange rate was about 13,000–14,000 VN dong = US$ 1). Storage and processing is a problem, so most output is marketed as fresh fruit shortly after harvest. Farmers reported that they expected to get an average price of about 13,000 dong/kg.

Litchi production appeared to be quite profitable. With an average yield of about 235 kg/sao (in northern Vietnam, one sao equals 360 m^2) and a market price of 13,000 dong/kg, average revenue per sao is about 3.055 million dong. Farmers reported variable costs of only about 150,000 dong per sao for litchi, leaving a significant amount for land taxes, other overhead costs, and living expenses. A litchi sapling costs only about 10,000 dong, so more trees can be planted at relatively little expense. A comparison with rice production shows that litchi was nearly five times more profitable. As a result, farmers in Tru Huu only planted rice for home consumption, not for commercial sales.

Nearly all households also had some kind of small-scale livestock activity. The most common of these was raising market hogs, with 85 households engaged in this activity. The average annual production was about 240 kg per year (roughly two slaughter hogs), with the great majority of production being sold commercially. Just over half the households raised chickens, mainly for household consumption, while just over one quarter of the households had sow farrowing operations. Livestock were fed mostly crop residues and by-products and table scraps, so there was very little cash expense in these operations.

Regarding credit, 68 households said they had received loans the previous year from a special government program to promote fruit production. The typical loan in this program was for an amount of 1 million dong, at 0.7% interest per month, with a repayment period of 5 years. Only six other households reported borrowing money from other sources for agricultural purposes. Only three households reported borrowing money for non-agricultural purposes.

Only 18 households reported any non-farm income, and only a few of these received significant amounts of such. Non-farm income does not play a role in most families' financial plans. The average farm size among households in the sample was about 11 sao (about 0.4 ha), which is larger than average in northern Vietnam. The typical farm household included five people, and farmers had attended school for an average of 7 years.

Total annual household income averaged 26.6 million dong, or about 6.2 million dong per person in the household (roughly US$ 1973 and US$ 427, respectively). These amounts are noticeably higher than average for farm households in northern Vietnam. They seem best explained by the higher profitability of litchi production (compared to rice) and the relatively larger farm size. Average annual farm income per household was 24.6 million dong, and the average for minimum annual farm income was 19.4 million dong (about 79% of average annual farm income). The major source of income was litchi production.

These results answer some of the questions posed above. First, it appears that crop insurance is probably not necessary to promote the adoption of litchi production. The relatively high profitability of litchi production probably explains the rapidly expanding litchi plantings, and these will likely continue regardless of whether crop insurance is introduced.

Second, farm incomes do not appear extremely variable. While litchi yields showed some variability, it appears that farmers can expect at least two-thirds of their average incomes in even the worst of years. Farm incomes in the sample, while certainly low, were still above average for farmers in northern Vietnam, and farmers reported that they didn't expect to experience income levels less than about 75% of this average. Crop insurance for litchi could provide more stability to farmers' incomes, but it doesn't appear necessary to guarantee a subsistence level of income.

It's not clear whether crop insurance would improve farmers' access to credit. Farm loans came almost entirely from a special one-time credit program targeted specifically at promoting fruit tree production, and two-thirds of farm households participated in this program. This suggests that farmers are at least interested in borrowing money to support and expand their farming enterprises. Other agricultural lenders do not appear to be serving farmer needs very well. Closer examination of lender policies is needed to determine if crop insurance could serve as collateral and improve access to credit.

3. A hypothetical insurance program for litchi farmers

To assess farmers' interest in crop insurance, they were surveyed a second time in September 1998 about participating in a hypothetical insurance program for litchi production. This section describes how the insurance was designed.

First, the insurance was designated as all-risk insurance, rather than specific-risk insurance. The specific risk that concerned farmers most was the relatively recent problem of disease mentioned above. However, an insurance program specifically covering this disease was considered inappropriate for several reasons: insurance could create a moral hazard in caring for the trees, since management practices affect the disease's occurrence and its treatment; adverse selection might be a problem, since farmers alone would know which trees were planted deeply and thus more prone to disease; and finally, only 2 years of data would make it difficult to estimate premiums

accurately. Farmers also said they worried about losses due to the weather, but this was expressed as a concern for weather in general terms rather than specific perils, such as drought, hail, wind, etc. Consequently, an all-risk insurance program was considered most appropriate.

Next, should the insurance be based on individual farm yields or some kind of area yield? Several factors suggested that an area-based program would be more appropriate. First, area yield histories were available in the form of district and commune yield records, which would be needed to set coverage levels and estimate premiums. Few farmers had similar yield records. Second, the opportunity for fraud would be much greater with individual coverage, since farmers could easily conceal some output and claim a loss. Also, the administrative cost for monitoring an extremely large number of small farmers would be prohibitive. Similarly, other administrative costs would be higher with individual coverage, since multiple premium schedules would be needed, each farm's yield history would have to be examined in order to assign the appropriate premium, and every individual loss would have to be verified. These kinds of administrative costs are greatly reduced in an area-based scheme, since only the area yield is needed to establish premiums and evaluate losses.

Which type of area unit would be most appropriate? To the extent that farm and area yields differ in frequency and severity, area insurance does not provide an effective "yield hedge" (Barnaby and Skees, 1990). Thus, farmers would likely want the area defined in a way such that the area yield tracks closely with their own farm yields.

Two area units were used for the hypothetical insurance. The first area was defined as Luc Ngan district, since production conditions and weather patterns are fairly homogeneous over the area. However, out of concern that farmers might fear that the district yield would not reflect their own, Tru Huu commune was defined as a second area. This commune is one of more than 30 communes in the district, and it is the commune where the interviewed farmers lived, greatly reducing any chance that the area yield might differ significantly from their own yields. Several years of yield history were available at both the district level and the commune level for setting coverage levels and premiums.

Yield guarantee levels were set at 90 and 85% of the areas' expected yields. These relatively high percentages were used because of the low variability found in the areas' historical yields. Setting expected area yields and the consequent insurance coverage levels was complicated by the fact that tree productivity depends heavily on tree age, and that the planted area contained a large percentage of land with relatively young trees. Thus, average yield for an area could change substantially simply due to greater maturity and productivity of older trees, or conversely, due to a large number of young trees just beginning to bear fruit. In other words, while part of the area yield variation is due to weather, disease, pests, and other hazards, another part is due to the changing age distribution and thus changing productivity of the tree population. Both types of effects must be considered.

Ideally, expected area yield could be estimated by a survey determining the percentage of trees in various age categories, along with estimates of productivity typical for each age category. Unfortunately, such information was not available. Expected yields could only be set using the yield histories seen in Tables 1 and 2. For the district, the expected yield was set at 1.5 t/ha, and for the commune, it was 2.4 t/ha.

Indemnity payments per sao were defined as an indemnity price times the difference between actual area yield and the area yield guarantee when actual yield is below the guaranteed yield. Three indemnity prices were used: 15,000, 25,000, and 35,000 dong/kg. The lowest indemnity price was set close to the normal market price level, while the two higher indemnity prices were offered in case farmers might be concerned that their own farm loss might be larger than the area's yield loss. In this case, a higher indemnity price makes the indemnity payment larger, thus offsetting the smaller yield loss at the area level. Miranda (1991) and Mahul (1999) provide theoretical discussions about optimal coverage levels for area insurance.

The premiums were based on the yield histories seen in Tables 1 and 2. Yield distributions were fitted to the data, and expected yield losses below the yield guarantee levels were calculated. Due to the extremely low variability in this data, the "pure premiums" (the amounts needed to pay only expected indemnities) were quite low. Two kinds of loads were then added to the pure premiums: the first was a fixed load set at 5000 dong/sao for the 15,000 indemnity price, with

proportionately higher amounts added for the other indemnity prices. Then an additional 30% load was added to all of these premiums.

Two schedules were thus obtained for both the district and commune insurance. Premiums for the district insurance were slightly higher than those for the commune insurance. In both cases, the premiums for the 85% yield guarantee were about two-thirds the amount of those for the 90% yield guarantee. In all cases, the premiums were relatively small in comparison to the expected revenue; the highest premium for the district insurance was 33,200 dong/sao, only 1.09% of the expected revenue of 3.055 million dong/sao mentioned earlier. Even if farmers' yields were much lower, the premium would still be in the range of 2–3% of expected revenue per sao.

The insurance was presented as a voluntary program. No mention was made to farmers as to whether it was offered from a private company or through a government agency.

4. Farmer response to area crop insurance

In September 1998, staff members of the Faculty of Economics and Rural Development at Hanoi Agricultural University #1 interviewed the same 100 households regarding their interest in both the district insurance and the commune insurance. After explaining how area insurance would work, the staff offered the various insurance contracts to the farmers. Specifically, farmers were asked whether they would purchase a particular level of coverage or not. With two yield guarantee levels and three indemnity prices, this meant six possible coverage combinations for each type. For each of these combinations, farmers were first asked if they would purchase the coverage at the higher premium level (pure premium + fixed load + 30% load), and if they declined, then they were offered the coverage at the lower premium (pure premium + fixed load). Each household was given a gift of 20,000 dong for participating in the survey.

Tables 3 and 4 show the number of farmers buying each of the contracts for the district insurance and the commune insurance, respectively. Several patterns are apparent in these results. First, farmers showed greater interest for the district insurance than for the commune insurance. This is surprising at first glance, since the commune insurance was cheaper and farmers' yields would probably follow the commune yield more closely than the district yield. However, the interviewers reported that many farmers believed the expected commune yield used to establish the coverage levels was too low, meaning that they thought it was very unlikely that the commune yield would ever drop below the yield guarantee levels.

This is interesting, considering that the 1991–1998 average for the commune was 2.29 t/ha, while the expected commune yield for the insurance program was set at 2.4 t/ha. Considering that farmers in the sample reported much higher yields than the district or commune, the question arises whether farmers

Table 3
Number of farmers buying hypothetical district insurance coverage

Insurance contract description			Number of farmers buying contract
Yield guarantee (%)	Indemnity price, dong/kg	Premium level	
90	15,000	High	55
90	15,000	Low	62
90	25,000	High	33
90	25,000	Low	33
90	35,000	High	14
90	35,000	Low	16
85	15,000	High	16
85	15,000	Low	18
85	25,000	High	18
85	25,000	Low	21
85	35,000	High	9
85	35,000	Low	11

Table 4
Number of farmers buying hypothetical commune insurance coverage

Insurance contract description			Number of farmers buying contract
Yield guarantee (%)	Indemnity price, dong/kg	Premium level	
90	15,000	High	41
90	15,000	Low	44
90	25,000	High	19
90	25,000	Low	21
90	35,000	High	21
90	35,000	Low	21
85	15,000	High	14
85	15,000	Low	15
85	25,000	High	17
85	25,000	Low	17
85	35,000	High	12
85	35,000	Low	12

calculated their yields on the same basis as official statistics (e.g. yield from all trees, only mature trees, only fruit-bearing trees, etc.) and how the official statistics themselves were developed. Some clarifications on these issues may have helped farmers better understand the relationship between their own farm yields and area yields and coverage levels.

A second pattern in farmer responses is that farmers preferred the 90% yield guarantee level over the 85% yield guarantee level. This might be related to the issue just mentioned: farmers perceived the probability of area yield falling below 90% of average to be rather low, but the probability of falling below 85% would be even lower. This pattern was true for both district insurance and commune insurance.

A third result was that the farmers usually preferred lower indemnity prices. Several explanations of this result are possible. One might be that coverage with a higher indemnity price also has a higher premium. Another reason might be that farmers did not recognize that a higher indemnity price would provide a higher indemnity in cases when their own yield loss exceeded the area yield loss. It is also possible they believed their own yield losses might follow the area yields very closely, and that a higher indemnity price was unnecessary. No additional questions measured farmers' beliefs on any of these issues.

A fourth result is that farmers were not very responsive to reductions in premiums. In most cases, reducing the premiums 30% encouraged only a few more farmers to buy the insurance.

Participation was over 50% for only one of the district contracts, and was less than 50% for all of the commune contracts. However, participation rates are higher when considering how many farmers would buy at least one contract. Table 5 shows the number of contracts bought by each farmer — that is, how

Table 5
Number of insurance contracts bought per farmer

	Number of farmers	
	District insurance	Commune insurance
High premium level		
Bought 0 contracts	16	30
Bought 1 contract	49	38
Bought 2 contracts	22	24
Bought 3 contracts	5	0
Bought 4 contracts	5	5
Bought 5 contracts	1	0
Bought 6 contracts	2	3
Low premium level		
Bought 0 contracts	11	25
Bought 1 contract	45	42
Bought 2 contracts	30	25
Bought 3 contracts	5	0
Bought 4 contracts	6	5
Bought 5 contracts	1	0
Bought 6 contracts	2	3

many did not buy any insurance, how many bought at least one contract, two contracts, and so on. For district insurance, the largest category is the category for farmers buying only one contract, with more than 40 farmers responding this way. However, only 16 farmers did not buy any contracts at the high premium level, and only 11 did not buy any at the low premium level. So while farmers rejected most of the contracts, a sizeable majority still said they would buy at least one contract. For commune insurance, the pattern is similar, although the number of farmers who did not buy any insurance was higher.

5. An econometric model of insurance demand

What were the effects of insurance contract features and farmer characteristics on the decisions to buy insurance? To examine this question, binomial logit models were estimated for district and commune insurance decisions. There were 1200 observations for each data set, representing the various combinations of two yield guarantee levels, three indemnity prices, and two premium levels. The following section describes the model variables and regression results.

Three insurance contract features were used as explanatory variables: the premium, the yield guarantee level, and the indemnity price. One would expect higher premiums to reduce demand for insurance. A higher yield guarantee level represents a higher level of protection, so the coefficient for this variable should be positive. A higher indemnity price means a higher indemnity payment whenever a loss occurs, so a higher indemnity price should increase the demand for insurance (assuming no change in the premium).

Several farm and farmer characteristics were also used in the model. The first two variables were personal characteristics, years in farming and education. Two types of income variables were also included. The first was the ratio of minimum farm income to average farm income. This variable measures the risk of having relatively low income: when this ratio is low, a farmer has more income variability and might be more likely to buy insurance. The second income variable is average total income, which includes both farm and non-farm income. This measures the farmer's absolute income level, and it should also reflect the wealth of the household, and probably farm size, too.

Two other variables were used to reflect farmers' attitudes about risk and their responses to risk. The first of these is the number of risks affecting litchi yield that farmers mentioned on the first survey. These included disease, weather, using outdated technology, and bird damage, meaning the variable could range from 0 to 4. Similarly, on the first survey farmers were also asked about different management practices they used to reduce risk for litchi. They mentioned three kinds of responses: using improved cultivation methods, using chemicals against pests and disease, and using other technological innovations. Thus, this variable could range in value from 0 to 3.

The final two variables were the number of trees that died in 1997 and 1998, and the standard deviation of litchi yield. Both variables were used to represent litchi yield risk, and both variables should be positively correlated with higher demand for insurance. The standard deviation of litchi yield was derived from the probability distributions elicited in the first survey. Table 6 summarizes the description of these variables and shows the abbreviated variable names used in later tables.

The regressions were performed on both the district insurance decisions and the commune insurance data using the model described above. However, in both cases there was an unexpected result: the coefficient for the premium was positive, suggesting that farmers will buy more insurance when the price is higher. A problem of multicollinearity was suspected due to the correlation between a higher premium, a higher yield guarantee, and a higher indemnity price. In response to this problem, the yield guarantee was instead represented with a dummy variable defined to be 1 when the yield guarantee was 90% and 0 when it was 85%. Regressions for this revised model were performed for both types of insurance, and the results seemed more satisfactory.

Table 7 shows the results for the district insurance decisions. For the insurance contract variables, the coefficients for both the premium and the yield guarantee have the expected signs and t-statistics significant at the 95% confidence level. The coefficient for the indemnity price is negative, perhaps contrary to intuition but consistent with the patterns observed in Tables 3 and 4. It is significant at the 90% confidence level.

Among the seven explanatory variables for farm and farmer characteristics, only three have coefficients

Table 6
Names and descriptions for explanatory variables in the logit models

Variable name	Description
PREMIUM	Insurance premium per sao, in 1000 dong
YGDUMMY	Dummy variable for yield guarantee; 1 = 90%, 0 = 85%
INDPRICE	Indemnity price for litchi, in 1000 dong
EDUCATN	Number of years of education for farmer
YRSFARM	Number of years in farming profession
MINAVGIN	Ratio of minimum farm income to average farm income
AVGTINCM	Average total income, in million dong
SUMRISK	Number of risks mentioned for litchi production
SUMMANAG	Number of risk management responses mentioned for litchi production
DEADTREE	Number of litchi trees that died in 1997 and 1998
STDEVYLI	Standard deviation of litchi yield, based on elicited yield probabilities

which are significantly different from 0 at the 90% confidence level. The first is education, which has a negative sign. Thus, other things held constant, farmers with more education were less likely to buy insurance. The second significant coefficient was that for average total income. This suggests that wealthier farmers (who probably also have larger farms), were more likely to buy insurance. The third significant coefficient was that for the number of risks mentioned for litchi production. Its sign was negative, which surprisingly suggests that farmers who mentioned more types of risk for litchi production were less likely to buy insurance.

Regarding model summary statistics, the likelihood ratio statistic for the model as a whole was significant at the 99.9% confidence level. A total of 924 insurance decisions were predicted correctly, which is 77% of the 1200 observations. Most incorrect predictions occurred when the farmers did buy insurance but the model predicted they would not.

Table 8 shows the results of the regression for the commune insurance decisions. Here, the contract variables have the same signs as in the district results, though the coefficient for the premium is not statistically significant. There were somewhat different results for the farm and farmer characteristics, however.

Table 7
Logit model results for district insurance decisions

Variable name	Model coefficient	Standard error	*t*-statistic[a]
PREMIUM	−0.06663	0.02752	−2.421**
YGDUMMY	1.686	0.2523	6.685***
INDPRICE	−0.03787	0.02065	−1.834
EDUCATN	−0.07784	0.03854	−2.020*
YRSFARM	−0.004272	0.006967	−0.613
MINAVGIN	0.5273	0.5088	1.036
AVGTINCM	0.02519	0.004474	5.631***
SUMRISK	−0.1774	0.09921	−1.788
SUMMANAG	0.03234	0.1113	0.291
DEADTREE	0.01731	0.01914	0.904
STDEVYLI	−0.0001817	0.0002038	−0.892

[a] Summary results for model: likelihood ratio test statistic (degrees of freedom = 10) = 193.65 ($P < 0.001$).
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

Table 8
Logit model results for commune insurance decisions

Variable name	Model coefficient	Standard error	*t*-statistic[a]
PREMIUM	−0.02877	0.04025	−0.715
YGDUMMY	0.09178	0.2275	4.034***
INDPRICE	−0.03789	0.02158	−1.756*
EDUCATN	−0.0003338	0.03840	−0.009
YRSFARM	−0.01484	0.007382	−2.011*
MINAVGIN	−0.8011	0.5246	−1.527
AVGTINCM	0.02174	0.004214	5.272***
SUMRISK	0.01244	0.09927	0.125
SUMMANAG	−0.1274	0.1139	−1.118
DEADTREE	0.04346	0.01865	2.331**
STDEVYLI	−0.0000804	0.0002080	−0.387

[a] Summary results for model: likelihood ratio test statistic (degrees of freedom = 10) = 90.168 ($P < 0.001$).
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

The coefficients significant at a 90% confidence level were those for the number of years farming, average total income, and the number of dead trees. Younger farmers, or those with less experience, were less likely to buy commune insurance. Farmers with higher incomes were more likely to buy commune insurance, similar to the case for district insurance. And farmers with more dead trees in 1997–1998 were also more likely to buy insurance. The ratio of minimum to average income had the expected sign here (farmers with relatively lower minimum incomes were more likely to buy insurance) and was significant at an 85% confidence level.

The summary statistics for the model are similar to those for the district case. The likelihood ratio statistic was highly significant and almost 79% of the insurance decisions were predicted correctly. Again, most incorrect predictions occurred when the farmers did buy insurance but the model predicted they would not.

Looking at the two sets of results, the coefficients for the insurance contract variables came out mostly as expected. However, the results related to farm and farmer characteristics were rather disappointing. The only clear result seems to be that farmers with higher incomes, who are probably larger, wealthier farmers, are more likely to buy insurance. Beyond that, it is more difficult to predict who might buy insurance.

The regression coefficients can be converted to a more usable form by calculating values for aggregate choice probability elasticities. These are presented for both district and commune models in Table 9. These elasticities show the change in the percentage of farmers who would buy insurance when one of the explanatory variables is changed by a small amount. The most important elasticity is that for the premium, which can be interpreted similarly to a price elasticity. For both district and commune insurance, the responses to changes in premiums were inelastic; for the district insurance, a 10% reduction in the premium would increase participation only 6.8%. For the commune insurance, a 10% premium reduction would increase participation about 2.2%.

Table 9
Aggregate choice probability elasticities for district and commune insurance

Variable name	Elasticity for district model	Elasticity for commune model
PREMIUM	−0.6833	−0.2179
YGDUMMY	0.6587	0.3326
INDPRICE	−0.5485	−0.5772
EDUCATN	−0.3676	−0.0016
YRSFARM	−0.0644	−0.2240
MINAVGIN	0.2612	−0.0399
AVGTINCM	0.4271	0.3702
SUMRISK	−0.1942	0.0137
SUMMANAG	0.0399	−0.1588
DEADTREE	0.0414	0.1045
STDEVYLI	−0.1665	−0.0740

6. Some conclusions

This study evaluated the need for a crop insurance program for litchi production in northern Vietnam and how farmers there might participate in such a program. Two hypothetical insurance plans were developed and presented to them.

Results indicate there is not a strong case for establishing such a crop insurance program. While insurance would reduce the variability of farm income, it is not needed to promote adoption of litchi, a very profitable crop, nor is farm income so variable that farmers' subsistence needs are threatened without insurance. Litchi producers already have incomes substantially above average for farmers in northern Vietnam, so using insurance to provide a subsidy for poverty alleviation would seem to have little merit, too.

Regarding insurance design, all-risk insurance based on area yields was considered the most appropriate form of coverage. The biggest challenge in designing the coverage turned out to be establishing an expected area yield on which to base the yield guarantees. Variation in tree productivity by age and a rapidly expanding planted area have the potential to substantially change the area's average yield, quite apart from the effects of weather and other risks.

In spite of these difficulties, a majority of farmers were willing to buy some kind of crop insurance if it were available. Farmers clearly preferred higher yield guarantees and lower indemnity prices. Even after some significant loading, the premiums, which were based on each area's yield history, were relatively low compared to the typical amount of revenue that litchi production can generate. Farmer response to premium

changes was inelastic. Other factors, such as farmers' perceptions about yield coverage levels, were probably more important in their buying decisions. Farmers with higher incomes were more likely to buy insurance, but the correlation between insurance demand and other farmer characteristics was less clear.

It should be emphasized that this research did not analyze some important aspects of insurance program feasibility. For example, marketing methods, program staffing needs, operating costs, and the amount of reserves required for catastrophic losses would also need to be evaluated. Administrative costs of crop insurance programs in developing countries appear to vary widely. For example, Mishra's (1996) study of India's area-based scheme found that administrative costs accounted for less than 4% of total program costs (p. 266); in contrast, the Philippines' crop insurance program had a loss ratio of 0.41 in 1996 but still required subsidy to cover its administrative costs (Philippine Crop Insurance Corporation, 1997).

The other major potential cost of the program, of course, relates to the actuarial soundness of the insurance. Setting accurate area yield coverage levels would be crucial to actuarial performance, as artificially high values could lead to unwarranted indemnity payments. The premiums used in the study carried significant loads and would reflect some margin for error; the most popular coverage level chosen by farmers had what amounted to a 46% load on top of the pure premium, while other coverage levels carried even higher loads. Even so, probably only several years of experience could reveal whether the rates were in fact adequate.

Further analysis of these issues was not undertaken because the other arguments for establishing an insurance program were not particularly strong. Farm households observed in this survey can continue to cope with risk through current practices, such as household savings, a bit of enterprise diversification, good production practices, borrowing from relatives, and so on. And Vietnamese government investment in agricultural programs would probably be best directed elsewhere.

In conclusion, a few generalizations about insurance in a developing country context are also ventured. First, area-based insurance offers some important advantages but also has some potential drawbacks. It is hard to overestimate the importance of establishing appropriate values for the expected area yields and the related insurance coverage levels, both for achieving significant farmer participation and for avoiding actuarial problems. Related to this, it seems worthwhile to assess farmers' perceptions regarding area average yield and area yield variability, as well as farmers' perceptions of the correlation between their own yields and area yields. Some educational effort might be needed to correct any misconceptions. Some additional farmer education might also be needed to ensure they understand when to use a higher indemnity price.

From a broader policy standpoint, the costs and benefits of establishing a crop insurance program must naturally be compared with those of other agricultural programs. Because government spending on agriculture so often faces serious limits in developing countries, investing in a crop insurance program might be worthwhile only in more urgent cases, after careful investigation indicates its value.

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References

Barnaby, G.A., Skees, J., 1990. Public policy for catastrophic yield risk: an alternative crop insurance program. Choices second quarter 5, 7–9.

Food and Agriculture Organization, 1991. FAO Crop Insurance Compendium 1991. Rome.

Hardaker, J.B., Huirne, R.B.M., Anderson, J.R., 1997. Coping with Risk in Agriculture. CAB International, New York.

Hazell, P., Pomerada, C., Valdes, A, 1986. Crop Insurance for Agricultural Development: Issues and Experience. Johns Hopkins University Press, Baltimore.

Hueth, D., Furtan, W., 1994. Economics of Agricultural Crop Insurance: Theory and Evidence. Kluwer Academic Publishers, Boston.

Mahul, O., 1999. Optimum area yield crop insurance. Am. J. Agri. Econ. 81, 75–82.

Miranda, M.J., 1991. Area-yield crop insurance reconsidered. Am. J. Agri. Econ. 79, 233–242.

Mishra, P., 1996. Agricultural Risk, Insurance and Income: A Study of the Impact and Design of India's Comprehensive Crop Insurance Scheme. Avebury Publishing, Aldershot, UK.

Philippine Crop Insurance Corporation, 1997. Annual Report 1996. The Philippine Crop Insurance Corporation, Manila.