CHAPTER 6: THE EMPIRICAL ANALYSIS

6.1 Introduction

The SFDP Song Da's ultimate purpose is to help farmers in the two districts of Yen Chau and Tua Chua improve their crop production. As a technical project, its intervention at the farm level is focused on the provision of training to local farmers in new technologies in order to give farmers better information about the new technologies. On the other hand, the SFDP Song Da also provides a limited amount of subsidized inputs for the promotion of new technologies. By having better access to information, it is expected that farmers will change their traditional farming practices in order to 1) improve their crop production and 2) improve soil fertility.

As discussed in the Chapter 4, though new technologies are normally promoted as a package, farmers often adopt them sequentially rather than as a whole package. In this thesis, farmers are assumed to gradually change their farming practices in accordance with their exposure to training and information. This chapter analyses the different stages in the process of adopting new technologies. In the first stage, the training model is used to characterize farmers with training in the selected technologies and farmers without training. After that, the adoption model will be employed to estimate the adoption of new technologies. Finally, the yield model will be used to estimate the results from adopting the related technologies.

6.2 The Training Model

Training is assumed to have a strong influence on the adoption decision of a farmer since it should provide farmers with information about the new technologies. It is assumed that the probability that a farmer receives training in a new technology is dependent on the household socio-economic characteristics; which include cultivated maize area, household wealth and the position of the household head in the village. It is also assumed that the differences between the two districts, which include soil condition, and social and cultural differences of the local ethnic groups, play a role in a farmer's decision to participate in training event. The model is mathematically expressed as:

$$\text{Train}_i^* = f(\text{Maizeland}, \text{Position}, \text{District}, \text{Rich}, \text{Poor}) \qquad (6.1)$$

Table 6.1 gives a description and the expected sign of variables in this model:

Table 6.1: Description and Expected Signs of Variables in the Training Model

Variable	Description	Expected sign
Train_i^*	Probability that a farmer receive training in improved maize (im), fertilizer use (f), and hedgerows (h) technologies	n/a
Maizeland	Available land for the crop (maize) in sq.m	+
Position	Position of family head in the village (1=Yes, 0=Otherwise)	+
District	The district where the household lives (1=Yen Chau, 0=Tua Chua)	+
Rich	The household is rich (1=Yes, 0=Otherwise)	+
Poor	The household is poor (1=Yes, 0=Otherwise)	-

In this model, it is expected that farmers decide to participate in a training events based on their own needs and interests. The amount of land available for maize crop (MAIZELAND*)* is expected to have positive correlation with the probability that a farmer gets trained. The reason is larger farmers may find it easier than small farmers to spare a piece of land to try out new technologies. Thus, they may participate more in training than smaller farmers do. Farmers with a formal position in the village management (POSITION)*,* including village president, vice president, accountant, secretary, and people in charge of the mass organizations like youth union and women union, are expected to participate more in training events than ordinary farmers, i.e. farmers without position in the village. This is because the former are often more educated than the latter. In most of the cases, more educated farmers are often among the first adopters of new technologies.

Household wealth is also assumed to influence the decision to participate in training activities. New technologies often mean more investment, so poor farmers may not be interested due to their limited cash availability. Poor farmers may find it safer to invest their scarce capital in something more certain, such as traditional varieties and schooling for children, than trying out new agricultural technologies. They may, therefore, be indifferent to training events. However, richer farmers may have different preferences for training in and adoption of new technologies. They are expected to be active participants in the training activities. With regard to differences by districts, since Thai farmers in Yen Chau are said to be more educated and more open to changes than H'mong farmers in Tua Chua the DISTRICT variable is expected to be positively related to the probability that a farmer participates in a training event. A summarized table of statistics of the total sample, farmers receiving training and farmers not receiving training is presented in Table 6.2.

Table 6.2: Summary Table of the Training Model

	Total sample	With training	W/o training	Test stat.	Sig. Level
Improved maize	70 HHs	45 HHs	25 HHs		
Maize land (sq.m)	6,949	7,337	6,252	-0.88	38.05%
Yen Chau*	57%	42%	84%	3.96	0.02%
Tua Chua	43%	58%	16%	-3.96	0.02%
With position	14%	16%	12%	-0.41	68.07%
Rich	40%	49%	24%	-2.16	3.51%
Medium	21%	22%	20%	-0.22	82.99%
Poor	39%	29%	56%	2.22	3.15%
Fertilizer use	70 HHs	32 HHs	38 HHs		
Maize land (sq.m)	6,949	7,386	6,582	-0.66	51.37%
Yen Chau	57%	47%	66%	1.59	11.63%
Tua Chua	43%	53%	34%	-1.59	11.63%
With position	14%	19%	11%	-0.95	34.50%
Rich	40%	50%	32%	-1.56	12.32%
Medium	21%	22%	21%	-0.08	93.47%
Poor	39%	28%	47%	1.67	9.93%
Hedgerows	70 HHs	44 HHs	26 HHs		
Maize land (sq.m)	6,949	7,431	6,135	-1.06	29.4%
Yen Chau	57%	43%	81%	3.44	0.1%
Tua Chua	43%	57%	19%	-3.44	0.1%
With position	14%	11%	19%	0.85	39.97%
Rich	40%	45%	31%	-1.23	22.44%
Medium	21%	18%	27%	0.82	41.57%
Poor	39%	36%	42%	0.48	63.12%

*: Mean of a discrete variable should be understood as the percentage of the category in the group; e.g.: 57% of the total sample are people from Yen Chau (Thai farmers).

Table 6.2 shows that generally the difference in training received by farmers with large land and farmers with small land is insignificant. Interestingly, Thai people in Yen Chau generally receive less training than H'mong people in Tua Chua. In two out of three cases the differences are significant at the 1% level. On the other hand, there is not a clear distinction between training received by people with and without a position in the village. Table 6.2 also shows that the differences in training received by rich, medium and poor farmers are not very significant for fertilizer use and hedgerows. Only with improved maize technology that significant difference is observed in rich and poor groups.

The training model for separate activities is estimated with probit model using PROC IML commands and PROC PROBIT procedure in SAS system and Limdep statistics software. Table 6.3 below shows the coefficient estimates and the marginal effects at the mean value of the independent variables for each technology. In addition, the contingency tables comparing the training model's prediction with the actual results are presented in Table 6.4 on page 72.

Table 6.3: Estimation Results of the Training Model

Variable	Estimate	Marginal effect	Standard error	Pr>Chi sq
Improved maize				
Intercept	1.3855**		0.5592	1.32%
MAIZELAND	-2.64E-05	-9.43E-06	4.71E-05	57.43%
POSITION	0.0643	0.0229	0.5580	90.83%
DISTRICT	-1.2577***	-0.4485	0.3689	0.07%
RICH	0.5155	0.1838	0.5079	31.01%
POOR	-0.5822	-0.2076	0.4979	24.23%
Log likelihood:	-36.1315			

Fertilizer use				
Intercept	0.2164		0.4621	63.95%
MAIZELAND	-2.3E-05	-9.28E-06	3.90E-05	54.82%
POSITION	0.3924	0.1555	0.4906	42.37%
DISTRICT	-0.5174*	-0.2051	0.3133	9.86%
RICH	0.4366	0.1730	0.4425	32.38%
POOR	-0.2687	-0.1065	0.4528	55.29%
Log likelihood:	-44.9703			

Hedgerows				
Intercept	0.6099		0.4834	20.70%
MAIZELAND	3.7E-05	4.57E-06	4.24E-05	38.17%
POSITION	-0.5354	-0.0471	0.5285	31.11%
DISTRICT	-1.0702***	-0.1403	0.3469	0.20%
RICH	0.4014	0.0630	0.4804	40.35%
POOR	0.1411	-0.1392	0.4692	76.36%
Log likelihood:	-39.4304			

*, **, ***: estimate is significant at 10%, 5% and 1% significance levels, respectively.

Table 6.4: The Training Model's Goodness of Fit

		Predicted		
		$Train_i=0$	$Train_i=1$	Total
Improved maize				
Actual	$Train_{im}=0$	14	11	25
	$Train_{im}=1$	6	39	45
	Total	20	50	70
Fertilizer use				
Actual	$Train_f=0$	28	10	38
	$Train_f=1$	18	14	32
	Total	46	24	70
Hedgerows				
Actual	$Train_h=0$	15	11	26
	$Train_h=1$	11	33	44
	Total	26	44	70

Very few estimates are statistically significant. For all the selected technologies, the statistically significant estimates are mostly for intercept (for improved maize technology only) and DISTRICT variable. None of the household socio-economic characteristics appear to be statistically significant.

Table 6.2 and results of the multiple regression that simultaneously controls for all household characteristics show consistent findings. Within a community there are no significant differences in socio-economic characteristics of the farmers receiving training compared to farmers without training. Generally, the statistics from Table 6.2 and the significantly negative estimate for DISTRICT variable in Table 6.3 implies that H'mong farmers in Tua Chua are more likely to participate in training events than Thai farmers in Yen Chau, which is opposite to the prior expectation. Results from the probit regression shows that only district variable (DISTRICT) is statistically significant in all cases. Since farmers in Yen Chau are Thai people (DISTRICT=1) and in Tua Chua are H'mong (DISTRICT=0), the negative sign of the estimated coefficient for DISTRICT as shown in Table 6.3, page 71, implies that farmers in Yen Chau have less training than people in Tua Chua.

The finding about more H'mong people participate in training than Thai people is rather interesting as it is often believed that Thai people are more literate than H'mong people. The explanation could be that people in Yen Chau get information related to new technologies not only through training but also other channels, such as newspaper, radio and other sources, so they participate less in formal extension training. On the other hand, since H'mong people in Tua Chua have less access to education and mass media, the main source of information related to new technologies for them is training. The estimation results from the adoption model provide more definite conclusion about the relationship between literacy and adoption of new technologies. However, if literacy is not positively related to the probability that a farmer participates in the training and adopts a new technology, the correlation between education, training and adoption of new technologies in this region may be an interesting topic for further studies.

Estimates for socio-economic characteristics are not significant, which implies that they do not affect the decision of the farmers to participate in the training. This necessarily means there are no distinctive socio-economic characteristics between farmers with training and farmers without training. In other words, the decision that a farmer makes to participate in the training events is not based on the farm characteristics. Instead, it may be influenced by other factors, such as a farmer's availability of time, the training location, number of training courses available, knowledge of the farmer about the training event, and any other unknown factors; which are not covered in this study.

In short, estimation results of the training model show that maize cultivated area, farmer's position in the village management, and household economic status do not affect the likelihood that a farmer received training. Within a community, there is no clear group of farmers who are more likely to receive training than do the others. The estimation of this model also shows that, in general, H'mong people in Tua Chua receive more training than Thai people in Yen Chau do.

6.3 The Adoption Model

With regard to the adoption of new technologies, the probability that a farmer adopts a new technology is expected to be dependent on the related training, the available land for the crop and the position of the household (head) in the village and the geographical location. It is assumed that there exists complementarity in the adoption of seed-fertilizer technologies (improved seed and fertilizer) and sustainable technology (hedgerows), so that the probability that a farmer adopts one of these technologies is expected to depend on whether or not the other technologies have been adopted. High level of complementarity across the new technologies implies that farmers adopt them as a package. The adoption model for each of the activities can be expressed as:

$$\text{Prac}_i^* = f(\text{Train}_i, \mathbf{Complement}_i, \text{Maizeland}, \text{Position}, \text{District}, \text{Rich}, \text{Poor}) \quad (6.2)$$

Table 6.5 gives a description and the expected signs of variables in this model:

Table 6.5: Description and Expected Signs of Variables in the Adoption Model

Variable	Description	Expected sign
Prac_i^*	Probability that a farmer practices improved maize (im), fertilizer use (f), and hedgerows (h) technologies	n/a
Train_i	Training received by the farmer in improved maize (im), fertilizer use (f), and hedgerows (h) technologies	+
$\mathbf{Complement}_i$	Vector of adoption of complementary technologies. For improved maize technology, this vector includes Prac_f and Prac_h. For fertilizer technology, this vector includes Prac_{im} and Prac_h, and for hedgerow technology, this vector includes Prac_{im} and Prac_f.	+
Maizeland	Available land for the crop (maize) in sq.m	+

Position	Position of family head in the village (1=Yes, 0=Otherwise)	+
District	The district where the household lives (1=Yen Chau, 0=Tua Chua)	+
Rich	The household is rich (1=Yes, 0=Otherwise)	+
Poor	The household is poor (1=Yes, 0=Otherwise)	-

It is noted that in this model the household socio-economic characteristics are explicitly present together with the TRAIN variable though they are already estimated in the training model as discussed in the previous section. This implies that household characteristics may explain the probability that a household adopts a new technology independently of training. Although training is important to the adoption of a new technology, it is assumed that household characteristics may influence the household decision to adopt the new technology in other ways as well. For instance, depending on the land availability, a household may decide to try out a new seed variety or not.

In the adoption model, the TRAIN variable is expected to have positive effect on the adoption of new technology since people who receive training have information about the potential benefits as well as the availability of the technology. Household socio-economic characteristics are expected to have the same direction in effect on the probability to adopt a new technology as they are expected in the training model since training and adoption are closely linked. Since it is expected that a farmer who adopts seed-fertilizer technologies may want to also adopt hedgerows and vice versa, a positive sign of the $COMPLEMENT_i$ variable is expected in the adoption of new technologies. The reason is that the adoption of yield-enhancing technologies in the studied areas is expected not to substitute the adoption of hedgerow technology. Instead, it is assumed to be complementary. A summary table of statistics about adopters of studied technologies is produced and presented in Table 6.6 below.

Table 6.6: Statistics about Adopters

Adopt. of technologies	No of cases	Adoption of technologies	No of cases
Improved maize	63	Improved maize and hedgerows	33
Fertilizer use	47	Improved maize and fertilizer	45
Hedgerows	36	Hedgerows and fertilizer	24
		All three technologies	24

A summary table of statistics of total sample, adopters and non-adopters for each of the studied activities in the adoption model is produced and presented in Table 6.7 below.

Table 6.7: Summary Table of the Adoption Model

	Total sample	Adopter	Non-adopter	Test statistics	Sig. Level
Improved maize	70 HHs	63 HHs	7 HHs		
With training	64%	70%	14%	-3.60	0.68%
Adopt fertilizer	67%	71%	29%	-2.22	6.09%
Adopt hedgerows	51%	52%	43%	-0.45	66.61%
Maize land (sq. m)	6,949	7,326	3,557	-4.21	0.03%
Yen Chau*	57%	57%	57%	0	100.00%
Tua Chua	43%	43%	43%	0	100.00%
With position	14%	16%	0%	-3.42	0.11%
Rich	40%	44%	0%	-7.04	<0.01%
Medium	21%	24%	0%	-4.40	<0.01%
Poor	39%	32%	100%	11.55	<0.01%

Fertilizer use	70 HHs	47 HHs	23 HHs		
With training	46%	53%	30%	-1.86	6.98%
Adopt impr. seeds	90%	96%	78%	-1.88	7.04%
Adopt hedgerows	51%	51%	52%	0.09	93.21%
Maize land (sq. m)	6,949	8,178	4,439	-3.68	0.05%
Yen Chau	57%	64%	43%	-1.60	11.72%
Tua Chua	43%	36%	57%	1.60	11.72%
With position	14%	19%	4%	-2.04	4.51%
Rich	40%	49%	22%	-2.37	2.15%
Medium	21%	23%	17%	-0.59	55.87%
Poor	39%	28%	61%	2.70	1.02%

Hedgerows	70 HHs	36 HHs	34 HHs		
With training	63%	86%	38%	-4.66	<0.01%
Adopt impr. seeds	90%	92%	88%	-0.47	63.83%
Adopt fertilizer	67%	83%	84%	0.09	93.17%
Maize land (sq. m)	6,949	7,344	6,531	-0.67	50.67%
Yen Chau	57%	47%	68%	1.74	8.61%
Tua Chua	43%	53%	32%	-1.74	8.61%
With position	14%	8%	21%	1.45	15.23%
Rich	40%	47%	32%	-1.27	20.91%
Medium	21%	19%	24%	0.41	68.31%
Poor	39%	33%	44%	0.92	36.22%

*: Mean of a discrete variable should be understood as the percentage of the category in the group; e.g.: 57% of the total sample are people from Yen Chau (Thai farmers).

The multiple regression model is estimated using SAS and Limdep statistics software. The function coefficients along with the marginal effects calculated at mean value of the independent variables are presented in Table 6.8 on page 79.

Table 6.8: Estimation Results of the Adoption Model

Variable	Estimate	Marginal effects	Standard error	Pr>Chi sq
Improved maize +				
Intercept	5.9593		514,418	100.00%
$TRAIN_{im}$	1.9013**	1.21E-08	0.8981	3.43%
$PRAC_f$	0.7672	4.88E-09	0.6847	26.25%
$PRAC_h$	0.0109	6.96E-09	0.6387	98.63%
MAIZELAND	1.39E-03	8.85E-14	9.55E-05	88.42%
POSITION	-0.2658	-1.69E-09	593,685	100.00%
DISTRICT	0.8194	5.22E-09	0.8159	31.52%
RICH	1.0355	6.60E-09	540,802	100.00%
POOR	-6.8737	-4.38E-08	514,418	100.00%
Log likelihood	-11.3963			
Fertilizer use				
Intercept	-1.4988*		0.8989	9.54%
$TRAIN_f$	0.7299*	0.2402	0.3919	6.25%
$PRAC_{im}$	0.6802	0.2239	0.6045	26.05%
$PRAC_h$	-0.1213	-0.0399	0.3752	74.64%
MAIZELAND	1.03E-04*	3.38E-05	0.0001	6.06%
POSITION	0.5134	0.1690	0.7570	49.76%
DISTRICT	0.8097**	0.2665	0.3812	3.37%
RICH	0.0710	0.0234	0.5240	89.22%
POOR	-0.1073	-0.0353	0.5289	83.93%
Log likelihood	-33.7879			
Hedgerows				
Intercept	-0.5592		0.8434	50.73%
$TRAIN_h$	1.3505***	0.5388	0.3868	0.05%
$PRAC_{im}$	0.0546	0.0218	0.6344	93.14%
$PRAC_f$	-0.1402	-0.0559	0.4004	72.63%
MAIZELAND	3.46E-06	1.38E-06	0.0000	93.56%
POSITION	-0.7184	-0.2866	0.5281	17.37%
DISTRICT	-0.0686	-0.0273	0.3713	85.35%
RICH	0.0891	0.0355	0.4823	85.34%
POOR	-0.4063	-0.1621	0.5213	43.57%
Log likelihood	-37.8529			

*, **, *** : estimate is significant at 10%, 5%, and 1% significance levels, respectively.

[+]: There are slight differences in estimation results by SAS and by Limdep for this activity. Estimation results shown in this table are from Limdep (see Appendix G for details).

The contingency tables comparing the adoption model's prediction with the actual results are presented in Table 6.9 below.

Table 6.9: The Adoption Model's Goodness of Fit

		Predicted		
		$Prac_i$=0	$Prac_i$=1	Total
Improved maize				
Actual	$Prac_{im}$=0	4	3	7
	$Prac_{im}$=1	4	59	63
	Total	8	62	70
Fertilizer use				
Actual	$Prac_f$=0	12	11	23
	$Prac_f$=1	6	41	47
	Total	18	52	70
Hedgerows				
Actual	$Prac_h$=0	22	12	34
	$Prac_h$=1	5	31	36
	Total	27	43	70

Training is significantly correlated to the adoption of new technologies. In improved maize and hedgerow technologies, the effect of training on the adoption is very high. It is represented by the significance level of the estimates at 5% and 1%, respectively. It can, therefore, be predicted with 95% confidence (improved maize technology) and 99% (hedgerows technology) that if a farmer receives training in these two technologies, he is more likely to adopt the technologies than does a farmer who has not training. In fertilizer use technology the effect of training on the adoption is also significant but only at 10% level.

Estimates of DISTRICT variable show interesting results between the training and adoption models. Though more H'mong people in Tua Chua received training, their rate of adoption of the new technologies is not significantly higher than do Thai people in Yen Chau. In addition, with respect to fertilizer use technology, H'mong farmers in Tua Chua is lagged behind in the adoption of this technology though they received more training. The above findings raises the question of suitability and effectiveness of training and the monitoring of training activities, which will be discussed in more details in the conclusion chapter.

Household socio-economic characteristics, like position of the farmer in the village and the wealth of the household, are not significantly correlated to the adoption of new technologies. The estimates of these factors, shown as POSITION, RICH and POOR in Table 6.8, are not significant in the estimation of all the activities. There is no difference between farmers with and without position, and between rich, medium and poor farmers in the adoption of new technologies. The only strong result is that all the non-adopters of the improved maize technology are poor, which may be explained by the fact that adoption of improved seed is capital intensive and is not attractive to poor farmers. Cultivated land area (MAIZELAND) is only significant in the case of fertilizer technology, which implies that larger farmers are more likely to adopt fertilizer. With other two technologies, there is no significant difference in the adoption between farmers with small land and farmers with larger land size.

There is no observed complementarity in the adoption of the three studied technologies. Estimates of $COMPLEMENT_i$ ($PRAC_f$ and $PRAC_h$ in the cases of improved maize, $PRAC_{im}$ and $PRAC_h$ in the case of fertilizer technology, and $PRAC_{im}$ and $PRAC_f$ in the case of hedgerows) are insignificant in all the cases. These results indicate that farmers do not adopt new technologies as a package. Farmers that have hedgerows are not more likely to adopt yield-enhancing technologies than do those without hedgerows. Similarly, farmers adopting fertilizer-seed technologies are neither more nor less likely to adopt hedgerows than do those using local seeds. The complementarity among the studied technologies may show up in future study when there is additional data since the yield-enhancing effects of hedgerows can only be expected to materialize after several years.

To conclude, the studied technologies are not adopted as a package. Training is significantly correlated to the adoption of each of the three technologies. Geographical difference and cultivated maize area are significant for adoption of fertilizer technology. No other household socio-economic characteristic variables are significant in explaining adoption. Household wealth and position of the household head have no effects on the decision to adopt new technologies. Though there are some significant estimates, a farmer's decision to adopt new technologies is mostly independent of the household socio-economic characteristics.

6.4 The Yield Model

It is often assumed that the adoption of a new technology follows a self-selection process, which means the decision to adopt the technology or not is based on individual self-selection. This implies that the $PRAC_i$ variables (to adopt the promoted technology or not) of the yield model, which will be presented later in this section, should be treated as an endogenous variables and, thus, be estimated by instrumental variable technique (Maddala 1983). Therefore, the definition of the yield model is based on the estimation of the adoption model defined in (6.2). The value of $PRAC_i$ variables in the yield model is defined as:

$$\text{Prac}_i = 1 \text{ if } \text{Prac}_i^* \text{ (Adoption model)} > 0$$
$$\text{Prac}_i = 0 \text{ if } \text{Prac}_i^* \text{ (Adoption model)} \leq 0$$

Under this assumption, the adoption model will be estimated using a probit model. The results will then be used to estimate the yield model using OLS method. This estimation method is suggested by Heckman (Maddala 1983) to test for selectivity bias, which may occur in a model with self-selectivity. However, since adoption of new technologies are not significantly related to household characteristics, as concluded in the previous section, the assumption that the decision to adopt is endogenous is not maintained. Therefore, the use of adoption variable as an exogenous variable is employed in the estimation of the yield model in an OLS estimation.

In farm production, many different factors influence the farm yield. It is assumed that the increase in farm yield is dependent on the adoption (practice) of new technologies, and household socio-economic characteristics, which include the position of the farmer in the village, maize land area and the household wealth. Since the study intends to test whether there are complementarities across the studied technologies, interactive dummy variables for the other two technologies are also included in the model. Moreover, it is assumed that training has incremental benefits on the increase of yield, multiplicative variables of training and adoption are also included in the model. Mathematically, the model can be written as:

$$\log(\text{Yield}) = f(\text{lgmaizeland}, \text{Position}, \text{Rich}, \text{Poor}, \text{District}, \mathbf{Prac}_i, \text{Pr\_all}, \mathbf{Pt}_i) \quad (6.3)$$

The description of variables and the expected signs is given in Table 6.10:

Table 6.10: Description of Variables and Expected Signs of the Yield Model

Variable	Description	Expected sign
log(Yield)	Log of actual maize yield	n/a
lgmaizeland	Log of available land for the crop (maize)	-
Position	Position of family head in the village (1=Yes, 0=Otherwise)	+
Rich	The household is rich (1=Yes, 0=Otherwise)	+
Poor	The household is poor (1=Yes, 0=Otherwise)	-
District	District where the household lives (1=Yen Chau, 0=Tua Chua)	+/-
$\mathbf{Prac}_i$	Vector of variables about practice of improved maize (im), fertilizer use (f), and hedgerows (h) technologies	+/-
Pr_all	Practice of all the technologies at the same time (1=Yes, 0=Otherwise)	+
$\mathbf{Pt}_i$	Vector of variables about practice and receive training in improved maize (im), fertilizer use (f), and hedgerows (h) technologies (1=Yes, 0=Otherwise)	+

The variables for household socio-economic characteristics and $PRAC_i$ variables are explicitly present in the yield model. Empirical studies show that the household characteristics on one hand may implicitly influence the farm yield through the decision to adopt new technologies. In addition, household characteristics may explicitly influence the yield through other production decisions besides the decision to adopt the three studied technologies. The presence of both household characteristics and the $Prac_i$ variables in the same model is to take into consideration all the possible influence from household characteristics on the farm yield.

This model is estimated with log of actual maize yield as dependent variable and log of maize land area as an independent variable. Within this formulation, the interaction among independent variables is built-in. Specifically, the model as expressed in (6.3) can be re-written as:

$$\text{Yield} = \text{Maizeland} \cdot e^{(\alpha + X\beta)} \tag{6.4}$$

Therefore, the marginal effect of MAIZELAND is defined as:

$$\frac{\partial \text{Yield}}{\partial \text{Maizeland}} = e^{(\alpha + X\beta)} \tag{6.5}$$

and the marginal effects of other independent variables are:

$$\frac{\partial \text{Yield}}{\partial x} = \text{Maizeland} \cdot (\alpha + X\beta) \cdot e^{(\alpha + X\beta)} \tag{6.6}$$

where y is the actual maize yield, MAIZELAND is the maize land area, α is the intercept, β is a vector of estimated coefficients and X is a vector of right hand sign variables in (6.3) except LGMAIZELAND.

The prior hypothesis that a farmer who gets trained and adopts improved maize and fertilizer technologies will be likely to have higher yield compared to the one who does not have training or doesn't adopt the activities. However, hedgerows give shading to the crop on the field, compete with crops for nutrients and water, occupy space which can be used for main crop, reduce residues available to crop, and require extra labor for pruning (Bunch 1997; Foerster and Nguyen 1999). Therefore, a negative sign on the adoption of this technology is expected.

With regard to household wealth, it is expected that richer families are more likely to be able to accept risk related to the adoption of new technologies. Therefore, in a normal year, their yield is expected to be higher compared to that of the poorer households. Innovative farmers are more likely to try out a couple of new technologies at the same time, which may give them better chance to earn more. Thus, a farmer practicing a combination of activities have higher yield than an average farmer does. For households whose heads are among the leadership of the village, it is believed that they are generally more educated than ordinary farmers. It is, therefore, assumed that they will be likely to have higher expected yield on their farm.

On the other hand, empirical studies show that farmers with smaller land size have higher yield than do the larger farmers. It is, therefore expected that a negative sign will return for the estimate of land size. A mixed effect is expected from the DISTRICT variable as different villages may have different situations, which may negatively or positively influence the crop production.

Summary tables of statistics about the adoption of each technology and the mean yield for each group are presented in Table 6.11, and Table 6.12 below.

Table 6.11: Summary of Interactive Cases between $Train_i$ and $Prac_i$ Variables

	Improved maize		Fertilizer use		Hedgerows	
	No of cases	Avg. yield (kg/ha)	No of cases	Avg. yield (kg/ha)	No of cases	Avg. yield (kg/ha)
$Train_i$=0, $Prac_i$=0	6	1,716	16	4,148	21	5,151
$Train_i$=1, $Prac_i$=0	1	1,667	7	2,607	13	3,318
$Train_i$=0, $Prac_i$=1	19	5,509	22	5,048	5	7,332
$Train_i$=1, $Prac_i$=1	44	4,064	25	3,991	31	3,467

Table 6.12: Summary of Interactive Cases between $Prac_{im}$ and $Prac_f$ Variables

	Number of cases	Avg. yield (kg/ ha)
$Prac_{im}$=0, $Prac_f$=0	5	1,542
$Prac_{im}$=0, $Prac_f$=1	2	2,125
$Prac_{im}$=1, $Prac_f$=0	18	4,272
$Prac_{im}$=1, $Prac_f$=1	45	4,591
Total observations:	**70**	**4,220**

The yield model is employed to evaluate the effects on yield of the related technologies. The actual maize yield at household level is used to evaluate the success of the promoted technologies. The yield model is estimated based on the ordinary least squared (OLS) estimation method. Table 6.13 presents the results of the estimation and the model statistics. In general, not many estimated coefficients are significant but the model's goodness-of-fit is fairly good.

Table 6.13: Estimation Results and Model Statistics of the Yield Model

Variable	Estimate	T-statistics	Variable	Estimate	T-statistics
Intercept	11.2647***	10.3996	$PRAC_{im}$	0.5886**	2.2003
LGMAIZELAND	-0.4759***	-3.7864	$PRAC_f$	0.1305	0.5305
POSITION	0.3864*	1.7613	$PRAC_h$	-0.3256	-0.8913
RICH	0.1504	0.7422	PR_ALL	0.1856	0.6134
POOR	-0.5757***	-2.7362	PT_{im}	-0.0174	-0.0889
DISTRICT	0.9349***	6.0203	PT_f	-0.3059	-1.5171
			PT_h	0.1198	0.3679

Model's statistics and goodness-of-fit	
No of observations	70
R^2	0.6148
Adj-R^2	0.5337
Standard deviation	0.5443
F-statistics	7.5818

*, **, ***: estimate is significant at 10%, 5% and 1% significance levels, respectively.

Variable PR_ALL in this model is a multiplicative variable of adopting all the technologies. It is the product of $PRAC_{im}$ times $PRAC_f$ times $PRAC_h$, which results in 1 if the farmer practices all the activities and 0 if he adopts one, two or none of them. This variable is employed to find out if there is complementarity among adopting yield enhancing technologies and hedgerow technology.

Two heteroscedasticity tests were conducted for the yield model to test for unequal variances among independent variables. In the first test, the White test of heteroscedasticity, which examines the effects to error variance from any of the regressors, their squares or cross-products, is applied (Kenedy 1998). The test statistics follows the Chi-squared (χ^2) distribution with the maximum degree of freedom of K*(K+1)/2 where K is the number of regressors including the intercept (White 1980). With the data set, the test statistics of $\chi^2_{59} = 56.69$ with the significance level of 56.1% is returned. Therefore, the hypothesis of homoscedasticity is not rejected. The second test follows the Goldfeld-Quandt testing method (Greene 2000; Kennedy 1998). The data set is sorted according to MAIZELAND variable, which is the only continuous independent variable in the data set that may be the cause of heteroscedasticity, and then divided into two groups of 35 observations each. Each group of data is then estimated separately with OLS method (see Appendix H for estimation results). The F-ratio between error terms of two groups is calculated. The resulting $F^{22}_{22} = 1.5629$ with significance level of 15.22% is returned. Thus, the hypothesis of homoscedasticity is not rejected. Based on the two test results, it is concluded that the hypothesis about heteroscedasticity cannot be accepted.

Another test, a Chow test of structural change, is conducted with regard to the yield model (Greene 2000). The purpose of this test is to test the difference in estimated coefficients of the sub-sets of data for Yen chau and for Tua chua. The test statistic, which follows Fisher distribution, is calculated based on the following formula:

$$F^{(G-1)K}_{n-GK} = \frac{\left(SSE - \sum SSE_g\right) / (G-1)K}{\sum SSE_g / (n-GK)} \qquad (6.7)$$

where SSE is sum of squared errors of the model estimated with the whole data set, SSE_g is sum of squared errors of the model estimated with each subset of data, G is total number of different groups of data (g=1, 2), K is the number of independent variables in the model and n is the total number of observations in the data set.

In this test, the 70 observations are divided into two subsets, one for Yen Chau where DISTRICT=1, and the other for Tua chua, where DISTRICT=0. It is noted that since the data set is divided according to DISTRICT variable, this variable becomes a constant in each subset and is dropped from the model. In addition, in the estimation of the subset for Tua Chua, perfect collinearity between $PRAC_h$ and PT_h is detected. Therefore, PT_h variable is dropped from the model. The yield model is estimated again with the whole data set and with each subset. The results are presented in Appendix I. Based on these estimations, the $F_{48}^{11} = 6.2077$ as specified in (6.7) is returned. This F statistics is significant at 3.13^{-6}%. Thus, the hypothesis that coefficient vectors are the same in two districts is rejected.

Results from Table 6.13 show an interesting finding that, contrary to the expectation, training has no direct effects on the maize yield in all the cases. This implies that the follow-up of the training activities need to be strengthened to make sure that farmers follow what they learn from the training course. Surprisingly, the adoption of most technologies has no effects on yield. Adoption of hedgerows and fertilizer technologies generally has no effects on maize yield. Only with the adoption of improved maize shows a clear correlation with increased yield. More discussion about yield and profitability from adoption will be presented later in this section. The interactive variable for $PRAC_{im}$, $PRAC_f$ and $PRAC_h$ shows neither a significant gain nor loss of farmers adopting all the technologies simultaneously. This implies that the complementarity in yield among the technologies does not exist or the data set is not quantitatively enough to say.

The estimation results reveal diseconomies of scale. The coefficient of maize land area indicates that small farmers significantly have higher yield than larger farmers do. This finding supports the results of previous empirical studies that small farmers are more efficient in land productivity than larger farmers. The position of the farmer in the village implies that he (his family) has better yield than ordinary farmers, which can be explained by the fact that farmers with village positions are often more educated and have better access to information than ordinary farmers. Poor farmers have significantly lower yields compared to medium and rich farmers.

Results from Table 6.13 on page 88 show that there is a clear difference in maize yield across the two districts. The estimate of DISTRICT variable shows that Thai farmers in Yen Chau harvest significantly better crop than H'mong farmers do in Tua Chua. Many other geographical differences between the two districts influence the maize yield; such as soil suitability and fertility, irrigation and others; which may be explained by the DISTRICT variable.

In terms of actual gain from adopting new technologies, a summary table is produced to illustrate the predicted yield between the adopters and non-adopters. It is noted that since only adoption of improved maize is statistically significant, its effect is, therefore, taken into account. Estimates for adoption of other technologies are not statistically significant. Therefore, their effects are assumed to be zero.

Table 6.14: Predicted Yields of Adopters and Non-Adopters

	Adopter		Non-adopter	
	Poor	Not poor	Poor	Not poor
Tua Chua				
▪ Farmers without position				
Predicted yield (kg/ha)	1,158	2,060	643	1,143
▪ Farmer with position				
Predicted yield (kg/ha)	1,704	3,030	946	1,682
Yen Chau				
▪ Farmers without position				
Predicted yield (kg/ha)	3,015	5,362	1,674	2,977
▪ Farmers with position				
Predicted yield (kg/ha)	4,991	7,891	2,463	4,380
Average increase in yield due to adoption: 80%				
Average difference in yield by geographical location: 160%				

Table 6.14 presents a comparison of yield between adopters and non-adopters in Yen Chau and Tua Chua separately. The log of yield is calculated based on the corresponding significant estimates from Table 6.13 on page 88 and values of independent variables. The inverse log function is then employed to calculate the corresponding yield figures. It is to be noted that the Table 6.14 also takes into account the difference in average land size in the two districts. In other words, the predicted yield for Yen Chau farmers is based on the mean value of land size for Yen Chau while the predicted yield for Tua chua is based on average land size of Tua Chua (see Appendix F).

The figures presented in Table 6.14 shows that on average adoption of new technologies may increase the yield by 80%, which is very good. Average difference in yield by region (Yen Chau and Tua Chua) is also calculated. However, no calculation about profitability can be done due to the absence of data about production factors and their prices. It is noted that figures in Table 6.14 do not take into account the benefits from improved soil fertility from adopting sustainable technologies (hedgerows), which may be substantial in the long run.

To conclude, the yield model shows that the adoption of improved maize technology definitely enables farmer to get better maize yield. However, adoption of other technologies does not significantly affect the yield. Training related to the adoption of new technologies does not help adopters gain better harvest. The findings also support the classical assumption of small farms are more sufficient in land productivity.

6.5 Conclusion

This chapter covers the presentation of and the discussion on the theoretical models, the expected output from the models, the intended methodology, the estimation procedures and the estimation results, and the implication of the model estimates.

Three models presented and discussed in this chapter: the training model, which aims to characterize the trainees and the non-trainees; the adoption model, which is to find out the distinctive features of the adopters and non-adopters; and the yield model, which is used to evaluate the success of the concerned technologies.

The estimation results show that there are not significant differences in the socio-economic characteristics of farmers with training compared to those without training. Likewise, there are not significant differences in the socio-economic characteristics between adopters and non-adopters of these technologies. While training in general shows significant effects on the adoption of new technologies, it does not have any significant additional direct effects on the farm yield. Study results also show that farmers do not adopt the studied technologies as a package. Since the current data set lacks the farmer's adoption history, future studies that take into account the time series data may verify this conclusion.

Adoption of new technologies generally benefits farmers since even the adoption of sustainable technologies, which takes away land for main crop, does not have significant negative effects on yield. If a farmer ever decided to adopt the studied technologies, he would be able to get about 80% higher yield than what he harvested without adopting them. This gain in yield is, however, attributed to only improved maize technology. However, since the studied technologies do not show up to be complementary, the use of yield-enhancing technologies as a means to promote hedgerows is not sufficiently good enough for the expansion of hedgerows in the area.

CHAPTER 7: SUMMARY AND CONCLUSIONS

Though industry and service sectors are playing an increasingly important role in the economic development, the significance of agriculture in a nation's economy should not be neglected. The growth and development of agricultural economy is more crucial in the developing countries, whose the national economy is mostly agricultural based, than in more developed economies. Empirical and theoretical studies on the economics of agricultural production and development in both developed and developing countries have been among the major concerns of economists throughout the history of the profession.

This thesis aims to study the adoption of maize-related technologies in the Northwest upland area of Vietnam with emphasis on the effects of farmers' training. The selected technologies include one sustainable technology, namely the use of hedgerows in the upland; and two fertilizer-seed technologies. The data set is from a household survey in 15 villages, 6 H'mong and 9 Thai villages, in two districts: Tua Chua of Lai Chau province, and Yen Chau of Son La province, Northwest region of Vietnam.

The working hypotheses are to test the effects of farmers' training on farm yields via the adoption of the selected technologies. Through these tests, it is expected to have some conclusions about the effectiveness of the technical assistance that the farmers have from the local extension services and the technical cooperation project named the Social Forestry Development Project (SFDP) Song Da.

Previous literature about adoption model shows that though new technologies are often promoted as packages, farmers often adopt them in a sequence rather than adopting them as a package. The decision to adopt the new technologies is often based on both financial and non-financial factors related to new technologies. Studies also show that education/ training is quite important to the adoption of new technologies, particularly with regard to sustainable technologies. Studies about sustainable technologies suggest that the use of both agricultural and non-agricultural means is required to promote adoption of sustainable technologies.

Some of the initial expectations from this study are that training is positively related to the adoption of new technologies and the increase of yield; and the adoption of seed-fertilizer technologies is positively related to the yield while the adoption of sustainable technology may have negative effect on the average yield at least in the short time frame covered in this study. If a loss in yield occurs with the adoption of sustainable technologies, which is normally due to the reduction of land for main crop, it is expected that the loss can be regarded as the willingness to pay for the future value of the improved soil fertility and the conservation of soil quality. It is noted that full effects of sustainable technologies can only be measured over time; hedgerows in the long run may reduce the need for fertilizer.

Three theoretical models are set up for the hypothesis testing. The models are training model, which aims to analyze and differentiate the characteristics of the trainees and non-trainees; the adoption model, which is used to characterize and distinguish adopters from the non-adopters; and the yield model, which is to evaluate the effects of the selected technologies. The training and adoption models are estimated with the probit model while the yield model is regressed with ordinary least squares (OLS) method.

In the adoption model, a data separation problem was encountered in the estimation of the improved maize technology because the number of non-adopters is too few to estimate the model. The data separation problem can be avoided by improving the data quantity and, possibly, the data quality.

Generally, the estimation results show interesting findings. Within a community, the socio-economic characteristics of farmers who receive training are not significantly different from those who do not receive training. Similarly, households that adopt the yield improving and sustainable technologies are not significantly different from non adopters in terms of their socio-economic characteristics. In addition, the empirical analysis with the current data set shows that farmers in the studied area do not adopt the studied technologies as a package. The probability that a household has adopted any single technology is not conditional on whether other technologies have been adopted. A farmer who has adopted improved maize is not more likely to adopt hedgerows than a farmer not using improved maize. However, it is to be noted that since the data set does not include the time a farmer started with each technology, this study only looks at the current situation of adoption and misses the adoption history of each household. Further study needs to take into account the time that a farmer started with a new technology.

With respect to the adoption of new technologies, training is, as expected, significantly and positively related to the adoption of studied technologies. This finding highlights the importance of training to farmers, particularly the upland farmers living in such remote areas as the studied villages. On the other hand, the fact that training shows up to have no direct effects on yield poses the question of follow-up activities, which is to make sure that the trained farmers do according to what they learn from the courses. In additions, farmers in Tua Chua show up to have more training but adopt no more, even less in fertilizer technology, than do farmers in Yen Chau. This brings in the question of suitability of the training topics and the selection of trainees, if there ever is a selection of participants for training courses.

Adoption of new technologies has non negative effects on a farmer's yield, even in the case of sustainable technology where the land for main crops is taken away. In general, adopters of all the selected technologies unambiguously have better yield than the non-adopter. This gain in yield is attributed to the adoption of improved varieties, which helps increase the yield about 80% on average. However, the fact that there is no complementarity among the selected technologies both in the adoption of new technologies and in the increase of yield may imply that the use of fertilizer-seed technologies to compensate for the loss in the adoption hedgerows is not sufficiently good enough to promote hedgerow technology. If the hedgerow technology is to be further promoted in the area, other diffusion methods may be required. This finding is in line with results from empirical studies which suggest the use of both agricultural and non-agricultural effort in the promotion of sustainable technologies. However, it is again noted that complementarity among the studied technologies may exist over a longer period of time but cannot be analyzed with the available data.

Most of the household socio-economic characteristics have no effects on the training and adoption decision but are statistically significant to the yield. Land size is significantly important to yield. Estimation shows that small farmers have higher yield than do larger farmers, which is explained by the fact that farmers maximize their profit based on their scarcest resource. On the other hand, poor farmers have lower yield than medium and do rich farmers but rich farmers do not have better yield than do medium farmers. This implies that the level of intensification may slow down as the farmer becomes richer and achieves a certain level of yield or the response of yield to the incremental investment slows down as the level of investment goes up at a certain level. Farmers with position in the village also show up to have higher yield than do other farmers. This fact can be explained by the possible higher education and better access to resources by farmers with position in the village management. This explanation is in line with findings from previous studies in adoption model as discussed in chapter 4.

Based on the findings from the study, the following conclusions and recommendations are made:

1. The estimation results show that in with the current data set, farmers have not adopted the studied technologies as a package. This finding is consistent with the empirical studies about sequential adoption model as discussed in the literature review chapter.

2. Training is important to the adoption of new technologies. People who get trained are more likely to adopt the technologies than people who do not. In the area where the educational level of the farmers is low, the organization of training in the adoption of new technologies is very important.

3. Following-up of training activities is important. In the context of the SFDP Song Da, this activity needs to be strengthened since it is closely linked to the effectiveness of training activities. For the less educated farmers and/or for the adoption of sustainable technologies, whose existence values are not clear, following-up of training activities becomes even more important. After training events, technical staff should visit the farmers once in a while to make sure that they are doing the right thing in the right time.

4. Though adoption of hedgerow technology evidently reduces the land available for main crop, the study results show that no significant reduction of yield is experienced. Since it is believed that this technology helps increase soil fertility and protect the soil from erosion, it is concluded that adoption of hedgerow technology may be promoted in larger scale. However, since there is no complimentarity among studied technologies, different method may be needed for the promotion of hedgerows in the area.

5. Adoption of new technologies, particularly the improved seed varieties, helps increase the farm yield. Since poor farmers do not participate adequately in training and are not significantly among the adopters of new technologies, supports should be more targeted to help them increase the farm yield.

6. Future studies may need to take into account factors like the time when a household started with each technology, the education level of the family head, and the area of land under each technology. Since it is assumed that education is strongly related to the adoption of new technologies and the increase of yield, inclusion of education variable in the future study may help test this hypothesis. In addition, the scale by which a farmer decides to adopt a technology is also assumed to be significant to the change in the crop yield. It is therefore expected that by including this data in future study, it will help test this hypothesis and verify the results from the study in this thesis.

7. Although the organization and follow-up of training activities should be strengthened, given all the findings discussed in the study it is concluded that the technical assistance from the SFDP Song Da and the local extension services to H'mong farmers in Tua chua and Thai farmers in Yen chau is a successful undertaking.

In brief, the thesis looks at issues related to the adoption of new technologies by the upland farmers in the remote areas in the Northwest of Vietnam. Models are set up and econometric tools are employed to test the hypotheses. Though data problem was confronted during the estimation process, the findings are interesting and useful for the improvement of both the future extension programs and the impact monitoring system of the on-going extension programs.

APPENDIX A: THE HOUSEHOLD INTERVIEW QUESTIONNAIRE

Social Forestry Development Project (SFDP) Song Da
MARD - GTZ/GFA

Questionnaire for Monitoring Project Impact on Farming system (1st Interview)*

1) Date:	6) Village:
2) Name of Interviewee:	7) Commune:
3) Sex:	8) District:
4) Ethnic Group:	9) Province:
5) Position in village	10) Name of enumerator:
11) What is the size of your agricultural land? ha	
12) Do you have a Red Book Certificate RBC for agricultural land? Yes: ☐ No: ☐	

13) What are the 3 most important agricultural products (upland, paddy, vegetable, fruits, animal production) **for you**? What is the cultivated area/number of heads?

Agricultural product	Area/head
1) ______________	________
2) ______________	________
3) ______________	________

(ask first the most important than continue with the second most important and than ask for the third important) Which crop, which animal?

14) What was the yield/ha in **your** last harvest (if they do not know the yield/ha ask for the yield and area they have)

	yield/ha	(area and yield/area)
Paddy Rice	________ kg/ha	(____________)
Upland Rice	________ kg/ha	(____________)
Main season Maize	________ kg/ha	(____________)
Autumn Maize	________ kg/ha	(____________)

15) Do **you** have any surplus from your agricultural production to sell on the market?

Yes: ☐ No:☐

If yes, which are the 3 most important agricultural products (from upland, paddy, vegetable, fruits, animal production) **you** are selling on the market? How many kg did you sell in the last 12 month (if they sell in other measures ask the approximate quantity in kg)?

Product	Quantity (in kg)
1. ____________________	____________ kg
2. ____________________	____________ kg
3. ____________________	____________ kg

16) What do you think: Is **your** economic situation now better, worse or the same like to 2 years ago?

Better: ☐
Worse: ☐
Same: ☐

What do **you** think is the reason for the change?

____

____

17) Do **you** know the following technology/new method a (b, c,..).?
(**if yes:** go to next column, **if no:** go to next activity).

Did **you** take part in a training course for this technology/new method?

Do **you** practise presently, did you practise in the past and stopped doing it or did you never apply this method?

(**If presently:** ask for all columns, **if past or never:** then go to the next technology/new method)

Did **you** get any input supply for this technology/new method?

Has **your** (not family in general) workload increased, decreased or remind stable through this technology/new method?

Is the yield through the practice of the technology/new method increased, decreased or remained stable?

Technology/ method	Knowledge (interview-ee)	Training (from outside)	Practise (family of interviewee)	Input supply	Workload (for interviewee)	Yield/ha
Technologies/methods for special crops on upland						
1. Improved maize (compare to trad. variety)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
2. Second maize crop (autumn maize)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
3. Inter-cropping maize-bean (compare to maize w/o bean)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
4. Improved upland rice (compare to trad. variety)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
Technologies/methods on upland fields						
5. Hedgerows	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
6. Micro-terraces	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
7. Fertilizer use on upland field	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐

Technologies/methods for paddy production						
8. Improved paddy rice (compare to traditional variety)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
9. IPM	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
10. Winter crop (vegetable on paddy land in winter)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
11. Improved seed for vegetable (tomato, cucumber, soy bean, green bean, compare to traditional variety)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
Technologies/methods for fruit gardens						
12. Improvement of existing fruit gardens	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
13. Improved fruit trees	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐

Technologies/methods for animal production						
14. New methods for fish raising	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐
15. Planting of grass for fodder (yield: increase of animal production)	Yes: ☐ No: ☐	Yes: ☐ No: ☐	Present: ☐ Past*: ☐ (but stopped) Never: ☐	Yes: ☐ No: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐	Increase: ☐ Decrease: ☐ Stable: ☐ I don' know: ☐

18) Did you hear from a toolkit for the para-veterinarians? Yes: ☐ No: ☐
Do you get help trough the veterinarian-toolkit-service? Yes: ☐ No: ☐
If yes: Which help did you get?

____

19) Did you have direct contact to the extension service in the last 12 month? If yes continue with question No a), if no go to question No c)

No: ☐ Yes: ☐

a) Did they go with you to your fields?
No: ☐ Yes: ☐

b) What did they do? Did you get training or did they give you inputs (subsidised, free)?
Training: ☐
Input: ☐
Others: ☐ Specify: ________________________

c) What is your impression of the extension service in general? Is it good, bad or medium (medium means: good and not so good parts)?
Good: ☐ Bad: ☐ Medium: ☐
Why is good/bad/medium?

____

d) What is more important for you today: training or input supply? Why is it more important?
Training: ☐ Input supply: ☐
Reason for importance:

____

For the enumerator:
Characterise the economic situation of the household. (ask the head of the village) Rich: ☐ Medium: ☐ Poor: ☐
Signature from the enumerator:

*: Permission to the use of this questionnaire in this thesis is granted by the Social Forestry Development Project (SFDP) Song Da.

APPENDIX B: THE DATA SET*

Code	Household/ farm characteristics					
	Yield (kg/ha)	Maize land (sq.m)	District	Position	Rich	Poor
11111	10000	1400	1	0	0	1
11112	4762	10500	1	1	0	0
11113	5714	14000	1	1	1	0
11114	4500	20000	1	0	0	1
11115	8286	7000	1	0	1	0
11122	3750	8000	1	1	0	0
11123	8961	2790	1	0	0	1
11124	1250	4000	1	0	0	1
11125	8667	3000	1	0	1	0
11131	7143	7000	1	0	1	0
11133	3681	1630	1	0	0	1
11141	2795	13595	1	0	1	0
11142	1099	4550	1	0	0	1
11143	2026	5430	1	0	0	1
11144	1741	11490	1	0	0	0
11145	2301	8690	1	0	1	0
11151	16064	1245	1	0	0	1
11152	5750	4000	1	0	0	1
11153	9483	4218	1	0	0	0
11154	10204	4900	1	0	1	0
11155	6250	4000	1	0	1	0
11161	6250	8000	1	0	1	0
11162	8339	8994	1	1	1	0
11163	7948	6920	1	1	0	0
11164	3000	4000	1	0	0	1
11165	4878	2050	1	0	0	1
11171	6000	5000	1	0	1	0
11172	4000	10000	1	0	1	0
11173	5000	3000	1	0	0	0
11174	9883	1619	1	0	0	1
11175	5556	2340	1	0	0	1
11181	3574	13990	1	0	1	0
11182	7467	15000	1	1	1	0
11183	3000	5000	1	0	0	1
11184	11667	3000	1	0	0	0

APPENDIX B: THE DATA SET - ***continued***

Code	Household/ farm characteristics					
	Yield (kg/ha)	Maize land (sq.m)	District	Position	Rich	Poor
11185	4605	7600	1	0	0	1
11191	5000	5000	1	0	0	0
11192	2326	8600	1	0	1	0
11193	5333	15000	1	0	1	0
11194	847	5900	1	0	0	1
22211	2667	3000	0	0	0	1
22212	1000	2000	0	0	0	1
22213	1500	20000	0	0	1	0
22214	1250	20000	0	1	1	0
22215	1000	10000	0	0	0	0
22221	1200	2500	0	0	0	0
22222	3200	7500	0	0	1	0
22223	1000	3000	0	0	0	1
22224	5600	5000	0	0	0	0
22225	1905	10500	0	0	1	0
22231	2667	15000	0	0	1	0
22232	933	7500	0	0	0	1
22233	2000	15000	0	0	0	0
22234	2000	2000	0	0	0	1
22235	2500	20000	0	0	1	0
22241	5714	3500	0	0	0	0
22242	1000	3000	0	0	0	1
22243	2667	3000	0	0	1	0
22244	1400	5000	0	0	1	0
22245	1500	4000	0	0	0	1
22251	2000	10000	0	0	1	0
22252	2500	10000	0	1	1	0
22253	2667	7500	0	1	0	0
22254	1667	1500	0	0	0	1
22255	1200	2500	0	0	0	1
22261	1000	10000	0	0	1	0
22262	600	2000	0	0	0	1
22263	3000	5000	0	0	1	0
22264	8000	3000	0	1	0	0
22265	1000	1000	0	0	0	1

APPENDIX B: THE DATA SET - *continued*

Improved maize		Fertilizer use		Hedgerows	
$Train_{im}$	$Prac_{im}$	$Train_f$	$Prac_f$	$Train_h$	$Prac_h$
0	1	0	0	0	0
0	1	0	1	0	0
0	1	0	1	0	1
0	1	0	1	0	0
0	1	0	1	0	1
0	1	0	1	0	0
0	1	0	1	0	0
0	0	0	1	0	0
1	1	0	1	0	1
0	1	0	0	0	0
0	1	0	0	0	0
1	1	1	1	1	1
1	1	1	0	1	0
1	1	1	1	1	0
1	1	1	1	1	0
1	1	1	1	1	0
1	1	0	0	1	1
1	1	0	1	0	0
1	1	1	0	1	1
1	1	0	1	1	1
1	1	1	1	1	1
1	1	1	1	1	1
1	1	1	1	0	0
1	1	1	1	0	0
0	0	0	1	1	0
0	1	0	0	0	0
1	1	0	1	1	1
1	1	1	1	1	0
0	1	0	1	0	0
1	1	1	1	0	0
0	1	1	1	1	1
1	1	1	1	1	1
1	1	1	1	1	0
0	0	0	0	1	1
0	1	0	1	0	1

APPENDIX B: THE DATA SET - ***continued***

Improved maize		Fertilizer use		Hedgerows	
$Train_{im}$	$Prac_{im}$	$Train_f$	$Prac_f$	$Train_h$	$Prac_h$
0	1	0	1	1	1
0	1	0	1	0	0
0	1	0	0	0	1
0	1	0	1	0	0
0	0	0	0	1	1
1	1	0	0	1	0
0	0	1	0	1	1
1	1	0	1	1	1
1	1	1	1	1	1
1	1	1	0	1	1
1	1	1	1	1	1
1	1	1	1	1	1
1	1	1	1	1	1
1	1	1	1	1	1
1	1	0	0	0	0
1	1	0	1	1	0
1	1	0	1	1	1
1	1	0	1	1	1
1	1	1	0	1	1
1	1	1	1	1	1
1	1	0	0	0	0
1	1	0	0	1	1
1	1	0	0	1	0
1	1	1	1	1	1
0	1	0	1	0	0
0	1	1	0	1	1
1	1	1	1	1	0
1	1	0	0	1	1
1	0	1	0	0	0
0	0	0	0	0	0
1	1	1	1	1	1
1	1	0	0	1	1
1	1	1	1	1	0
1	1	1	1	1	0
1	1	1	1	1	1

*: Permission to the use of this data set is granted by the SFDP Song Da.

APPENDIX C: LIST OF VARIABLES USED IN THREE THEORETICAL MODELS

Variable	Description	Type
Yield	Actual maize yield in kg at household level	Continuous
Lg(Yield)	Log of maize yield	
MAIZELAND	Land size in m for maize crop of the household	Continuous
LGMAIZELAND	Log of land area for maize	
POSITION	Position of the household head in the village	1=Y[+], 0=N[+]
RICH	The household is rich	1=Y, 0=O[+]
POOR	The household is poor	1=Y, 0=O
DISTRICT	The location of the district where the household lives. This variable takes into account the differences between the two studied districts.	1=Yen Chau, 0=Tua Chua
$PRAC_i$	The household currently practices/ adopts improved maize (im), fertilizer use (f) and hedgerows (h) technologies.	1=Y, 0=O
$PRACi^*$	Probability that a farmer/ household adopts/ practices improved maize (im), fertilizer use (f) and hedgerows (h) technologies.	
PR_ALL	The household currently practices all the studied technologies: improved maize, hedgerows and fertilizer use.	1=Y, 0=O
$TRAIN_i^*$	Probability that a farmer receives training in improved maize (im), fertilizer use (f) and hedgerows (h) technologies	
PTi	Household receives training and adopts improved maize (im), fertilizer use (f) and hedgerows (h) technologies.	1=Y, 0=O

[+]: Y=Yes, N=No, O=Otherwise

APPENDIX D: SUMMARY OF MEAN AND STANDARD DEVIATION OF INDEPENDENT VARIABLES IN TRAINING MODEL

	Total sample n=70		Improved maize			
			W/o training, n=25		With training, n=45	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
MAIZELAND	6,949.3	5,071.1	6,252.4	4,702.8	7,336.5	5,275.8
DISTRICT	0.5714	0.4984	0.84	0.3742	0.4222	0.4995
POSITION	0.1429	0.3525	0.12	0.3317	0.1556	0.3665
RICH	0.4	0.4934	0.24	0.4359	0.4889	0.5055
POOR	0.3857	0.4903	0.56	0.5066	0.2889	0.4584

	Total sample n=70		Fertilizer use			
			W/o training, n=38		W/ training, n=32	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
MAIZELAND	6,949.3	5,071.1	6,582	5,050.9	7,385.5	5,140.7
DISTRICT	0.5714	0.4985	0.6579	0.4808	0.4688	0.5070
POSITION	0.1427	0.3525	0.1053	0.3110	0.1875	0.3966
RICH	0.4	0.4934	0.3158	0.4710	0.5	0.508
POOR	0.3857	0.4903	0.4737	0.5060	0.2813	0.4568

	Total sample n=70		Hedgerows			
			W/o training, n=26		W/ training, n=44	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
MAIZELAND	6,949.3	5,071.1	6,134.7	4,765.3	7,430.6	5,236.8
DISTRICT	0.5714	0.4984	0.8077	0.4019	0.4318	0.5011
POSITION	0.1429	0.3525	0.1923	0.4019	0.1136	0.3210
RICH	0.4	0.4934	0.3077	0.4707	0.4546	0.5037
POOR	0.3857	0.4903	0.4231	0.5038	0.3636	0.4866

APPENDIX E: SUMMARY OF MEAN AND STANDARD DEVIATION OF INDEPENDENT VARIABLES IN ADOPTION MODEL

	Total sample n=70		Improved maize			
			Non-adopter, n=7		Adopter, n=63	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
$TRAIN_{im}$	0.6429	0.4826	0.1429	0.3780	0.6984	0.4626
MAIZELAND	6949.3	5071.1	3557.1	1619.5	7326.2	5188.6
DISTRICT	0.5714	0.4984	0.5714	0.5345	0.5714	0.4989
POSITION	0.1429	0.3525	0	0	0.1587	0.3684
RICH	0.4	0.4934	0	0	0.4444	0.5009
POOR	0.3857	0.4903	1	0	0.3175	0.4692

	Total sample n=70		Fertilizer use			
			Non-adopter, n=23		Adopter, n=47	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
$TRAIN_f$	0.4571	0.5018	0.30435	0.4705	0.5319	0.5044
MAIZELAND	6949.3	5071.1	4438.8	3050.4	8177.8	5424.9
DISTRICT	0.5714	0.4984	0.4348	0.5069	0.6383	0.4857
POSITION	0.1429	0.3525	0.0435	0.2085	0.1915	0.3977
RICH	0.4	0.4934	0.2174	0.4217	0.4894	0.5053
POOR	0.3857	0.4903	0.6087	0.4990	0.2766	0.4522

	Total sample n=70		Hedgerows			
			Non-adopter, n=34		Adopter, n=36	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
$TRAIN_h$	0.6286	0.4867	0.3824	0.4933	0.8611	0.3507
MAIZELAND	6949.3	5071.1	6531.3	4718.2	7344.1	5420.1
DISTRICT	0.5714	0.4984	0.6765	0.4749	0.4722	0.5063
POSITION	0.1429	0.3525	0.2059	0.4104	0.0833	0.2803
RICH	0.4	0.4934	0.3235	0.4749	0.4722	0.5063
POOR	0.3857	0.4903	0.4412	0.5040	0.3333	0.4781

APPENDIX F: MEAN VALUES OF VARIABLES IN THE DATA SET

Variable	Total sample mean	Yen Chau	Tua Chua
Number of observations:	70	40	30
Yield (kg/ ha)	4,220	5,727	2,211
Maize land (sq.m)	6,949	6,811	7,133
District*	0.57	1.00	0.00
Position	0.14	0.15	0.13
Rich	0.40	0.40	0.40
Poor	0.39	0.40	0.37
$Train_{im}$	0.64	0.48	0.87
$Prac_{im}$	0.90	0.90	0.90
$Train_f$	0.46	0.38	0.57
$Prac_f$	0.67	0.75	0.57
$Train_h$	0.63	0.48	0.83
$Prac_h$	0.51	0.43	0.63

*: Since Yen Chau=1 and Tua Chua=0, the mean value for district should be understood as 57% of the total sample are from Yen Chau, the rest (43%) are from Tua Chua.

APPENDIX G: DESCRIPTION OF THE DATA PROBLEM IN THE ESTIMATION OF ADOPTION MODEL FOR IMPROVED MAIZE

A data separation problem was encountered in SAS IML in the model for improved maize adoption. This data problem, which may influence the model fit, occurs in SAS IML when the cumulative distribution function (CDF) gives the result of 1, causing the log likelihood function to stop iterating. The convergence criterion is not met and the coefficients are estimated based on the last iteration. Based on recommendation from SAS online help to change continuous variable to categorical variable, I drop the Maizeland variable, which is the only continuous variable in the model, and try to estimate the model again with SAS IML but the problem is persistent. I conclude that the data separation problem with regard to this activity (Improved maize) can only be solved by improving the number of observations in the data set. This conclusion is based on the fact that for this activity only 7 households out of a total 70 in the data set are non-adopters (see Table 6.6 on page 77). A data set with a too small number of non-adopters (7) should be liable for the persistent data separation problem. It is also noted that the PROC PROBIT in SAS system and Probit model in Limdep still return the estimation results as well as the model's goodness of fit. However, results from these two statistical packages for this activity are not the same as they are with other activities. The results shown in Table 6.8 are from Limdep.

APPENDIX H: ESTIMATION RESULTS FOR GOLDFELD-QUANDT TEST OF HETEROSCEDASTICITY

Sub-set with lower Maizeland:

Variable	Coefficients	T-Stat.	Variable	Coefficients	T-Stat.
Intercept	12.1745***	4.5011	$Prac_{im}$	0.4389	1.1830
lgmland	-0.5939*	-1.8211	$Prac_f$	0.0363	0.1028
Position	1.1254	1.4747	$Prac_h$	0.3492	0.5029
Rich	0.2712	0.6776	Pr_all	-0.4298	-0.8156
Poor	-0.6514*	-1.9581	pt_{im}	0.0029	0.0090
District	1.2648***	5.1054	pt_f	-0.0359	-0.0812
			pt_h	-0.3649	-0.5875

Model's statistics and goodness-of-fit			
No of observations:	35	Standard deviation:	0.6081
R^2:	0.7138	F-statistics:	4.5729
Adj-R^2:	0.5577	Sum of squared errors:	8.1351

Sub-set with higher Maizeland:

Variable	Coefficients	T-Stat.	Variable	Coefficients	T-Stat.
Intercept	10.9815***	4.7414	$Prac_{im}$	1.0884	1.7037
lgmland	-0.4591*	-1.8613	$Prac_f$	0.0425	0.0954
Position	0.3183	1.4348	$Prac_h$	-0.6657	-1.3023
Rich	0.1633	0.6664	Pr_all	0.5326	1.0555
Poor	-0.4315	-1.2893	pt_{im}	-0.3451	-1.1420
District	0.6202**	2.5337	pt_f	-0.0822	-0.3145
			pt_h	0.2234	0.5534

Model's statistics and goodness-of-fit			
No of observations:	35	Standard deviation:	0.4864
R^2:	0.6605	F-statistics:	3.5665
Adj-R^2:	0.4753	Sum of squared errors:	5.2050

*, **, ***: estimate is significant at 10%, 5%, and 1% significance levels, respectively.

APPENDIX I: ESTIMATION RESULTS FOR CHOW TEST OF STRUCTURAL CHANGE

Yield model: whole data set

Variable	Coefficients	T-Stat.	Variable	Coefficients	T-Stat.
Intercept	11.8171***	8.9466	$Prac_{im}$	0.8288**	2.4976
lgmaizeland	-0.5025***	-3.2859	$Prac_f$	0.5027*	1.6802
Position	0.3097	1.1357	$Prac_h$	-0.1522	-0.5133
Rich	0.2632	1.0644	Pr_all	-0.1224	-0.3256
Poor	-0.5090*	-1.9472	pt_{im}	-0.4240*	-1.8914
			pt_f	-0.2823	-1.1566

Model's statistics and goodness-of-fit			
No of observations:	70	Standard deviation:	0.6868
R^2:	0.3652	F-statistics:	3.3944
Adj-R^2:	0.2576	Sum of squared errors:	27.8282

Yield model: sub-set for Yen Chau

Variable	Coefficients	T-Stat.	Variable	Coefficients	T-Stat.
Intercept	12.2231***	8.9011	$Prac_{im}$	1.1464***	3.4371
lgmaizeland	-0.6430***	-4.1465	$Prac_f$	0.6819**	2.2176
Position	0.5403**	2.1098	$Prac_h$	0.6699*	1.8516
Rich	0.4461	1.6843	Pr_all	-0.6152	-1.3902
Poor	0.0038	0.0144	pt_{im}	-0.0926	-0.4202
			pt_f	-0.2650	-1.1333

Model's statistics and goodness-of-fit			
No of observations:	40	Standard deviation:	0.4919
R^2:	0.5966	F-statistics:	4.2896
Adj-R^2:	0.4575	Sum of squared errors:	7.0175

Yield model: sub-set for Tua Chua

Variable	Coefficients	T-Stat.	Variable	Coefficients	T-Stat.
Intercept	8.5349***	4.4155	$Prac_{im}$	0.3215	0.6272
lgmaizeland	-0.0445	-0.1918	$Prac_{f}$	-0.0855	-0.2091
Position	0.0731	0.2131	$Prac_{h}$	-0.6557**	-2.1807
Rich	-0.4388	-1.4915	Pr_all	0.0447	0.1010
Poor	-0.8405**	-2.7030	pt_{im}	-0.1120	-0.2791
			pt_{f}	0.1879	0.4776

Model's statistics and goodness-of-fit			
No of observations:	30	Standard deviation:	0.4850
R^2:	0.5790	F-statistics:	2.6129
Adj-R^2:	0.3574	Sum of squared errors:	4.4695

*, **, ***: estimate is significant at 10%, 5%, and 1% significance levels, respectively.

APPENDIX J: EXCHANGE RATE OF VIETNAMESE DONG (VND) VERSUS U.S. DOLLAR (USD) IN SELECTED YEARS

Year	Exchange rate 1 USD=	Year	Exchange rate 1 USD=
1991	8,819 VND	1996	11,050 VND
1992	11,200 VND	1997	11,689 VND
1993	10,650 VND	1998	13,613 VND
1994	10,954 VND	1999	13,932 VND
1995	11,029 VND		

Source: United Nations –United Nations Development Program– "Vietnam: Socio-Economic Statistical Bulletin" (2000)

REFERENCES

Bunch, R. "Report on Soil Conservation, Soil Improvement and Extension for the Song Da Watershed and Care Projects" Consultancy Report Number 09, Social Forestry Development Project Song Da, Hanoi, March 1997.

Economist Intelligence Unit, *Country Profile: Vietnam 1998-99.* London, 1998.

FAO. "FAOSTAT Database Collections [On-line]." Available HTTP: http://apps.fao.org/page/collections?subset=agriculture (August 2000).

Feder, G. "Farm Size, Risk Aversion and the Adoption of New Technology under Uncertainty." *Oxford Economic Papers* 32 (July 1980):263-283.

Feder, G., R. E. Just, and D. Zilberman. "Adoption of Agricultural Innovation in Developing Countries: A Survey." Working Paper Number 542, World Bank, Washington, DC,1982.

Filho, H. M. "*The Adoption of Sustainable Agricultural Technologies: A Case Study in the State of Espírito Santo, Brazil.* Vermont: Ashgate Publishing Co., 1997.

Foerster, E., and T. H. Nguyen. "Technical Agriculture and Agroforestry Options for Sustainable Development Promoted by SFDP in the Song Da Watershed." Working Paper Number 5, Social Forestry Development Project Song Da, Hanoi, May 1999.

Greene, W.H. *Econometrics Analysis.* 4th. ed., New Jersey: Prentice Hall, 2000.

Hassan, R. M., F. Murithi, and G. Kamau. "Determinants of Fertilizer Use and the Gap between Farmer's Maize Yields and Potential Yields in Kenya." *Maize Technology Development and Transfer: A GIS Application for Research Planning in Kenya.* Rashid M. Hassan, ed., pp. 137-62. Cab International, 1998.

Hassan, R. M., K. Njoroge, M. Njore, R. Otsyula, and A. Laboso. "Adoption Patterns and Performance of Improved Maize in Kenya." *Maize Technology Development and Transfer: A GIS Application for Research Planning in Kenya.* Rashid M. Hassan, ed., pp. 107-36. Cab International, 1998.

Hodgdon, L. "The Adoption of New Agricultural Inputs and Practices by Indian Farmers." *Small Farm Agricultural Development Problems.* Huntley H. Biggs, and Ronald L. Tinnermeier, eds., pp. 69-96. Fort Collins, CO.: Colorado State University, 1974.

International Monetary Fund. *Vietnam: Statistical Appendix.* IMF Staff Country Report No. 99/56, Washington, D.C., 1999.

Kaiser, K. "Proposals to Increase the Efficiency and Effectiveness of Extension Services Supported by SFDP Song Da in the Districts of Yen Chau and Tua Chua" Consultancy Report Number 07, Social Forestry Development Project Song Da, Hanoi, March 1997.

Kennedy, P. *A Guide to Econometrics*. 4th. ed. Boston, MA: The MIT Press, 1998.

Leathers, H. D., and M. Smale. "A Bayesian Approach to Explaining Sequential Adoption of Components of a Technological Package." *American Journal of Agricultural Economics* 73(August 1991):734-741.

Lin, J.Y. "Education and Innovation Adoption in Agriculture: Evidence from Hybrid Rice in China." *American Journal of Agricultural Economics* 73(August 1991):713-723.

Littooy, S. "Tua Chua Extension Unit: SWOT Analysis and Support Plan for 1995." Consultancy Report Number 03, Social Forestry Development Project Song Da, Hanoi, June 1995.

Luibrand, A. "Monitoring Project Impacts on Farming Systems." Consultancy Report Number 20, Social Forestry Development Project Song Da, Hanoi, December 1999.

Maddala, G.S. *Limited-Dependent and Qualitative Variables in Econometrics.* Cambridge University Press, 1983.

Miller, T., and G. Tolley. "Technology Adoption and Agricultural Price Policy." *American Journal of Agricultural Economics* 71(November 1989):847-857.

Pehu, E. "Upland Agriculture: Regional Report." Poverty Reduction and Environmental Management in Remote Greater Mekong Subregion Watershed Project, [1999a?].

_____. "Upland Agriculture: Vietnam." Poverty Reduction and Environmental Management in Remote Greater Mekong Subregion Watershed Project, [1999b?].

Pingali, P. L., and X. T. Vo. "Vietnam: Decollectivization and Rice Productivity Growth." *Economic Development and Cultural Change* 40(July 1992):697-718.

Rosegrant, M. W., and R. Livernash. "Growing More Food, Doing Less Damage." *Environment* 38 (September 1996):6-16.

Ryan, J.D., and J. C. Wandel. *Vietnam's Reform Experience – the Quest for Stability During Transition*. Hanoi, May 1996.

Saha, A., H. A. Love, and R. Schwart. "Adoption of Emerging Technologies under Output Uncertainty." *American Journal of Agricultural Economics* 76(November 1994):836-846.

Salamon, S., and R. L. Farnsworth. "Family Factors Affecting Adoption of Sustainable Farming Systems." *Journal of Soil and Water Conservation* 52(July/ August 1997):265-271.

Scherr, S. J. "Economic Factors in Farmers Adoption of Agroforestry: Patterns Observed in Western Kenya." *World Development* 23(May 1995):787-804.

SFDP Song Da. *Project Planning Matrix for Implementation Phase III (1/1999-12/2001),* Hanoi, March 1998.

______. *SFDP Song Da 2000 Annual Plan of Operations,* Hanoi, December 1999.

Smale, M., R. E. Just, and H. D. Leathers. "Land Allocation in HYV Adoption Models: An Investigation of Alternative Explanations." *American Journal of Agricultural Economics* 76(August 1994): 535-546.

United Nations, United Nations Development Program. "Vietnam Socio-Economic Statistical Bulletin [On-line]." Available HTTP: http://www.undp.org.vn/ efault.htm (July 2000).

United Nations. *Looking Ahead – A United Nations Common Country Assessment of Vietnam.* Hanoi, 1999.

Van der Poel, P., and D.K. Nguyen. "Land Use in the Song Da Watershed – Northwest of Vietnam." Baseline Study Number 02, Social Forestry Development Project Song Da, Hanoi, December 1993.

Vietnam Embassy. "Vietnam Embassy, Washington DC, Website [On-line]." Available HTTP: http://www.vietnamembassy-usa.org/ (July 2000)

Vietnam, Socialist Republic of, The Communist Party. *Chi Thi 100-CT/TW Ngay 13/01/1981 cua BCH TW Dang ve Cai Tien Cong Tac Khoan, Mo Rong Cong Tac "Khoan San Pham den Nhom va Nguoi Lao Dong" trong HTX Nong Nghiep.* (The Directive Number 100-CT/TW of the Central Communist Party Dated January 13, 1981 on Improvement and Expansion of "Product-Based Contract to Individual and Group of Laborers" in Agricultural Cooperatives). Hanoi, January 1981.

Vietnam, Socialist Republic of, The Government. *Nghi Dinh cua Chinh Phu so 13/CP Ngay 02/03/1993 Ban Hanh Ban Quy Dinh ve Cong Tac Khuyen Nong.* (The Decree Number 13/CP of Government Dated March 2, 1994 on Agricultural Extension Regulation). Hanoi, March 1993a.

Vietnam, Socialist Republic of, The Ministry of Agriculture and Rural Development. *Review of Phase Two of the Social Forestry Development Project Song Da.* Hanoi, [1998].

Vietnam, Socialist Republic of, The National Assembly. *Luat Dat Dai.* (Law on Land). Hanoi, July 1993b.

Vietnam, Socialist Republic of, The Politburo. *Nghi Quyet so 10-NQ/TW cua Bo Chinh Tri Ngay 05/04/1988 ve viec Doi Moi Cong Tac Quan Ly Kinh Te Nong Nghiep.* (The Decree Number 10NQ/TW of the Politburo Dated April 5, 1988 on Reform in Agricultural Economic Management). Hanoi, April 1988.

Vu, T. T, and S. Littooy. "Yen Chau Agricultural Extension Plan – 1995." Consultancy Report Number 02, Social Forestry Development Project Song Da, Hanoi, April 1995.

White, H. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica* 48(May 1980):817-838.

World Bank. "Data: Data by Topic [On line]." Available HTTP: http://www. worldbank.org/data/databytopic/GNPPC.pdf. (November 2000a).

_____. "Vietnam: Advancing Rural Development from Vision to Action [On-line]." Available HTTP: http://www.worldbank.org.vn/rep7/vis001.htm. (July 2000b).

_____. *Vietnam – Preparing to Take-off? How Vietnam Can Participate Fully in the East Asian Recovery.* An Informal Economic Report of the World Bank Consultative Group Meeting for Vietnam, Hanoi, 1999.