CHAPTER 18

Determinants of insecticide-use decisions of lowland rice farmers in Laos

M.M. Escalada, K.L. Heong, V. Sengsoulivong, and J.M. Schiller

In Lao rice production, pests and diseases are minor constraints compared to other agronomic factors such as infertile soils, unavailability of water, floods, and general lack of farmers' crop management knowledge (Schiller et al 2001). Yields in farming areas of the lowland environment in much of Laos, even under irrigated conditions, have remained relatively low for improved Lao varieties, despite their demonstrated yield potential in appropriate management conditions. Although insect pests are not perceived as a significant yield constraint in many areas of Laos, there are suggestions that farmers are prepared to rapidly adopt the use of insecticides if they become more readily available at reasonable prices. Current attitudes of farmers toward insects and pesticides seem to favor this adoption (Heong et al 2002) and thus Lao farmers can potentially fall victim to insecticide misuse just like farmers elsewhere in Asia, such as Indonesia, the Philippines, Vietnam, and Thailand. Integrated pest management (IPM) programs in these countries have thus concentrated on pesticide reduction through training (Matteson 2000) and media campaigns (Escalada et al 1999).

An earlier study on farmers' insect management beliefs and practices (Heong et al 2002) examined the qualitative elements of farmers' beliefs and how they can influence practices. This study was conducted in two irrigated areas, Vientiane Municipality (n = 101) and Vientiane Province (n = 99), and two rainfed areas, Savanneket Province (n = 150) and Champassak Province (n = 150). The results of the study indicated that most Lao farmers strongly believe that insects will decrease yields and about 56% were using insecticides; the main chemicals used were methyl parathion, diazinon, and monocrotophos, which are highly hazardous to human health. There was also strong local social pressure favoring pesticide use. In this chapter, we revisited the data set and applied a psychometric model, the theory of reasoned action (TRA, Ajzen and Fishbein 1980), to understand farmers' insecticide-use decisions and to explain such behavior.

Explaining farmers' decisions using a psychometric model

Farmers' insecticide use is the result of conscious decisions to respond to an insect attack that is perceived to be causing loss. Rice farmers are often described as irrational and lacking sufficient knowledge to make good judgments. Studies on human judgment and choices have, however, shown that economic models have been unable to account for how people actually make decisions (Slovic et al 1977, Simon 1978). Most violate prescriptive principles because decision making is behavioral in nature. A group of sciences concerned with understanding and improving decision-making, called decision sciences (Kleindorfer et al 1993), has recently emerged and begun to explore the behavioral aspects of decisions. To better understand the determinants of farmers' insecticide-use decisions, models from psychology have been adopted.

The psychometric model used in the study reported in this chapter is the theory of reasoned action (TRA), developed by Fishbein and Ajzen (1975) and Ajzen and Fishbein (1980). It provides a theoretical framework to explain a person's behavior. This model was adopted to understand the components of farmers' insecticide spray decisions. The TRA assumes that attitudes toward spraying and perceived social pressures are important determinants of farmers' decisions to spray. Attitudes toward spraying are, in turn, affected by spraying beliefs and their outcome evaluations. Perceived social pressures, termed subjective norms (SN), are influenced by the individual farmer's normative beliefs and his/her motivation to comply.

Methodology

Focus group discussions

Two focus group discussions (FGD) were undertaken to develop survey questions. These FGDs were conducted in farmers' homes using an inquiry format, which involved discussions on how farmers perceive and respond to insects in their crops. The approach sought to avoid leading questions and prompting for responses, with questions asked in no fixed order.

Questionnaire development

Independent variables were measured using five-point semantic differential scales. All points on these scales were described with a corresponding statement and presented to farmers using a prompt chart. The number of insecticide sprays individual farmers applied in a season was also measured and used as the independent variable. Seven belief statements (b_i) related to insect pest control were used to measure attitude toward spraying. These were "All insects can cause loss in yields," "There is a need to kill all insects in the crop," "Applying insecticides will increase yields," "Insecticides will kill natural enemies," "Some insects are beneficial to rice yields," "Insecticides are harmful to health," and "Insecticides can cause more pest problems." Farmers were then asked to evaluate the importance of each item (e_i) using another five-point semantic differential scale from "completely unimportant" to "very important." The measure for attitude toward spraying (SP) was computed as the sum of the products of belief and evaluation, $SP = \sum b_i e_i$.

The subjective norm (SN) attitude was measured using four reference groups, neighbors, village head, spouse, and agricultural technician. Farmers were asked what each of the reference groups expected of them with regard to insecticide spraying

(nb_i). Responses were scored as (1) "Never spray," (2) "Spray rarely," (3) "Spray once every 2 years," (4) "Spray once a year at least," and (5) "Spray every season." Another assessment of the SN component was motivation to comply (mc_i) and this was determined by another five-point semantic differential scale going from "I don't care at all" to "What they think I should do is very important." The subjective norm attitude was computed as the sum of the product of normative beliefs (nb) and motivation to comply (mc), $SN = \sum nb_i mc_i$.

Statistical analyses

Cronbach's alpha available in SPSS version 11.5 (SPSS 2001) was used to assess the reliability of the two independent determinants of spray behavior, SP and SN. Categorical regression (CATREG) was used to analyze the relationship between the determinants of behavior and the dependent variable, insecticide spray behavior. Correlation analysis (two-tailed) was used to analyze between the subcomponents.

When a variable is generated from a set of questions, its reliability can be assessed by Cronbach's alpha, the index of reliability ranging from 0 to 1. The higher the alpha, the more reliable the generated scale is. As a general guide, alpha > 0.7 is commonly an acceptable reliability coefficient (Nunnaly 1978, Santos 1999). The use of categorical regression is appropriate for predicting a categorical dependent variable from a set of categorical independent variables. The spray behavior of farmers was grouped into four categories: 1 = none, 2 = 1 spray, 3 = 2 sprays, and 4 = > 3 sprays, representing farmers whose sprays are none, low, medium, and high.

Results

Reliability analyses

The spray attitude scale with all six belief subcomponents was computed and subjected to reliability analysis. The initial Cronbach's alpha was 0.43 and, after removing three of the subcomponents, the scale reliability index increased to 0.73. Subsequent analyses were conducted using the spray attitude scale with the three subcomponents, "All insects can cause loss in yields," "There is a need to kill all insects in the crop," and "Applying insecticides will increase yields." The subjective norm attitude scale using all four subcomponents had a reliability index of 0.90 and thus all four subcomponents were used.

Regression analyses

The theory of reasoned action describes farmers' spray behavior based on the two predictor components. Since the data are nonparametric, categorical regression analysis was used to evaluate the contributions of the predictors to spray behavior. The intercorrelation among the two predictors was extremely low (Spearman's rho = 0.08), implying that the regression was reliable. Farmers' spray behavior was directly correlated with subjective norm attitudes. The ANOVA of the regression was significant ($F = 57.6$, $P < 0.001$) but yielded a coefficient of determination (R^2) of 0.374, indicating that only 37.4% of the variance was explained by the regression. Table 1 shows the

Table 1. Regression coefficients of spray categories as dependent variable and subjective norm and spray behavior attitudes as independent variables.

Item	Standardized coefficients		Correlations		Importance
	Beta	Std. error	Zero-order	Partial	
Subjective norm (SN)	0.63	0.06	0.583	0.611	0.982
Spray behavior (SP)	–0.19	0.06	–0.035	–0.228	0.018

Table 2. Mean scores of subcomponents in subjective norm (SN) attitudes in the different spray behavior categories.[a]

Spray behavior category	Referent groups			
	Neighbors	Village heads	Spouses	Technicians
Did not spray at all	6.63 a	6.05 a	6.71 a	9.37 a
Sprayed once a season	11.02 ab	13.18 b	14.06 b	15.33 b
Sprayed twice a season	13.65 bc	13.12 b	13.53 b	16.06 b
Sprayed more than three times	16.08 c	16.46 b	10.43 b	17.38 b
F	15.04	21.47	19.06	16.13
P	<0.001	<0.001	<0.001	<0.001

[a]Scores vary from 5 to 25, with high scores indicating strong attitudes. The letters after the means indicate groups of homogeneous subsets from Tukey's honestly significant difference.

standardized regression coefficients. The subjective norm attitude was higher (0.63) than spray attitudes (–0.19). The subjective norm attitude is an important component determining decision-making. Besides seeking to satisfy personal beliefs, objectives, and gains, most people are also influenced by their perceptions of what referent groups (such as peers, neighbors, friends, village officials, and relatives) would think of them. The high subjective norm implies that the influence of referent groups on farmers' spray behavior is stronger than beliefs. This is relevant to designing change interventions. Since influence from beliefs is small, increased farmer training might not result in behavioral change. A better strategy might be to implement change at the communal level.

Since spray attitudes played only a small role in predicting farmers' spray behavior, a further investigation was made of the relationships of the subcomponents in subjective norm and spray behavior. Table 2 shows the mean scores of the subcomponents of farmers in different spray behavior categories. The scores of farmers who did not spray in all four subcomponents were significantly lower than for those who did. The intercorrelations among the subcomponents were high (Table 3). The regression with each subcomponent as independent variables was highly significant ($F = 35.1$, $P < 0.001$, d.f. 4, 84) and R^2 was 0.424. The regression coefficients are presented in

Table 3. Correlations (Spearman's rho) between spray categories and subcomponents of subjective norm (SN) attitudes.

Item	Subcomponents				
	1	2	3	4	5
1. Spray behavior category	–				
2. Neighbor subcomponent	0.45**	–			
3. Village head subcomponent	0.72**	–			
4. Spouse subcomponent	0.45**	0.67**	0.86**	–	
5. Technician subcomponent	0.39**	0.51**	0.67**	0.75**	–

**Indicates correlation significant at *P* = 0.01 (2-tailed).

Table 4. Regression coefficients of spray categories as dependent variable and subcomponents of subjective norm (SN) attitudes.

Group	Standardized coefficients		Correlations		Importance
	Beta	Std. error	Zero-order	Partial	
Neighbors	0.23	0.07	0.458	0.246	0.252
Village heads	0.54	0.09	0.506	0.411	0.643
Spouses	–0.45	0.08	0.185	–0.375	–0.196
Technicians	0.28	0.07	0.451	0.281	0.301

Table 4. Spouses seemed to have a negative influence over spray behavior, whereas village heads, neighbors, and technicians had a positive influence. Among these, the groups most influential on farmers' spray behavior in order of importance were village heads (importance = 0.643), technicians (0.301), neighbors (0.252), and spouses (negative 0.196).

Discussion

Many insecticide sprays that rice farmers in Asia apply are unnecessary, targeting leaf-feeding insects in the early crop stages (Heong and Escalada 1997). In Laos, 30% of the sprays are done at these stages and another 37% in late stages targeting the rice bug (Heong et al 2002). The rice bug is another one of those pests that are highly visible but that cause negligible loss (Van Den Berg and Soehardi 2000). Spray decisions can subject farmers to pesticide health hazards (Rola and Pingali 1993) and compromise a vital ecosystem service, natural biological control, and this can lead to the development of secondary pests (Way and Heong 1994, Heong and Schoenly 1998). Despite the negative effects, pesticide use tends to increase because farmers are often "locked" into continuing such unsustainable practices (Wilson and Tisdell

2001). Some of these factors are ignorance, lack of information about side effects, aggressive advertising and promotion by chemical companies, and loss aversion attitudes of farmers. Research and extension will need to go beyond developing technologies and focus on ensuring that the technologies are implemented to help farmers improve their practices.

The TRA provided a useful framework to explore farmers' spray decisions. Understanding the primary reasons why farmers spray is important in order to develop strategies to overcome misuse problems. In many cases, farmers' spray decisions are influenced by noneconomic factors such as perceptions and social factors. Subjective norm (or peer pressure) attitudes seem to have a big influence over Lao farmers' spray behavior. Since village heads and technicians are the two most influential referent groups in farmers' spray decisions, a strategy to train village heads and technicians on principles of integrated pest management (IPM) might pay more dividend than just training farmers. In addition, once village heads and technicians have acquired IPM knowledge, they can also provide *in situ* training to farmers besides functioning as influence groups. Establishing local village-level IPM clubs to initiate local participation and discussions about pest management and pesticides might also be useful.

In the Philippines, extension technicians were also found to play significant roles in onion farmers' pesticide misuse (Tjornhom et al 1997). In this case, the technicians were the main source for pesticide information and were also motivated to promote pesticide use. In countries such as China, where the government promotes a pesticide-first policy, overuse had been a direct consequence (Widawsky et al 1998). Extension technicians often supplement their incomes from pesticide sales, thus increasing their influence over farmers' spray decisions. Where extension plays both advisory and marketing roles in pest management, pesticide overuse often results (Norton et al 1991). Similarly, in Thailand, weak government policies had promoted pesticide misuse (Jungbluth 1996, Oudejans 1999).

There is a high potential for Lao farmers to become pesticide-dependent as several of its neighboring countries produce pesticides. Many old pesticides such as methyl parathion, monocrotophos, and metamidophos, banned in many developed countries, are still actively sold in local markets. Our brief visits to local general stores in villages revealed large quantities of pesticides from neighboring countries, with foreign language labels, sold among other household products. The availability of spray equipment can be another limiting factor, but, with the abundance of inexpensive plastic sprayers, this is likely to diminish. However, these sprayers are often poorly manufactured, have poor spray delivery, and often leak, posing a big health hazard to the operators. The poor pump and nozzle systems of sprayers provide delivery of pesticide active ingredients in large droplets, which results in contaminating soil and water systems and killing more natural enemies than pests. Besides pesticide control, agricultural authorities will need to develop mechanisms to control the quality of spray equipment manufactured locally or imported, to ensure that it adheres to minimum standards established by the FAO.

For Laos, the strong influence of village heads and technicians may in fact be used for improving farmers' decisions since current insecticide use is still low. Much of the insecticide misuse in rice production today has been attributed to the "unwelcome harvest" of the Green Revolution (Conway and Pretty 1991). The lessons learned from the implementation of the Green Revolution in the Philippines, Indonesia, and Vietnam could come to bear in initiating the "Doubly Green Revolution" (Conway 1997). A re-engineering of local village leaders and research and extension officials' knowledge and attitudes focusing on the new paradigms in IPM that place emphasis on ecological principles and enhancing naturally occurring biodiversity of biological control (Heong 1999) is urgently needed in Laos. In addition, pesticide policies need to be revisited and modified in order to control the import and sale of pesticide to avoid abuse. Programs such as the implementation of farmer training, such as the farmer field schools (Matteson 2000), the use of media to communicate (Escalada et al 1999), and entertainment education (EE) through radio and television (Singhal and Rogers 1999), will be useful in initiating social change in pesticide use.

References

Ajzen I. 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Processes 50:179-211.

Ajzen I, Fishbein M. 1980. Understanding attitudes and predicting social behavior. Englewood Cliffs, N.J. (USA): Prentice-Hall.

Conway G. 1997. The Doubly Green Revolution: food for all in the 21st century. Ithaca, N.Y. (USA): Comstock Publishing Associates. 335 p.

Conway GR, Pretty JL. 1991. Unwelcome harvest: agriculture and pollution. London (UK): Earthscan Publications Ltd. 645 p.

Escalada MM, Heong KL, Huan NH, Mai V. 1999. Communication and behavior change in rice farmers' pest management: the case of using mass media in Vietnam. J. Appl. Comm. 83:7-26.

Fishbein M, Ajzen I. 1975. Belief, attitude, intention and behavior: an introduction to theory and research. Reading, Mass. (USA): Addison-Wesley.

Heong KL. 1999. New paradigms and research opportunities in rice pest management. In: Zhang R, Gu D, Zhang W, Zhou C, Pang Y, editors. Integrated pest management in rice-based ecosystems. Zhongshan University, Guangzhou, China. p 3-14.

Heong KL, Escalada MM. 1997. Pest management of rice farmers in Asia. Los Baños (Philippines): International Rice Research Institute. 245 p.

Heong KL, Schoenly KG. 1998. Impact of insecticides on pest and natural enemy communities in tropical rice ecosystems. In: Haskell PJ, McEwen P, editors. Ecotoxicology: pesticides and beneficial organisms. London (UK): Chapman and Hall. p 381-403.

Heong KL, Escalada MM, Sengsoulivong V, Schiller J. 2002. Insect management beliefs and practices of rice farmers in Laos. Agric. Ecosyst. Environ. 92:137-145.

Jungbluth F. 1996. Crop protection policy in Thailand: economic and political factors influencing pesticide use. Publication Service Number 5. Pesticide Policy Project, Hannover, Germany. 75 p.

Kleindorfer PR, Kunreuther HC, Shoemaker PJH. 1993. Decision sciences: an integrative perspective. Cambridge (UK): Cambridge University Press. 480 p.

Matteson PC. 2000. Insect management in tropical Asian irrigated rice. Annu. Rev. Entomol. 45:549-574.

Norton GA, Holt J, Heong KL, Cheng JA, Wareing DR. 1991. Systems analysis and rice pest management. In: Heinrichs EA, Miller EA, editors. Rice insects: management strategies. New York City, N.Y. (USA): Springer. p 287-322.
Nunnaly J. 1978. Psychometric theory. New York City, N.Y. (USA): McGraw Hill.
Oudejans JHM. 1999. Studies on IPM policy in SE Asia: two centuries of plant protection in Indonesia, Malaysia and Thailand. Leiden (Netherlands): Backhuys Publishers. 316 p.
Rola AC, Pingali PL. 1993. Pesticides, rice productivity and farmers' health: an economic assessment. Los Baños (Philippines): International Rice Research Institute. 100 p.
Santos JR. 1999. Cronbach's alpha: a tool for assessing the reliability of scales. J. Extension 37. www.joe.org/joe/1999april/tt3.html.
Schiller JM, Linquist B, Douangsila K, Inthapanya P, Douang Boupha B, Inthavong S, Sengxua P. 2001. Constraints to rice production systems in Laos. In: Fukai S, Basnayake J, editors. Increased lowland rice production in the Mekong Region. Proceedings of an International Workshop, Vientiane, Laos, 30 Oct.-2 Nov. 2000. ACIAR Proceedings No. 101. p 3-19.
Simon HA. 1978. Rationality as process and as product of thought. Am. Econ. Rev.: Papers and Proceedings 68:1-16.
Singhal A, Rogers E.M. 1999. Entertainment-education: a communication strategy for social change. Mahwah, N.J. (USA): Lawrence Erlbaum Associates. 265 p.
Slovic P, Fishhoff B, Lichtenstein S. 1977. Behavioral decision theory. Annu. Rev. Psychol. 28:1-39.
SPSS (Statistical Package for Social Sciences). 2002. SPSS Graduate Pack 11.5 for Windows. Chicago, Ill. (USA): SPSS.
Tjornhom JD, Norton GW, Heong KL, Talekar NS, Gapud V.P. 1997. Determinants of pesticide misuse in Philippine onion production. Philipp. Entomol. 11:139-149.
Van Den Berg H, Soehardi. 2000. The influence of the rice bug, *Leptocorisa oratorious*, on rice yield. J. Appl. Ecol. 37:959-970.
Way MJ, Heong KL. 1994. The role of biodiversity in the dynamics and management of insect pests of tropical irrigated rice: a review. Bull. Entomol. Res. 84:567-587.
Widawsky D, Rozelle S, Jin S, Huang J. 1998. Pesticide productivity, host-plant resistance and productivity in China. Agric. Econ. 19:203-217.
Wilson C, Tisdell C. 2001. Why farmers continue to use pesticides despite environmental, health and sustainability costs. Ecol. Econ. 39:449-462.

Notes

Authors' addresses: M.M. Escalada, Leyte State University, Baybay, Philippines; K.L. Heong, International Rice Research Institute, DAPO Box 7777, Metro Manila, Philippines; V. Sengsoulivong, Ministry of Agriculture and Forestry, Vientiane, Lao PDR; J.M. Schiller, School of Land and Food Sciences, University of Queensland, St. Lucia, 4072, Australia.
Acknowledgments: We thank the Swiss Agency for Development and Cooperation (SDC) for supporting the research through the Rice IPM Network coordinated by the International Rice Research Institute. We thank Khamouane Khamphoukeo within the National Agriculture and Forestry Research Institute of Laos for facilitating the research.