ELSEVIER

PII: S0261-2194(98)00036-2

Crop Protection Vol. 17, No. 5, pp. 413–425, 1998

Printed in Great Britain
0261-2194/98 $19.00+0.00

Use of communication media in changing rice farmers' pest management in the Mekong Delta, Vietnam

K. L. Heong*†, M. M. Escalada‡, N. H. Huan§ and V. Mai§

†*International Rice Research Institute, P.O. Box 933, Manila, Philippines*

‡*Visayas State College of Agriculture, Baybay Leyte Philippines*

§*Plant Protection Department, Ministry of Agriculture and Rural Development, Ho Chi Minh City, Vietnam*

Many rice farmers decide to spray insecticides based on their perception of potential damage and losses caused by pest species. Farmers generally overestimate the seriousness of the rice leaf folder from visible damage and apply insecticides early, and therefore, changing perceptions may help reduce the perceived benefits of unnecessary spraying. Farmers in Long An province, Vietnam, were motivated to 'test' a heuristic or rule of thumb, 'insecticide spraying for leaf folder control in the first 40 days after sowing is not needed', by the distribution of carefully designed communication media materials. The media reached 97% of the farmers in the study sites. Leaflets, radio drama and posters had the most effective reach. Thirty-one months after the media introduction, the number of insecticide sprays dropped significantly from 3.35 sprays per farmer per season to 1.56. The proportion of farmers spraying at early and late tillering and booting stages was reduced from 59%, 84% and 85% to 0.2%, 19% and 30%, respectively. Those who did not use any insecticides increased from 1% to 32%. Correspondingly, farmers' perceptions of leaf folder damage as indicated in a belief index, decreased significantly from 11.25 to 7.62. The proportion of farmers who believed that leaf folders could cause losses was reduced from 70% to 25%, as did those who believed that early season spraying was required, from 77% to 23%, respectively. Farmers' insecticide spray frequencies and the belief index were significantly correlated and were not significantly different between farmers who had attended farmer field school training and those who had not. The cost (insecticide and labour) saving was the most important incentive for farmers to stop early season spraying as cited by 89% of the farmers. A survey of 12 other districts in Long An showed that 82% of the province's 210000 households were reached. About 20% had not applied any insecticides, 77% had stopped early season spraying and the average number of insecticide sprays was 1.6 (compared with 1.55 in study sites). The approach was readily adopted by extension in 15 provinces that launched their own programmes, extending to the whole Mekong Delta of 2 million farmer households.

Keywords: diffusion; rice leaf folders (*Cnaphalocrocis medinalis*); decision making; media campaign; insecticide use; pest management

Introduction

Pesticides have dominated pest management practices of rice farmers for the past 30 years. The agrochemical era of the 1960s and 1970s that had strongly influenced chemical oriented agricultural research and extension in the United States (Rossiter, 1975) is still having a dominant effect in many developing countries. Most Asian rice farmers have adopted pesticides as their main pest control tactic (Heong and Escalada, 1997b) using insecticides more frequently than herbicides and fungicides in most countries. In many cases, these insecticide applications are unnecessary and are unlikely to result in an economic return. In the Philippines, for example, about 80% of insecticide sprays were misused because they were applied at the wrong time and on the wrong targets (Heong *et al.*, 1995a). Farmers targeted most insecticides at leaf-feeding insects in the early growth stages (Heong *et al.*, 1994; Mai *et al.*, 1997). The most common species is the rice leaf folder (*Cnaphalocrocis medinalis* Guenee), which causes highly visible damage symptoms. Farmers generally perceive that the damage due to these pests (often referred to as 'worms') reduces yield so they

*Corresponding author. E-mail: kheong@cgnet.com

apply insecticides (often referred to as 'medicine'). The less expensive and highly toxic chemicals, such as methyl parathion, monocrotophos and methamidophos, are frequently used.

However, research has shown that the common leaf-feeding insects, such the leaf folder, whorl maggot (*Hydriella philippinensis*) and army worms (like *Spodoptera litura*) that often attack the rice crop during the vegetative stages are rarely in sufficiently high densities to reduce yield. Even when all hills were damaged by whorl maggots, no yield loss could be detected (Viajante and Heinrichs, 1986; Shepard *et al.*, 1990). For leaf folders, a larva could consume about 25 cm^2 or less than 40% of a normal leaf of *indica* rice (Heong, 1990). Incorporating this feeding rate, the rice model, MACROS, predicted that yield would decrease when the larval density reached 15 per hill (Fabellar *et al.*, 1994), but normal larval densities are usually well below three per hill (Gou, 1990; de Kraker, 1996), mainly because of natural biological control. Thus, in most cases, insecticides applied into rice fields during the early crop stages to control leaf folders are unlikely to benefit farmers economically. Instead, they can cause ecological disruptions to the herbivore–predator relationships by shortening the mean food web chain length, favouring an increase in the population of some herbivorous species, e.g. delphacids, and causing secondary brown plant hopper pest problems (Way and Heong, 1994; Heong and Schoenly, 1998).

Farmers' insecticide use decisions do not seem to be based on economic rationale (Lim and Heong, 1984; Waibel, 1986; Rola and Pingali, 1993; Heong and Escalada, 1997a). These decisions, often made under uncertainty, are influenced more by perceptions of the pest and benefits from spraying. When decisions are made under uncertainty, people often use decision rules (Einhorn and Hogarth, 1981; Eiser, 1986; Payne *et al.*, 1992). The term, heuristic, was introduced by Kahneman and Tversky (1973) to refer to an informal rule-of-thumb used by people in order to simplify information processing and decision making. Heuristics are developed through experience and guesswork about possible outcomes and may have inherent faults and biases (Tversky and Kahnemann, 1974; Slovic *et al.*, 1977). Farmers' reaction to damage by leaf feeding insects by spraying insecticides may well be due to faults in their beliefs or the heuristics that they use (Bentley, 1989). Heong and Escalada (1997a) applied the cognitive dissonance theory (Festinger, 1957) to motivate farmers to evaluate whether information expressed as a heuristic: 'Insecticide applications in the first 30 days after transplanting (or 40 days after sowing) for leaf folder control is not necessary'. After the experiments most farmers changed their perceptions. Similar farmer participatory evaluations conducted in the Mekong Delta had the same effects on farmer perceptions and practices (Heong *et al.*, 1995b).

It has been common practice for farmers to spray the early crop stages (Heong *et al.*, 1994; Mai *et al.*, 1997) to control leaf folders and other defoliators. Using a 15-week season-long training programme, the farmer field schools (FFS) in Indonesia significantly reduced the use of insecticides by trained farmers (Useem *et al.*, 1992; Matteson *et al.*, 1994; Rombach and Gallagher, 1994). Since its introduction in 1989, perhaps 2 million of Asia's more than 200 million rice farmers have attended FFS and presumably have acquired sufficient decision-making skills to apply insecticides rationally. The task and related costs and time necessary to reach the remaining 99% of Asia's rice farmers are thus enormous.

Extension media to communicate pest management messages has been successfully implemented in Asia (Escalada and Kenmore, 1988; Pfuhl, 1988; Adhikarya, 1994; Ho, 1996). Traditional media, such as folk songs, drama and puppet shows can also be effective (Van de Fliert and Matteson, 1990; Stone, 1992). The rat control campaign in Malaysia increased farmers' adoption of chronic poison baits from 61 to 98% and physical control methods from 31 to 60% (Matteson *et al.*, 1994). In the weed management campaign in Malaysia, farmers' herbicide use, although initially increasing (Matteson *et al.*, 1994), resulted in a 50% reduction 4 years after the campaign was launched (Adhikarya, 1994; Ho, 1996), a phenomenon known as the 'sleeper effect' (Schramm, 1973). Such marketing strategies have also been successfully used in improving health care practices, accelerating adoption of family planning and reducing cigarette smoking and in changing attitudes towards drug abuse (Rice and Paisley, 1981; Manoff, 1985; Kotler and Roberto, 1989).

As the mass media have been proven to be the most rapid and efficient means for diffusion of innovation (Rogers, 1995), rice farmers' beliefs, attitudes and practices in spraying against leaf feeding insects presented an opportunity for us to evaluate the use of communication media to motivate farmers. The innovation was presented as a conflict information, and farmers were motivated to evaluate it. In this paper, we report the effects of a media campaign on farmers' perceptions and practices related to pest management in general and leaf folder control in particular.

Methods

Study sites

The study sites were two districts in the province of Long An situated in the Mekong Delta in the southern part of Vietnam. Tan Tru district covers a total of 10200 km^2, whereas the Tan Thanh district covers 42600 km^2. Agriculture is the main economic activity in these two districts, with rice as the principal crop. In addition, watermelon, ground nuts, vegetable and other cash crops are cultivated. Most farmers grow two rice crops a year, whereas some grow three. The two study sites produce a total of 244000 tons of rice per annum, about 20% of the province's production of 1.2 million tons. The total number of farmer households in Tan Tru is about 11000 and in Tan Thanh, about 10000, accounting for 10% of the province's farmer population of 210000 (Cuc, 1995).

Planning workshop

A workshop with participants from research, extension and agricultural communications was conducted in Vietnam to develop media materials that will motivate farmers to evaluate the heuristic: 'Spraying insecticides for leaf folder control in the first 40 days after sowing is not needed'. In the 3-day workshop, several versions of a leaflet, a poster and a radio drama, were developed [see Rapusas *et al.* (1994) for a full report]. These materials were designed to provide both the information (What is the innovation?) and the innovation-evaluation information (What are the consequences of the innovation?). They were pre-tested in the sites with groups of farmers, and from the feedback, final versions of the three media were mass produced. A distribution plan was developed by the campaign management committee, headed by the Vice Chairperson of the Peoples' Committee of the province of Long An, and on 8 September 1994, the campaign was launched by the Vice Minister of Agriculture in a ceremony where a few selected farmers who had carried out the evaluation [see Heong *et al.* (1995b)] presented their findings.

Material distribution

A total of 21000 leaflets were distributed to all households in the two districts through the district Plant Protection offices. Four thousand posters were posted in village billboards, coffee shops, supply shops, government offices and markets. On the leaflets and posters, a message to encourage farmers to contact the Plant Protection Department to learn more about IPM concepts was also included. The drama entitled 'Well, I shall try', depicted a conversation between a farmer who had conducted the evaluation encouraging another farmer to try it (script in Appendix A). Three local actors were employed to produce the drama, recorded in 40 cassette tapes that were distributed to radio stations for broadcasting twice a week during the crop season (September 1994 to January 1995) and to coffee shops to be played over their audio systems. In addition, the Long An provincial government built nine billboards measuring 3×2 m that were placed along the main roads and market places. Vehicles with public address systems and posters were also used. Distribution of the materials was monitored through a management monitoring survey conducted in November 1994.

Data collection

The research design used was the pre-test–post-test design (Campbell and Stanley, 1973; Neuman, 1991), which involved a pre-test, the intervention, a monitoring survey and three post-tests. We used quantitative research methods for data gathering and qualitative methods to complement the data, in all surveys. The qualitative methods that we used included non-structured conversations with farmers that provided opportunities for probing into individual farmers' responses, focus group interviews to obtain group consensus in responses and participatory observations. In addition, supplementary data on pesticide sales, prices and farmer training activities over the research period were obtained from the provincial agricultural office.

Five evaluation surveys were used, the pre-test, the management monitoring survey, the post-test in February 1996, 18 months after introduction, the post-test in March 1997, 31 months after introduction and the post-test of farmers in the other 12 districts in Long An province conducted in September 1996. The variables and questions used in each survey were determined by conducting a conversational analysis in an exploratory field research carried out by the authors. Each questionnaire was then developed, translated into Vietnamese and pre-tested with 20–30 respondents. Ambiguous questions were modified to ensure clarity and further pre-tested, if necessary. In order to capture farmers' direct responses, we used open-ended questions wherever possible. The surveys were administered by students from the local agricultural institute. The provincial agricultural technicians supervised the operations but had no input in administering the questionnaires. For each survey, a training course, which included a practice session, for all involved in the survey was conducted by the authors to ensure quality and consistency. The student interviewers were trained to record the exact words farmers used in response to each question. We supervised each survey, and the field data obtained were immediately coded and entered into the computer using a spreadsheet program. Whenever errors in data entry were encountered, they were referred back for clarification. We also conducted quality assurance checks when the surveys were being conducted. Each survey was administered within a week.

The pre-test survey, conducted in August 1994, collected data on farmer profiles, pest management knowledge, perceptions, attitudes and practice from a sample of 633 randomly selected respondents in the two districts. Details of the survey are reported in Mai *et al.* (1997). A management monitoring survey was conducted in November 1994 with a sample of 2226 randomly selected farmers, to monitor the distribution and reach of the media materials. The first post-test survey was conducted in February 1996 with a sample of 452 randomly selected farmers. In this survey, besides monitoring the same variables as in the pre-test survey, we added seven perception questions. In March 1997, we conducted the second post-test survey using the same instrument with a sample of 628 randomly selected farmers. To monitor diffusion of the innovation to other districts in the province, a survey of 1449 randomly selected farmers from the other 12 districts in Long An province was conducted in September 1996.

Analytical methods

The field data were coded and entered into a spreadsheet program. Frequency distributions and cross-tabulations were generated by using Statistical Analysis Systems (SAS, 1985) and SPSS for Windows 7.5 (SPSS, 1997). Means were compared using *t*-test procedures, and both parametric and non-parametric

statistics were used for correlation and testing of variables.

Belief index

Farmers' beliefs were measured through the use of five statements to which respondents were asked to state whether they agreed, disagreed with them or were indifferent. A three-point Likert scale (1 for the preferred answer, 2 for indifference and 3 for the not preferred) was used to score responses. The three statements used to assess the components of belief about leaf folders were; 'Leaf folders in the first 40 days after sowing (DAS) can cause severe damages to the crop'; 'Leaf folders in the first 40 DAS will cause yield loss' and 'Spraying in the first 40 DAS to control leaf folders is necessary'. Two other statements were related to general insecticide use: 'Applying insecticides will increase yields' and 'Killing natural enemies by insecticide spraying will not cause more pest problems'. The belief index for each respondent was computed by summing across the scale ratings and statistically compared. The questions were framed in such a way that the bipolar points of the index would be 5 and 15 (5 means that all the statements were the preferred answers, and 15 means that all the statements were not preferred).

In the three follow-up post-tests, an additional seven belief statements were used (*Table 5*), and farmers were asked to respond whether they disagreed, were indifferent or agreed with the statements.

Results

Profiles of rice farmer respondents

Profiles of farmer respondents in the pre-test, the three post-test surveys in the study sites, Tan Tru and Tan Thanh and the post-test in the remaining 12 districts are summarized in *Table 1*. Most farmers interviewed were between ages of 31 and 50 with an education of between 1 and 9 years. Only a small proportion (<8%) had not attended school. Farm sizes were generally less than 1 ha, and the yields reported varied between 3 and 5 tons ha^{-1}.

Farmer access to communication media

From the pre-test survey, about 66% of the farmers interviewed said that they owned a radio. Farmers in the two districts generally listened to two radio stations, Radio Ho Chi Minh (49%) and the Long An provincial station (46%). These two stations were used to broadcast the mini drama. The preferred times for broadcasts were 5.00–8.00 a.m. (40%), 6.00–8.00 p.m. (29%) and 12.00–2.00 p.m. (16%). Farmers said that they preferred programmes with farming information (46%), news (17%) and drama (16%). Among the printed materials farmers frequently read were newspapers (47%), leaflets (37%) and magazines (8%). About 44% of the respondents owned a television and the most common stations that they had access to were TV Ho Chi Minh and TV Can Tho.

Table 1. Profiles of the randomly selected farmer respondents in the surveys in Long An

	In project sites, Tan Tru and Tan Thanh (%)			
	pre-test	post-tests		
	August 1994 $n = 633$	February 1996 $n = 452$	March 1997 $n = 628$	In 12 districts $n = 1449$
Age group (years)				
<31	14.8	16.5	17.4	12.7
31–40	35.1	27.3	33.7	32.2
41–50	19.8	25.1	24.1	28.6
51–60	15.1	16.9	13.3	17.0
61–70	12.1	11.3	7.7	8.4
> 70	3.2	3.2	3.8	1.1
Education (number of years in school)				
Did not attend school	5.9	5.3	7.7	6.3
1–5	54.7	45.3	45.9	31.3
6–9	25.8	31.8	38.6	40.0
10–12	13.3	17.6	12.8	22.3
> 12	0.3	0	0	0.1
Farm sizes (ha)				
<0.5	31.8	25.6	24.8	32.7
0.6–1	30.0	31.8	29.5	30.5
1.1–2	25.9	24.2	23.9	19.3
2.1–3	8.4	10.0	12.0	7.5
3.1–4	1.4	4.4	4.5	3.5
> 4	2.5	4.0	5.3	6.5
Yields (t ha^{-1}) reported				
<2	15.5	6.7	5.9	4.6
2.1–3	26.7	11.1	17.7	9.7
3.1–4	34.7	25.8	33.5	21.1
4.1–5	18.2	28.0	26.4	29.2
> 5	4.7	28.5	16.5	35.5

Delivery and reach of media materials

In the management monitoring survey conducted 2 months after the materials were distributed, 97% of the farmers interviewed were aware of the campaign. The most commonly cited source farmers heard from was the leaflet (89%), followed by the radio drama (72%), poster (69%), the demonstration plots (43%), friends (34%) and the billboards (34%). Most of the leaflets were delivered to the households (96%). The radio drama was heard over radio Ho Chi Minh (76%) and provincial radio (22%), whereas the posters that were displayed in buildings along the road were most frequently observed (60%), followed by those in the coffee shops (16%), market (5%), schools (4%) and friends' houses (3%).

What farmers learnt from the media materials

In the post-test, we used an open-ended question to assess what farmers learnt from the three media materials. Farmers learnt that there was no need for insecticide spraying against the leaf folder in the first 40 DAS (69%), that avoiding the use of insecticide during this period saves money and labour (30%), that spraying early in the season is detrimental to natural enemies (20%), that how to conduct an experiment (14%), that leaf folder damage during the early growth stages do not reduce yields as crops recover (11%), that insecticide spraying can be detrimental to one's health (13%) and that insecticides pollutes environment (6%). When they obtained the

information from the media, about 56% of the farmers said that they conducted the experiment, 15% said that they stopped spraying for leaf folders in the first 40 DAS, and 15% said that they did not do anything about it. The main reasons provided for not responding were that they were worried about pest attacks when they did not spray (34%), afraid of yield loss (19%), did not believe in the message content (11%), had no time to experiment (8%) and about 6% did not understand the information.

Changes in farmers' insecticide use patterns

Changes in farmers' insecticide use over the 31-month period are shown in *Table 2* and *Figure 1*. The mean number of sprays that farmers applied declined from 3.35 per farmer to 1.56 18 months after distribution. There was a slight increase to 1.76, although not significant, a year later. The mean number of insecticide sprays of farmers in the 12 districts outside the study sites in 1996 was 1.58, which was not significantly different from the study sites. The proportion of farmers who did not use any insecticides increased from 1% in pre-test to 20% in the first post-test and to 32% in the second post-test. In the 12 districts, 20% of the farmers interviewed did not apply any insecticides. The insecticide spray frequency distributions significantly shifted to the left with more farmers applying only once or twice after the introduction of the media materials (*Figure 1*). The proportion of farmers spraying during the early tillering, late tillering and booting stages declined significantly (Friedman test chi-square = 7.6, $P<0.05$) (*Figure 2*). In the pre-test, 59% and 84% of the farmers sprayed during the early and late tillering stages, respectively. In the first post-test, the proportion of farmers spraying in the early and late tillering stages dropped to 28% and 42%, respectively, and in the second post-test, these proportions further declined to 0.2% and 19%, respectively. In the 12 districts, 13% of the farmers sprayed during the early and 24% in the late tillering stages. The proportion of farmers spraying in the reproductive and maturing stages initially declined in the first post-test but increased in the second post-test, but were still lower than that in the pre-test.

Table 2. Changes in farmers' insecticide use

	In study sites, Tan Tru and Tan Thanh			
	pre-test	post-tests		
	August 1994	February 1996	March 1997	In 12 districts
Number of farmers interviewed	633	452	628	1449
Total number of insecticide sprays applied	2123	700	1103	2286
Mean number per farmer	3.35	1.56	1.76	1.58
SD	1.75	1.20	1.35	1.26
Range	0–11	0–8	0–9	0–10
Percentage of farmers not using insecticides	1.1	20.2	31.7	20.4

Although the number of insecticide sprays was reduced over the period, farmers' spray targets had not significantly changed (Friedman test chi-square = 0.33, $P > 0.05$). The rice leaf folder and other leaf-feeding insects remained the main targets, accounting for 44%, 52% and 53% of farmers' applications in the 1994 pre-test, 1996 post-test and 1997 post-test, respectively (*Table 3*). Farmers' targets in the 12 districts were also the same, with 40% of the sprays used for rice leaf folder control. The types of insecticides and farmers' belief that insecticides can

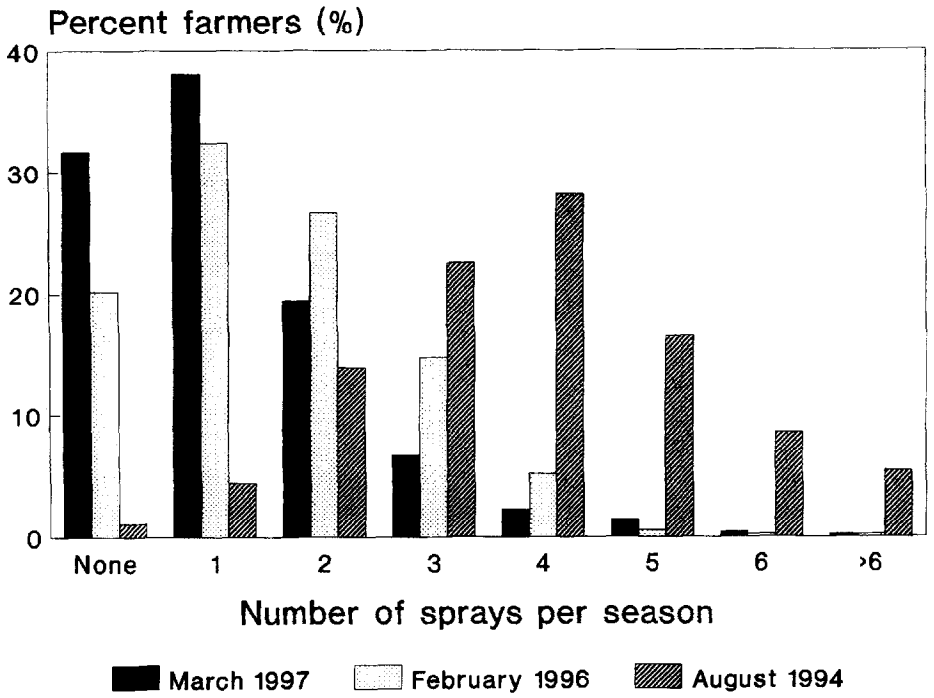

Figure 1. Changes in rice farmers' insecticide spray frequencies in Tan Tru and Tan Thanh districts, Long An province, in August 1994 just before the introduction, 18 months after in February 1996 and 31 months after in March 1997.

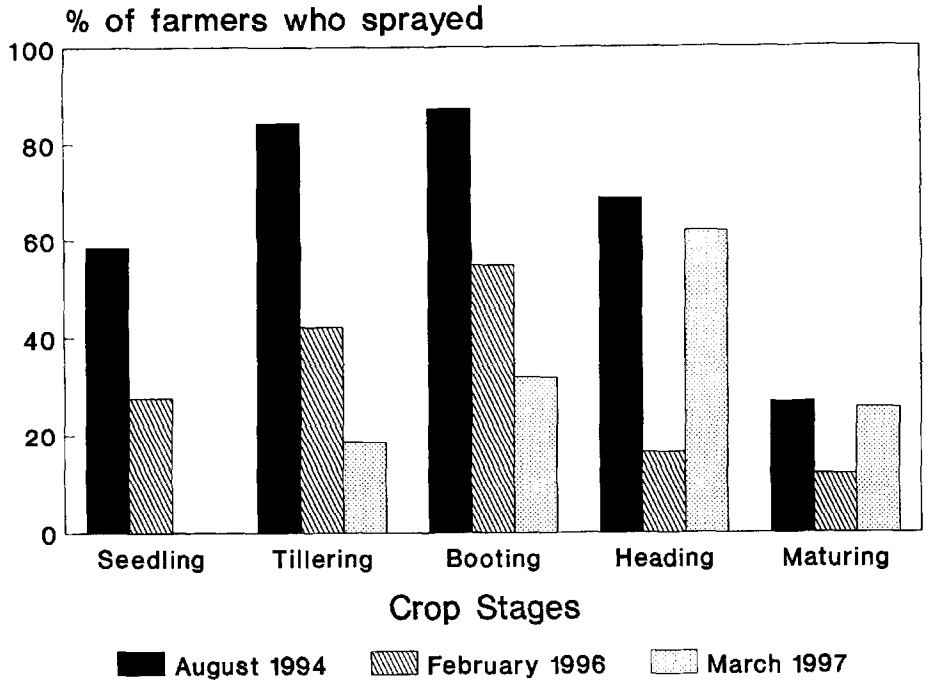

Figure 2. Rice farmers' insecticide applications in different crop stages in Tan Tru and Tan Thanh districts, Long An province, in August 1994 just before the introduction of the media materials, 18 months after in February 1996 and 31 months after in March 1997.

be harmful to health (*Table 5*) have also remained relatively unchanged. Methamidophos, monocrotophos and methyl parathion [all WHO category I pesticides (CIRAD, 1991)] accounted for 48% of the sprays in the 1994 pre-test and 1996 post-test (*Table 4*). In the 12 districts outside the study sites, these three WHO category I insecticides constituted 33% of the sprays used.

Changes in farmers' beliefs

The belief index reduced significantly from 11.25 (±0.18 at 95% CL) in the 1994 pre-test to 8.22 (±0.27 at 95% CL) in the 1996 post-test and 7.62 (±0.24 at 95% CL) in the 1997 post-test. The higher belief index in the pre-test meant that more farmers had non-preferred beliefs. In the 12 districts, the belief index was found to be 8.11 (±0.85 at 95% CL). *Table 5* shows changes in farmers' beliefs in the three statements related to the rice leaf folder problem to the two statements relating to insecticide use. Except for the statement 'Applying insecticides will increase yields', farmer responses to the four other statements were significantly changed. In the 12 districts, similar farmer responses were obtained (*Table 5*), implying that although the campaign was launched in the study sites, it had significantly influenced farmers in other districts quite distant from the sites. In the 1997 post-test, responses to the seven additional belief statements were significantly different from that of the 1996 post-test, implying that farmers had developed stronger beliefs that spraying insecticides in the first

Table 3. The main pest targets of farmers' insecticide sprays

	Percentage of sprays			
	In study sites, Tan Tru and Tan Thanh			
	pre-test	post-tests		
Targets	August 1994	February 1996	March 1997	In 12 districts
Rice leaf folders	33.4	37.0	43.8	39.5
Other leaf feeding insects	10.2	14.7	9.0	12.1
Stem borers	10.1	25.9	8.0	22.4
Thrips	14.0	6.1	8.5	5.5
Brown plant hoppers	28.0	7.6	12.4	11.5
Others	4.3	8.7	8.3	9.0

Table 4. Main insecticides (in percentage of sprays) of rice farmers in Long An Province

	WHO classification	In study sites, Tan Tru and Tan Thanh			
		pre-test	post-tests		
		August 1994	February 1996	March 1997	In 12 districts
Organophosphates					
Monocrotophos	Ib	6.8	9.7	6.1	4.2
Diazinon	II	1.6	5.6	1.1	9.2
Methyl parathion	Ia	12.1	7.2	3.4	3.4
Methamidophos	Ib	28.9	31.1	31.4	25.0
Organochlorines					
Lindane	II	0.0	0.3	0.2	0.5
Endosulfan	II	4.0	0.5	0.1	2.5
Carbamates					
BPMC (fenocarb)	II	16.5	9.5	9.6	10.1
MIPC (isoprocarb)	II	2.7	0.0	1.6	0.0
Carbofuran	Ib	0.1	0.2	1.1	0.4
Pyrethroids					
Cypermethrin	II	0.1	1.8	7.8	5.7
Deltamethrin	II	5.7	6.1	8.8	2.8
Lambda cyhalothrin	—	2.9	9.0	8.7	9.8
Others					
Cartap	—	0.0	10.0	7.4	10.7
Buprofezin	V	7.8	2.6	5.1	2.5

40 DAS was unnecessary and a waste of money, affected health and contaminated the environment (*Table 5*). Similarly, in the 12 districts outside the study sites, the farmers' responses to these statements were also significantly changed.

Benefits from not spraying in the early season

In the post-tests, farmers were asked an open-ended question as to the benefits for not spraying insecticides in the first 40 DAS. Savings in costs (insecticide and labour) were cited by 89% of the farmers, followed by reducing health risks (25%), less pollution to the environment (17%) and protection of natural predators (12%). These benefits were displayed in the poster placed in various public places. Most of the farmers (97%) said that they will continue not using insecticides in the first 40 DAS in the next season.

Relationship between belief index and insecticide use

Farmers' insecticide use frequencies were highly correlated with the belief index values in all three surveys, pre-test (Pearson 0.109, $p<0.05$), post-test 1996 (Pearson, 0.414, $p<0.01$) and post-test 1997 (Pearson, 0.285, $p<0.01$). These positive relationships imply that individual farmers with high belief indices had a higher tendency to spray insecticides (*Table 6*). Similarly, the correlation in the post-test of the 12 districts in Long An province was also significant (Pearson, 0.36, $p<0.01$).

Farmer-to-farmer spread and multiplier effects

In the 1996 post-test, about 77% of the farmers who were aware of the media materials ($n = 400$) said that they discussed the message content with members of his or her household, and 67% discussed it with other farmers. Persons with whom the information was discussed included the spouses (57%), the sons and daughters (31%), children (19%), siblings (12%) and other relations (16%). Some farmers recalled communicating the information from the media to more than 10 persons (33%), whereas most said that they had spoken to five or less persons (44%). The most common situations where the information was discussed were in the field (36%), in the coffee shops (24%), and at dinner parties (24%).

The media approach in the project sites in Long An province stimulated other provincial governments in the Mekong Delta to launch their own programmes using the approach. Between September 1994 and March 1997, 15 provincial governments initiated their own programmes, spending about US$ 151000, distributed 340000 leaflets, 35000 posters, organized 1390 demonstration plots and broadcast the radio drama about 1550 times. In addition, a total of 356600 farmers were invited to participate in testing whether early season spraying for leaf folder control was necessary.

In 1996, a post-test survey of 1499 farmers in the 12 districts of Long An province, besides the study sites, was conducted by the Provincial Plant Protection Department to evaluate the spread effect. About 82% of the 1449 farmers interviewed said that they had heard about the heuristic, and 64% said that they had tried it. Of those who tried, 77% said they had stopped spraying in the first 40 DAS. The spray frequency (*Figure 3*) showed that about 20% of the farmers had not applied any insecticides, and most farmers (59%) applied one or two sprays each season (average 1.6). About 37% of the farmers applied their first sprays in the first 4 weeks, 50% in the second 4 weeks and the remaining 13% after the 9th week. Using farmers' responses to the same five belief statements as in the pre-test and the two post-tests, the belief index of farmers in the 12 districts was found to be 8.11 (± 0.08 at 95% CL), which was significantly lower than that of the pre-test but not significantly different from the 1996 post-test in the study sites. It is evident that the communication

Table 5. Comparison of responses to belief statements by farmers of Tan Tru and Tan Thanh districts pre-test in 1994, post-tests in 1996 and 1997, and farmers of the other 12 districts in Long An province

	Percentage of farmers who agreed to the statements			
	pre-test	post-tests		
	1994	1996	1997	12 districts
Applying insecticides will increase yields	39.0	35.6	29.7[a]	32.0
Insecticides will harm natural enemies	—	87.3	82.1[b]	86.5[a]
Killing natural enemies can cause more pest problems	27.2[c]	52.9	68.3[a]	58.9[a]
Spraying insecticides can harm human health	—	96.7	97.5	97.2
Spraying insecticides contaminates the environment	—	63.5	78.0[a]	80.7[a]
Applying insecticides in the first 40 DAS is a waste	—	81.3	88.9[a]	79.5[a]
Applying insecticides in the first 40 DAS can cause more pests	—	70.9	74.9[b]	69.6[a]
Leaf folders in the first 40 DAS can cause severe damage	66.1[c]	27.2	24.0	25.7[a]
Leaf foders in the first 40 DAS will cause yield loss	69.8[c]	26.2	24.8	26.1[b]
Spraying in the first 40 DAS for leaf folder control is necessary	—	31.0	24.8[b]	27.0[a]
Spraying insecticides for leaf folders has to be done in early season	77.2[c]	21.6	23.2	25.3
Rice crops can recover from early-season leaf damages by pests	—	86.9	92.2[b]	83.2[a]

Critical values of chi-square tests at d.f. = 2, $P = 0.05$, 5.99 and $P = 0.01$, 9.21.
[a],[b]Significant differences at $P = 0.01$ and $P = 0.05$ probability levels, respectively, from post-test 1996.
[c],Significant differences at $P = 0.01$ probability levels, respectively, between pre-test (1994) and post-test (1996).

media introduced into the two study districts have influenced farmers' pest management beliefs and practices in the whole of Long An.

Farmer field schools

During the study period, a training programme using the FFS approach (Useem *et al.*, 1992; Matteson *et al.*, 1994) was implemented in the province. *Table 7* shows the number of farmers who were trained by FFS. At the end of 1994, the FFS reached 467 farmers or 2.2% of the households in study sites, whereas the media reached 97% of the population. By the end of 1996, the number of farmers trained in Long An was 7451, accounting for 3.5% of the total farmer households in Long An province. The 1996 post-test survey of 12 districts in Long An province showed that the media reached 82% of the farmer households. The number of farmers trained in the study sites was 1827 or 8.7%. In the 1996 post-test, there were 112 farmers in our sample who had been to the FFS. We regrouped the data and compared the responses of FFS trained farmers and those who had not attended the training. *Table 8* shows details of the comparison of some of the attributes. FFS trained farmers sprayed less but not significantly lower than untrained farmers, and there were more FFS trained farmers who did not spray any insecticides. The belief index of FFS trained farmers was also lower, although not significantly different, and the proportion of farmers who applied their first insecticide sprays in the first 4 weeks after sowing was also lower. There was, however, little difference in spray targets as the proportions of sprays for the control of leaf feeding insects was similar. The types of insecticides used also did not differ.

Table 9 shows farmers' responses to the belief statements. In all cases, the responses of the FFS-trained farmers and the untrained farmers were not significantly different. For instance, fewer FFS trained farmers believed that insecticides would increase yields (28.6% and 38.0%), leaf folders in the early crop stages could cause yield loss (21.4% and 27.8%), and spraying during the early crop season would be necessary (25.0% and 32.9%). This implied that the FFS training further reinforced farmers' beliefs that leaf folders were not important problems and that spraying was unnecessary.

Table 6. Regression analyses of farmers' insecticide spray frequency and belief index

	Constant B		Intercept			
Monitoring surveys	Value	95% CL	Value	95% CL	*F* value	*P*
pre-test 1994	0.075	±0.055	3.020	±0.625	7.376	0.007
post-test 1996	0.175	±0.036	0.116	±0.313	91.688	<0.001
post-test 1997	0.130	±0.034	0.797	±0.283	54.396	<0.001
In 12 districts	0.142	±0.019	0.434	±0.167	209.804	<0.001

Insecticide costs and sales in Long An province

The costs of the commonly used insecticides have not changed significantly over the study period (*Table 10*). The sales volume records of five retailers showed that the proportion of insecticide sales declined from 37% of total sales in 1994 to 21% in 1997.

Discussion

There are strengths and weaknesses in indigenous farmer knowledge as observed among Honduran farmers (Bentley, 1989), and farmers' beliefs in pests and their perceptions of the potential damage and

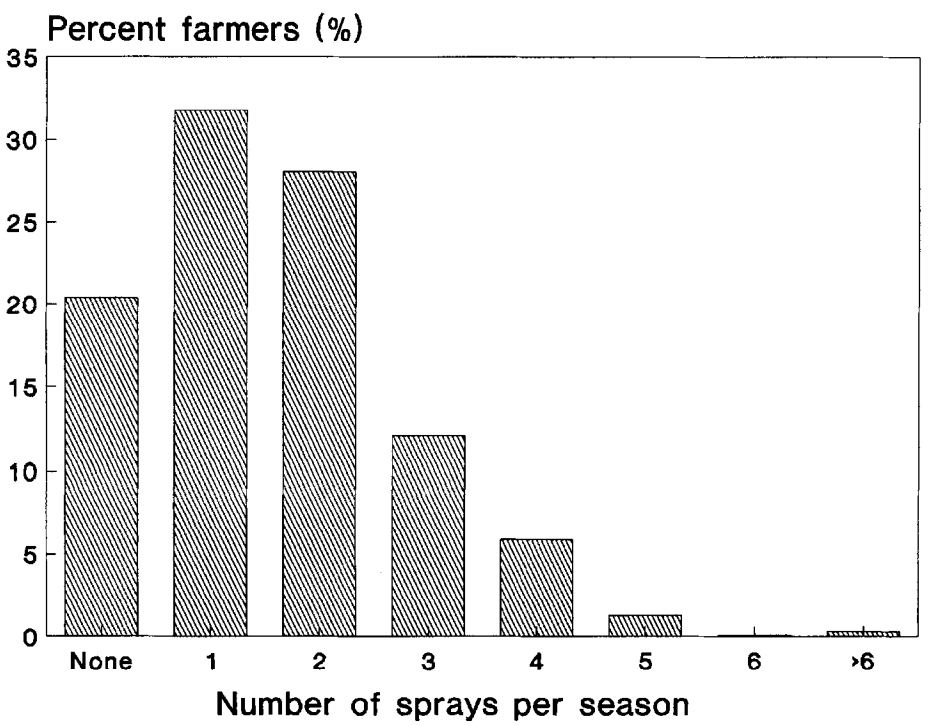

Figure 3. Insecticide spray frequencies of rice farmers in 12 districts in Long An province in September 1996. $n = 1449$.

Table 7. Number of farmers who had attended FFS during the period 1994–1996 in the study sites, Tan Tru and Tan Thanh and in the province of Long An

	1994	1995	1996	Total
Tan Tru	297	235	262	794
Tan Thanh	170	289	574	1033
Total in study sites	467	524	836	1827
Percentage of household population	2.2	2.5	4.0	8.7
Whole province of Long An	1909	2064	3478	7451
Percentage of household population	0.91	0.98	1.66	3.55

losses are examples of such weaknesses. Rice farmers in Asia generally overestimate losses due to highly visible pest damage, such as the rice leaf folder (Heong *et al.*, 1994) and stem borers (Lazaro *et al.*, 1993), In Honduras, Bentley (1989) found that farmers were worried about *Diabrotica* beetles, which are large and colourful but not important pests. In insecticide use, farmers' perceived benefits seem to be much higher than the actual benefits. Since perceptions, rather than the economic rational, determine the decisions of farmers, changing these perceptions may reduce the perceived benefits and intentions to spray. By using the conflict approach, farmers in the Philippines were motivated to stop their early season spraying (Heong and Escalada, 1997a). Using communication materials, farmers in the study sites were similarly motivated and reduced their insecticide sprays by 47%, from 3.35 to 1.76 sprays per season. This reduction seems to be attributed to the change in beliefs as indicated by the reduction in the belief index from 11.3 to 7.6. The direct relationships between number sprays and the belief index, further support this conclusion.

Farmers' insecticide spraying in the early crop stages had clearly reduced. Before the introduction of the communication materials, about 60%, 82% and 84% of the farmers applied insecticides during the early and late tillering and booting stages, respectively. Eighteen months after introduction, farmers' spraying during these stages had significantly reduced to 25%, 41% and 55%, respectively. Further reductions to 0%, 19% and 30% were observed 31 months after introduction. As the content of the communication campaign was to motivate farmers to reduce early season spraying, this reduction in early season spraying implied that the campaign had affected farmers' insecticide use. At the heading and maturing stages, there were initial reductions in farmers using insecticides, and spraying was increased although not significantly higher than in the pre-test. This increase was also reflected in the increase in mean number of sprays per season, from 1.55 to 1.76. In the 12 districts, the mean number of sprays was 1.58 at about 25 months after launching in Long An. Since these two surveys were done in different crop seasons, the general reduction in the number of insecticides in the whole province of Long An province reflected the effect of the media and not seasonal differences.

Although there appeared to be a substantial perception change in a large proportion of farmers, the rice leaf folders and other leaf feeding insects remained the targets of those farmers who were spraying. These sprays were used later, implying that

Table 8. A comparison of farmers who were trained through farmer field schools (FFS) and untrained farmers in the 1996 posttest survey in Tan Tru and Tan Thanh districts, Long An province

Attributes		FFS trained farmers $n = 112$	Untrained farmers $n = 338$
Number of insecticide sprays per farmer	Mean	1.43	1.60
	Mode	1	1
	SD	1.24	1.19
Percentage who did not spray insecticides		25.9	18.3
Belief index	Mean	7.99	8.29
	95% CL	7.49–8.49	7.98–8.61
Percentage of farmers' sprays targeted at:	rice leaf folders	27.3	39.3
	other leaf feeders	20.3	13.1
	stem borers	28.1	25.4
	brown plant hoppers	6.3	7.9
Percentage of farmers' sprays that were:	methamidophos	27.8	32.9
	methyl parathion	9.3	6.9
	monocrotophos	6.7	10.8
	deltamethrin	7.7	5.9
Percentage of farmers who applied first sprays in first 4 weeks		24.1	38.8

Table 9. Comparison of responses to belief statements by farmer field school (FFS) trained and untrained farmers in Tan Tru and Tan Thanh districts, Long An province

Belief statements	Percentage of farmers who agreed to the statements		
	FFS trained farmers	Untrained farmers	Chi-square
Applying insecticides will increase yields	28.6	38.0	5.33
Insecticides will harm natural enemies	89.2	87.0	0.38
Killing natural enemies can cause more pest problems	40.2	34.6	2.14
Spraying insecticides can harm human health	97.3	96.4	0.69
Spraying insecticides contaminates the environment	63.4	63.5	0.34
Applying insecticides in the first 40 DAS is a waste	85.7	79.9	2.15
69.6Applying insecticides in the first 40 DAS can cause more pests	69.6	71.3	0.49
Leaf folders in the first 40 DAS can cause severe damage	21.4	29.1	2.49
Leaf folders in the first 40 DAS will cause yield loss	21.4	27.8	1.79
Spraying in the first 40 DAS for leaf folder control is necessary	25.0	32.9	2.96
Spraying insecticides for leaf folders has to be done early in the season	17.1	23.1	5.95
Rice crops can recover from early season damage by pests	92.0	85.2	4.77

Critical values of chi-squared at d.f. = 2, $P = 0.05$, 5.99 and $P = 0.01$, 9.21.

Table 10. Prices of some common insecticides used by farmers between 1994 and 1997 in Long An province and mean percentage sales volumes of five retailers

	Application rates (g ai ha^{-1})	1994	1995	1996	1997
Monocrotophos (US$ per 500-cc bottle)	500	1.60	1.65	1.90	Banned
Methyl parathion (US$ per 500-cc bottle)	500	1.45	1.18	1.36	Banned
Methamidophos (US$ per 480-cc bottle)	500	2.20	2.30	2.30	2.30
Deltamethrin (US$ per 100-cc bottle)	12.5	1.20	1.28	1.30	1.30
Alpha cypermethrin (US$ per 100-cc bottle)	20	0.90	0.85	0.90	1.00
Lambda cyhalothrin (US$ per 250-cc bottle)	7.5	3.70	3.80	3.90	4.00
BPMC (US$ per 500-cc bottle)	500	1.00	1.14	1.36	1.45
Diazinon granules 10% (US$ per kg)	1000	0.77	0.84	0.93	1.02
Mean percentage of total sales in insecticides		36.6	30.6	24.2	21.4
SD		3.6	3.0	5.2	4.2

farmers were still worried about the leaf feeders, particularly leaf folders, that infest crops at the later crop stages.

While the communication materials were introduced, IPM training programmes through the FFS approach were also implemented in the study sites. In September 1994, when the media project started, there were 467 FFS trained farmers in the project sites. When the first post-test was conducted in February 1996, there were 991 FFS trained farmers, and in March 1977, the number increased to 1827. These accounted for 2.2%, 4.7% and 8.7% of the farmer households in the study sites at the time when the surveys were conducted. When we conducted post-tests in 1996 and 1997, most of the FFS trained farmers had been exposed to the media materials. The general reduction in insecticide use and farmers' perception change might be due to one or both of these interventions. In the study sites, the reduction in insecticide sprays, especially in the early crop stages, and the change in perception, were widespread, even among farmers who had not attended FFS. The relatively small proportion of farmers exposed to FFS ($<10\%$) may not be able to account for these changes over a large proportion of the farmers in the study area. Similar changes were also observed among farmers in other districts of Long An province, where only 3.5% of the farmer households had attended FFS.

We found that FFS trained farmers sprayed less insecticides and had lower belief index scores, although these were not significantly lower than those farmers who had not attended the FFS. In response to the belief statements, more FFS trained farmers had preferred responses than untrained farmers. As farmers in Long An were exposed to the media campaign before attending the FFS, the training further reinforced the perception change initiated by the media.

In the study sites, the media materials were distributed only for one season in 1994, and their effects on farmers' perceptions and practices were sustained for 31 months. Another 15 provincial governments adopted the same approach and extended the campaign to the whole of the Mekong Delta, with an estimated farm household population of about 2 million. It is evident that the new information had diffused to a large population and had reduced the uncertainty of farmers' attitudes toward not using insecticides. The media materials provided information aimed at reducing uncertainty, and this effect was evident from the significant reduction in the belief index. The information was aimed at reducing insecticide use in the early crop stages and a significant reduction in farmers' insecticide spraying during these crop stages was observed.

The adoption rate of an innovation depends on its characteristics (Rogers, 1995). In this case, the innovation has high relative advantages in terms of savings in chemical and labour costs. The innovation is also testable. The campaign emphasized this, and its benefits are also observable. Initially, the innovation was in conflict with farmers' perceptions. However, since it was presented together with an evaluation method and related information, it served as an important incentive to change perceptions (Heong and Escalada, 1997a). Such a change may be further reinforced and sustained by more frequent mass media and training programmes.

Since the approach was easy and inexpensive to adopt, it stimulated 15 provincial governments to establish their own programmes with provincial funds extending the campaign's reach to the entire Mekong Delta. The post-test survey of 12 districts carried out in September 1996 showed that a large proportion (82%) of the farmer households (about 2 million) had been reached, and many had ceased their insecticide spraying for leaf folder control in the early crop stages. In these provinces, the approach appears to be part of the agricultural technicians' routine tasks (or 'routinized'). It is evident that to enhance adoption, the innovation, besides being attractive to its potential adopters, will also need to be attractive to its potential implementers.

Mass media channels are relatively more important at the knowledge stage in the innovation-decision process (Rogers, 1995). They can reach a large audience rapidly, create knowledge and spread information, and these can lead to changes in some weakly held attitudes. Spraying insecticides at the early crop stages, though very common among farmers, may be a weakly held attitude. To change more strongly held attitudes, like insecticide spraying at other times of crop growth for high yields, might require interpersonal channels, like face-to-face exchange means. The information on the leaflets and posters encouraging farmers to contact the Plant Protection Department to learn more about pest management was primarily aimed at facilitating this process.

Discontinuance, a decision to reject an innovation after having previously adopted it (Rogers, 1995), among the adopters is a high possibility. This is especially so because negative messages about the

innovation will continue to circulate, through both the mass media and interpersonal networks. Although the results of this study seem to show that insecticide spraying during the early crop stages has been reduced, it is difficult to expect one campaign to sustain the adoption of the innovation. For this cessation of early season spraying to continue, there is a need to provide the same information frequently or similar information framed differently. In addition, there is a need to monitor changes and develop programmes to fully institutionalize and 'routinize' into ongoing practices and value systems of adopters.

Acknowledgements

The work was supported by the Rice IPM Network coordinated by IRRI and financed by the Swiss Agency for Development and Cooperation (SDC). We are grateful to many persons who have assisted in this project. In particular, we thank Madam Tran Thi Sua, the vice chairperson of the Peoples' Committee of Long An province, the former Vice Minister of Agriculture of Vietnam, Mr Le van The, Mr Nguyen Son Nam, Director of agriculture in Long An province and Madam Do Thi Ngoc and Mr Tran Huu Khuong, the former and present Directors of Plant Protection Department in Long An Province, who provided support and additional resources; Madam Tran Thi Mai Phuong, the Vice Director of the Plant Protection Department in Long An province, Mr Nguyen Chi Thien, Chief of Plant Protection Station in Tan Tru District, Mr Nguyen Van Vu, Chief of Plant Protection Station in Tan Thanh District, who helped organize the surveys; the students who served as enumerators and the farmers in the project sites who had responded to our questions. In addition, we thank Ms Amor Lazaro, for her assistance in processing the huge data sets; Mr Pham Minh Sang, who assisted in the translation, Ms Carolyn Dedolph and Ms Hermie Rapusas, who helped in the material design workshop.

Appendix

Radio drama script used in the broadcasts in Long An province

Scene: Early one morning in the rice field of Uncle Hai with Uncle Nam, his neighbour passing by carrying a knapsack sprayer

Uncle Nam: Hey Uncle Hai! Why don't we have some coffee instead of visiting your field so early in the morning?

Uncle Hai: Oh, I am watching some friendly insects attacking the worms. How about you? What are you spraying for?

Uncle Nam: My God! My crop is just 10 days old, but there are so many thrips. It looks terrible. So I have to spray it now. Ah, you just mentioned friendly insects. What are they?

Uncle Hai: Take your time. Put down your sprayer and I will tell you what they are.

Uncle (in Vietnamese, Bac) is used as a sign of respect when addressing a senior person in Vietnam.

Uncle Nam: Uh! Uh! I am very worried about my crop. How can I take my time? I will only stay for a short while.

Uncle Hai: Don't worry about thrips. Look at my field. There are lots of thrips there too. Sit down and I will tell you something interesting.

Uncle Nam: Okay. I will sit down.

Uncle Hai: You don't see any flies in my field, do you?

Uncle Nam: There are spiders. Everybody knows that.

Uncle Hai: And what about that insect on the leaf?

Uncle Nam: Quit joking with me. Even children know that it is a dragonfly.

Uncle Hai: Ay! It's that easy. I've just answered your questions. Those are the friendly insects. And now do you know why they are called friendly insects?

Uncle Nam: No. Why?

Uncle Hai: Because they live in the rice fields. Sometimes farmers think they are harmful but they really don't feed on the rice plants. Instead, they are looking for brown plant hoppers, leaf folders, stem borers, army worms and case worms to eat. They are farmers' friends because they eat these bad insects. So you don't have to spray to get a good crop.

Uncle Nam: A good crop without spraying? You are joking with me again. What does your crop look like without insecticides?

Uncle Hai: Ay! Ay! Do you remember my last crop? I got more than 30 gia per cong. You can ask my neighbours to confirm that I did not spray any insecticides.

Uncle Nam: Uhhhhh. It sounds ridiculous. I would like to know why.

Uncle Hai: Okay. Do you remember the situation in my field last season? The rice leaf folder damages looked very serious, but I did not spray. And I still got a good crop. Now look at my field now. There are thrips and leaf folders as well, but I shall still not spray.

Uncle Nam: Really??

Uncle Hai: Sure!! During the first 40 days after sowing, rice plants can recover from leaf removal by leaf folders. If you spray, you will waste money and sometimes you will suffer from brown plant hopper damages.

Uncle Nam: What a surprise!! It is hard to imagine.

Uncle Hai: It takes some time to explain the details. You have to buy me a drink.

Mr Ha, the local agricultural technician joins the two farmers.

Mr Ha: Hey!! What are you talking about? I just heard 'buying a drink'. Is there something interesting??

Uncle Hai: Uh! Uh! By the way, Mr Ha, can you tell us about testing whether early season insecticide spraying is needed in the field? You advised me about the experiment last season.

Uncle Nam: Well. Mr Ha, please tell me about it, and I can also try it in my field.

Uncle Hai: Oh, it is very easy.

Mr Ha: Yes. It takes some time to describe this, but the experiment is easy to perform. Now how many cong of field do you have? How old is your crop? Are you going to spray right now?

Uncle Nam: I have 5 cong. My crop is 10 days old. I am going to spray this morning for thrips and leaf folders.

Mr Ha: Well. It is good that you have not sprayed yet. If you want to try, you can divide your field into two parts. Do not spray one part of 2 or 3 cong. Spray the rest as normal. At harvest, we can compare the yields of these parts. You may find that there is no difference in yields.

Uncle Nam: Two or 3 cong? That is too big. What if something goes wrong?

Mr Ha: I assure you that there will be no yield difference. If you are still worried, use one cong as the unsprayed plot. I am afraid you might be sorry for unnecessarily spending money in insecticides and spraying.

Uncle Nam: Are you sure? Okay, I will follow your advice and try the experiment.
Uncle Hai: Come on Uncle Nam! I am sure. I have grown two crops without spraying in the first 40 days and have no yield loss. I save money and work and also have no hopper problems.
Uncle Nam: Well, I will try.

References

Adhikarya, R. (1994) *Strategic Extension Campaign — A Participatory-oriented Method of Agricultural Extension*. FAO of the United Nations, Rome, Italy

Bentley, J. W. (1989) What farmers don't know can't help them: The strengths and weaknesses of indigenous technical knowledge in Honduras. *Agric. Hum. Values* **6**, 25–31

Campbell, D. T. and Stanley, J. C. (1973) *Experimental and Quasi-Experimental Designs for Research*. Rand McNally College Publishing, Chicago, IL

CIRAD (International Co-operation Centre in Agronomic Research for Development) (1991) *Regional Agro-Pesticide Index. Volume 1: Asia*, 3rd edn. CIRAD, Montpellier, France

Cuc, N. S. (1995) *Agriculture of Vietnam 1945–1995*. Statistical Publishing House, Hanoi, Vietnam

Einhorn, H. J. and Hogarth, R. M. (1981) Behavioral decision theory: Processes of judgment and choice. *Annu. Rev. Psychol.* **32**, 53–88

Eiser, J. R. (1986) *Social Psychology: Attitudes, Cognition and Social Behavior.* Cambridge University Press, Cambridge

Escalada, M. M. and Kenmore, P. E. (1988) Communicating integrated pest control to rice farmers at the village level. In *Pesticide Management and Integrated Pest Management in Southeast Asia*, P. S. Teng and K. L. Heong (eds). Consortium for International Crop Protection, College Park, MD, pp. 221–228

Fabellar, L. T., Fabellar, N. and Heong, K. L. (1994) Simulating rice leaf folder feeding effects on yield using MACROS. *Int. Rice Res. Newslett.* **19**, 7–8

Festinger, L. (1957) *A Theory of Cognitive Dissonance.* Stanford University Press, Stanford, CA

Gou, Y. (1990) Larval Parasitization of Rice Leaf Folders (Lepidoptera: Pyralidae) under Field nad Laboratory Conditions. Ph.D. thesis, University of the Philippines, Los Banos, Philippines

Heong, K. L. (1990). Feeding rates of the rice leaf folder, *Chaphalocrocis medinalis* (Lepidoptera: Pyralidae), on the different plant stages. *J. Agric. Entomol.*, **72**, 81–90.

Heong, K. L., Escalada, M. M. and Mai, V. (1994) An analysis of insecticide use in rice: Case studies in the Philippines and Vietnam. *Int. J. Pest Manage.* **40**, 173–178

Heong, K. L., Escalada, M. M. and Lazaro, A. A. (1995a) Misuse of pesticides among rice farmers in Leyte, Philippines. In *Impact of Pesticides on Farmers' Health and the Rice Environment*, P. L. Pingali and P. A. Roger (eds). Kluwer Academic, Norwell, MA, pp. 97–108

Heong, K. L., Thu Cuc, N. T., Binh, N., Fujisaka, S and Bottrell, D. G. (1995b) Reducing early season insecticide applications through farmers' experiments in Vietnam. In *Vietnam and IRRI: A Partnership in Rice Research*, G .L. Denning and V. T. Xuan (eds). International Rice Research Institute, Los Baños, Philippines and Ministry of Agriculture and Food Industry, Hanoi, Vietnam, pp. 217–222

Heong, K. L. and Escalada, M. M. (1997a) Perception change in rice pest management: A case study of farmers' evaluation of conflict information. *J. Appl. Commun.* **81**(2), 3–17

Heong, K. L. and Escalada, M. M. (eds) (1997b) *Pest Management of Rice Farmers in Asia*. International Rice Research Institute, Los Baños, Philippines.

Heong, K. L. and Schoenly, K. G. (1998) Impact of insecticides on pest–natural enemy assemblages in tropical rice ecosystems. In *Ecotoxicology: Pesticides and Beneficial Organisms*, P.J. Haskell and P. McEwen (eds), Chapman and Hall, London, pp. 381–404

Ho, N. K. (1996) Introducing integrated weed management in Malaysia. In *Herbicides in Asian rice: Transitions in Weed Management* R. Naylor (ed.). Stanford University, California and International Rice Research Institute, Los Baños, Philippines, pp 167–182

Kahneman, D. and Tversky, A. (1973) On psychology of prediction. *Psychol. Rev.* **80**, 237–251

Kotler, P. and Roberto, E. L. (1989) *Social Marketing — Strategies for Changing Public Behavior*. The Free Press, Macmillan, New York.

de Kraker, J. (1996) The Potential of Natural Enemies to Suppress Rice Leaf Folder Populations. Ph.D. thesis, Wageningen Agricultural University, The Netherlands

Lazaro, A. A., Rubia, E. G., Almazan, L. P. and Heong, K. L. (1993) Farmers' estimates of percent whiteheads (WH). *Int. Rice Res. Newslett.* **18**, 4

Lim, G. S. and Heong, K. L. (1984) The role of insecticides in rice integrated pest management. In *Judicious and Efficient Use of Insecticides on Rice*. International Rice Research Institute, Los Banos, Philippines, pp. 19–40

Mai, V., Huan, N. H., Heong, K. L., Escalada, M. M. and Lazaro, A. A. (1997) Rice farmers' pest management perceptions and practices in Long An province, Vietnam. In *Pest Management of Rice Farmers in Asia*, K.L. Heong and M.M. Escalada (eds). International Rice Research Institute, Los Banos, Philippines, pp 215–226.

Manoff, R. K. (1985) *Social Marketing: New Imperatives for Public Health*. Praeger, New York.

Matteson, P.C., Gallagher, K.D. and Kenmore, P.E. (1994) Extension of integrated pest management for planthoppers in Asian irrigated rice: Empowering the user. In *Planthoppers: Their Ecology and Management*, R.F. Denno and T.J. Perfect (eds). Chapman & Hall, New York, pp. 656–685.

Neuman, W. L. (1991) *Social Research Methods: Qualitative and Quantitative Approaches*. Allyn & Bacon, Boston, MA.

Payne, J. W., Bettmanm, J. R. and Johnson, E. J. (1992) Behavioral decision research: a constructive processing perspective. *Annu. Rev. Psychol.* **43**, 87–131

Pfuhl, E. H. (1988) Radio based communication campigns: A strategy for training farmers in IPM in the Philippines. In *Pesticide Management and Integrated Pest Management in Southeast Asia*, P. S. Teng and K. L. Heong (eds). Consortium for International Crop Protection, College Park, MD, pp. 251–256

Rapusas, H. R., Dedolph, C., Escalada, M. M. and Heong, K. L. (1994) Workshop Report: Message Design for a Campaign to Encourage Farmers' Participation in Experimenting with Stopping Early Insecticide Spraying in Vietnam. International Rice Research Institute, Los Banos, Philippines (unpublished report)

Rice, R. E. and Paisley, W. J. (1981) *Public Communication Campaigns*. Sage, Beverly Hills, CA.

Rogers, E. M. (1995) *Diffusion of Innovations*, 4th edn. The Free Press, New York

Rola, A. C. and Pingali, P. L. (1993) *Pesticides, Rice Productivity and Farmers' Health: An Economic Assessment*. International Rice Research Institute, Los Banos, Philippines

Rombach, M. C. and Gallagher, K. D. (1994) The brown plant hopper: Promises, problems and prospects. In *Biology and Management of Rice Insects*, E.A. Heinrichs (ed.). Wiley Eastern, New Dehli, India, pp. 693–712

Rossiter, M. W. (1975) *The Emergence of Agricultural Sciences*. Yale University Press, New Haven, CT.

SAS (1985) SAS (Statistical Analysis System) *Users' Guide Version 5 Edition*. SAS Institute, Cary, NC

Schramm, W. (1973) *Men, Messages and Media: A Look at Human Communication*. Harper & Row, New York

Shepard, B. M., Justo, H. D., Rubia, E. G. and Estano, D. B. (1990) Response of the rice plant to damage by the rice whorl maggot, *Hydriella philippina* Ferino (Diptera: Ephydridae). *J. Plant Protect. Tropics* **7**, 173–177

Slovic, P., Fishhoff, B. and Lichtenstein, S. (1977) Behavioral decision theory. *Annu. Rev. Psychol.* **28**, 1–39

SPSS (1997) SPSS (Statistical Package for Social Sciences) *SPSS Base 7.5 for Windows. User's Guide*. SPSS, Chicago, IL

Stone, R. (1992) Researcher score victory over pesticides and pests in Asia. *Science* **256**, 1272–1273

Tversky, A. and Kahnemann, D. (1974) Judgement under uncertainty: heuristics and biases. *Science* **185**, 1124–1131

Useem, M., Setti, L. and Pincus, J. (1992) The science of Javanese management: organizational alignment in an Indonesian development programme. *Public Admin. Dev.* **12**, 447–471

Van de Fliert, E. and Matteson, P. C. (1990) Rice integrated pest control training needs identified through a farmer survey in Sri Lanka. *J. Plant Protect. Tropics* **7**, 15–26

Viajante, V. D. and Heinrichs, E. A. (1986) Rice growth and yield as affected by the whorl maggot, *Hydriella philippina* Ferino (Diptera: Ephydridae). *Crop Protect.* **5**, 176–181

Waibel, H. (1986) *The Economics of Integrated Pest Control in Irrigated Rice*. Springer, Berlin

Way, M. J. and Heong, K. L. (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

Received 25 February 1998
Revised 23 March 1998
Accepted 23 April 1998