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Quantifying rice farmers' pest management decisions: beliefs and subjective norms in stem borer control

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Abstract

The paper introduces the pest belief model and Fishbein and Ajzen's theory of reasoned action to analyze farmers' decisions in stem borer management. Farmers spent an average of \$39/ha (median \$18) on insecticides believing that if they had not controlled an average loss of 1004 kg/ha or \$402 (median 592, \$237) would occur. Farmers' estimates of the worst attack averaged 19 white heads/m^2 (median10) with the associated average loss of 1038 kg/ha or \$415 (median 592, \$270), implying that farmers' decisions were guided by the worst attacks. Perceived benefits from insecticides were directly related with farmers' insecticide use and perceived severity. Perceived susceptibility was also high, with 59% of farmers believing that a loss of 450 kg/ha would be "extremely or very likely". Farmers believed insecticides could destroy natural enemies but placed only moderate importance to conserving them. Health was believed to be very important but farmers had mixed beliefs that spraying could bring about poor health. This study also provides evidence suggesting high peer pressure on farmers' spray decisions directly influencing perceived benefits from sprays, insecticide spending and spray frequency.

Keywords: Stem borer; Pest belief model; Pest management decision making

1. Introduction

Rice farmers' pest management practices represent the direct results of decisions they make every season. Several authors (e.g. Herdt et al., 1984; Waibel, 1986) have shown that farmers who use pest resistant varieties should have fewer economic incentives to apply pesticides. However, recent surveys from 10 Asian countries showed that most rice farmers continue to believe that insects are important yield constraints and that insecticides are needed in order to protect yields (Heong and Escalada, 1997b). Many insecticide sprays are targeted at leaf feeding insects in the early crop stages. The most common species is the rice leaf folder (*Cnaphalocrocis medinalis* Guenee), which causes highly visible damage symptoms, but negligible yield loss (Graf et al., 1992). For control farmers generally use the least expensive but highly toxic broad-spectrum chemicals, such as methyl parathion, monocrotophos and methamidophos. In the Philippines, stem borers are also common spray targets of farmers (Heong et al., 1994,1997). The most common species is the yellow stem borer, *Scirpophaga incertulas* (Walker). Stem borer attacks at the later crop stages often result in panicle deaths, or "white heads" (*Uban* in Cebuano meaning white hairs). Stem borers are common pests of rice in Asian countries and according to Pathak and Khan (1994) they are serious pests responsible for annual damages of 5–10% of rice crops. When heavily infested with more than 5 panicles destroyed, rice hills can have as much as 80% loss in yield (Rubia-Sanchez et al., 1997). However, slightly infested hills, with one or two panicles destroyed often have higher yields because of plant compensation. Normal stem borer infestations in insecticide-free crops are usually very low, with $>80\%$ of the hills not infested (Schoenly pers. comm.). Often farmers tend to overestimate damages and yield loss associated with white heads (Lazaro et al., 1993) and these misperceptions had influenced management decisions.

The root of the problem appears to lie in the way that farmers make decisions on pest management. They choose those pest management options that appear to meet their objectives best, an assessment based largely on

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their beliefs and attitudes of damage and control. Often to simplify this decision making process, farmers use heuristics, a term introduced by Kahnemann and Tversky (1974) to refer to informal rules-of-thumb. 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' misuse of insecticides may well be due to these faults, as discussed by Bentley (1989). Clearly, research to understand existing heuristics and how they might be improved is critical to designing effective management strategies. In this paper, we report the use of a decision framework to quantify and investigate rice farmers' stem borer management decisions.

1.1. Farmers' beliefs, attitudes and behavior

A group of sciences, concerned with understanding and improving decision making, collectively known as decision sciences (Kleindorfer et al., 1993), has recently emerged. Literature from the 1970s on agricultural decision making (e.g. Raiffa, 1970; Halter and Dean, 1971; Anderson et al., 1977) focused on the prescriptive aspects which indicate how decisions should be made according to a set of well-defined criteria. Studies on human judgement and choices have shown that these prescriptive models are unable to account for how people actually make decisions (Slovic et al., 1977; Simon, 1978). Most people violate these prescriptive principles because decision making is behavioral in nature (Einhorn and Hogarth, 1981). Behavioral decision research is increasingly being used in fields such as public health management, business management and public policy management, making important contributions in the design of services, information environments and decision systems (Payne et al., 1992).

Norton and Mumford (1983) introduced a behavioral decision model for pest management. According to this model, pest management decisions are mainly influenced by farmers' perceptions of the problem and related control actions. To understand factors that affect these perceptions, we adopted a pest belief model and the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975). The belief model and TRA provide a system of theoretical constructs, which may help to understand the direct determinants of behavior in response to different pests and attitude–behavior relationships.

1.2. Pest belief model

In the 1950s social psychologists developed a health belief model in an attempt to understand why people failed to make use of disease prevention (Stroebe and de Wit, 1996). We adapt this model into the pest belief model (Fig. 1) to provide us with a framework to understand and quantify the direct relationships between beliefs and pest management decisions. Basic to this model is the assumption that pest management behavior is determined by four components:

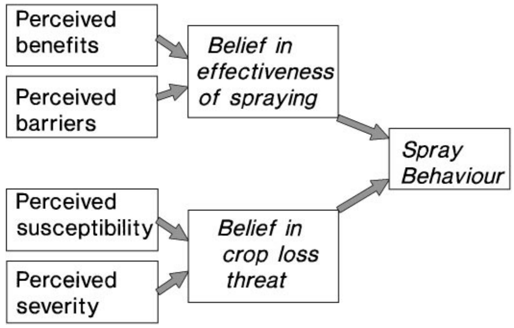

Fig. 1. The pest belief model.

(1) *Perceived benefits:* the degree to which a certain action will be seen as reducing the perceived susceptibility or severity of the pest attack;
(2) *Perceived barriers:* the perceived negative aspects of a particular action;
(3) *Perceived susceptibility:* the subjective risk of getting pest attacks if no countermeasures are taken; and
(4) *Perceived severity:* the severity of the pest attack.

Farmers' heuristics are governed by all four components in varying degrees, each of which may be studied or quantified. For instance, using interview techniques, one can quantify farmers' perceived benefits, susceptibility and severity and determine perceived barriers to a particular action.

1.3. Theory of reasoned action

Fishbein and Ajzen's (1975) theory of reasoned action provides a framework for studying relationships between attitudes and behavior (Fig. 2). Behavioral intention is influenced by attitudes of the decision-maker towards the behavior and his or her subjective norms. Attitudes are thus the extent to which the individual farmers see the consequences of the action and are in turn influenced by behavioral beliefs (b_i) and evaluations of these beliefs (e_i). The attitudinal measure can thus be obtained by summing the products of belief and evaluation scores, $\Sigma\, b_i e_i$. Degree of normative belief (nb_i) and motivation to comply (mc_i) affect the subjective norm of the decision-maker and the summation of the products, $\Sigma\, nb_i\, mc_i$, provides the subjective norm measure.

2. Methods

2.1. Study site and data collection procedures

The study was carried out in seven rice-growing municipalities in Leyte province in the Philippines with an

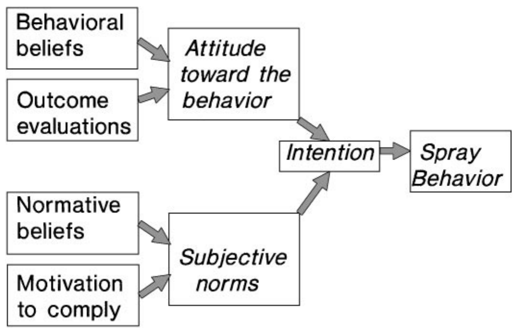

Fig. 2. The theory of reasoned action (After Fishbein and Ajzen, 1975).

estimated population of 11,700 farmers involved in rice production. Agriculture is a major economic activity with coconut, rice, sugar and corn as principal crops. About 72% of the rice area is irrigated, 23% rain-fed and the remaining 5% upland rice. Lowland rice is grown in two cropping seasons per year.

Data were collected through the use of a questionnaire administered by undergraduate students trained and directly supervised by one of us (MME). A total of 402 randomly selected farmers (272 men and 130 women) representing about 3.4% of rice farmers in the area, were interviewed. Quality assurance checks were conducted during the survey to ensure data reliability. The questionnaire was developed using qualitative methods, focus group interviews and participatory observations, which we carried out in several exploratory surveys. Drafts of the questionnaire were prepared in English, translated into Cebuano, pretested twice and amended accordingly. The theme of the questions centered on farmers' use of insecticides to control stem borers, as this was their most important concern. The data were coded using the spreadsheet program EXCEL® and the data set was error checked using the EXPLORE procedure in SPSS® 7.5 for Windows® (SPSS, 1997) before analyses. We use the pooled data of the 402 respondents as an earlier analysis showed that there was no evidence of gender differences in farmers' decisions (Escalada and Heong, 1999). Means were compared using t-tests, correlation between variables was computed using Pearson's correlation coefficient and regression analyses were carried out using analysis of variance.

2.2. Measuring beliefs, attitudes and subjective norms

In the questionnaire, we used five attributes related to the use of insecticides for stem borer control. These attributes were presented in the following statements:

(1) "insecticide spraying for stem borer control increases yields";
(2) "insecticide spraying for stem borer control will cause poor health",
(3) "insecticide spraying for stem borer control will cause more pests",
(4) "insecticide spraying for stem borer control will kill natural enemies",
(5) "insecticide spraying for stem borer control will control stem borers".

Each respondent was asked to individually assess his or her degree of belief (b_i) using descriptor phrases in a 5-point Likert scale. The descriptors were "definitely not true", "in most cases not true", "may be true", "in most cases true" and "always true". Farmers were also asked to evaluate the importance of each of the above beliefs (e_i) by using 5 descriptors, "completely not important to me", "not important to me", "no opinion" or indifference, "important to me" and "very important to me".

Subjective norms (or peer pressures) were measured by assessing each respondent's perception of what specific reference groups expected him or her to do. The 5 reference groups used were neighbors, village heads, spouses, extension technicians and chemical company sales agents. For the measure of normative beliefs (nb_i) each respondent was asked the question, "What do you think each reference group expected you to do for stem borer control?" Responses were assigned scores as follows:

(1) "never spray insecticides";
(2) "spray insecticides rarely";
(3) "spray insecticides once every 2 years (occasionally)";
(4) "spray insecticides at least once a year (frequently)";
(5) "spray insecticides every season (very frequently)".

Measures of motivation to comply (mc_i) were determined by another set of 5 questions for the 5 reference groups: "How much do you care about what each reference group think you should do?" Responses were assigned scores as follows:

(1) "I do not care at all";
(2) "what they think is not important";
(3) "what they think will have no influence on what I do";
(4) "what they think I should do is important";
(5) "what they think I should do is very important".

3. Results

3.1. Respondents' profile

The profile of the farmer sample is shown in Table 1. Most of the farmers were aged about 50 y and have about 6 y education. They cultivated about 1 ha of rice and reported yields between 2 and 3 t/ha. Each season, farmers applied insecticides an average of 3 times for pest management. The first sprays were applied within the first 15 days after transplanting.

Table 1
Profile of farmers interviewed

		Central tendency measures			
		Mean	Mode	Median	Variance
Number of respondents	402				
Age (y)		52.0	60	53	174.4
Education (y)		6.1	6	6	12.9
Size of farm holdings (ha)		1.1	1	1	1.0
Number of insecticide sprays applied in 1997/98 dry season crop		3.2	3	3	4.1
Timing of farmers' first insecticide sprays		16.8	15	15	118.5
Yields per ha obtained in 1997/98 dry season crop (t/ha)		2.8	1.8	2.3	1300

3.2. Stem borer management variables

Farmers seemed to regard stem borers as important as 35% of the farmers ranked it as the most important pest, followed by tungro disease (27%) and rice bugs (15%). In controlling stem borers, farmers mainly relied on insecticides, spraying about 2 times and spending about $ 39/ha per season (Table 2). Farmers' perceptions of benefits from using insecticides were highly variable with a mean of 1004 kg/ha (mode = 900, median = 592). In the worst stem borer attack that farmers said they had experienced in the last 10 years (perceived severity), farmers reported losing a mean of 1038 kg/ha (mode = 900, median = 675). With the farm gate price of $0.40/kg, the perceived benefit was computed to average about $402 (mode = $360, median = $237) and the perceived severity was about $415 (mode = $360, median = $270). The highest number of white heads/m^2 farmers said they had experienced averaged 19.1/m2 (mode = 10, median = 10). The loss computed from the known agronomic characteristics of IR 64 was about 191,000 white heads/ha or 351 kg valued at $140/ha (mode = 10, $74, median = 10, $74). Based on the median, about 50% of the farmers spent more than $18/ha in stem borer control and expected a loss of more than $237 if they had not done so, representing a cost–benefit ratio of greater than 1:13.

Table 3 shows that the number of sprays farmers used for stem borer control was significantly correlated with perceived loss, amount spent for control, perceived loss from the worst stem borer infestation, the amount farmers intend to spend for control and the loss they expected to prevent. Farmers' perceived losses when no sprays were applied and in the worst stem borer attacks were both significantly correlated with insecticide spending (Spearman rho = 0.97 and 0.78, respectively). Farmers' estimates of white heads were not related to the number of sprays they used, amount they spent for control and their perceived loss, indicating that decisions were not associated with pest estimates. While their white heads estimates might be realistic, farmers seemed to have overestimated losses associated with the symptoms. To estimate perceived severity, we asked farmers to rate the likelihood of losing 450 kg/ha from stem borers in the next season if no chemicals were to be used. Thirty-one percent (31%) of the farmers reported "extremely likely", followed by 28%, "very likely", and 27%, "maybe", implying that perceived susceptibility among farmers was generally high. It is evident that perceived benefits from insecticide use is directly related with farmers' insecticide use, perceived severity and perceived susceptibility but not related to farmers' white head estimates. The loss farmers expected to prevent was also significantly correlated with perceived loss and worst loss (Spearman rho = 0.58 and 0.61, respectively). Regression analyses of

Table 2
Farmers' management of stem borers in the 1997/98 dry season crop, their estimations of damages, loss, spending for control and expected loss prevention

	Central tendency measures			
	Mean	Mode	Median	Variance
Amount spent on stem borer control (US$/ha)	$39	$16	$18	> 5000
Number of insecticide sprays applied	2.6	2	2	2.1
Farmers' perceived loss in yield (kg/ha) if sprays were not applied	1004	900	592	> 5000
Cost (US$) of perceived loss if sold at $0.40/kg	$402	$360	$237	
Estimates of the worst loss due to stem borers (kg/ha)	1038	900	675	1100
Cost (US$) of worst loss if sold at $0.40/kg	$415	$360	$270	
Highest number of white heads per m^2 ever seen	19.1	10	10	1679
Calculated yield loss (kg/ha) for the highest white heads[a]	351	184	184	
Cost (US$) if sold at $0.40/kg	$140	$74	$74	
Amount (US$/ha) budgeted for next season	$43	$16	$21	> 5000
Expected loss prevented (kg)	950	450	450	3180
Cost (US$) of expected loss if sold at $0.40/kg	$380	$180	$180	

[a]Calculated from average yield component variables for IR64 where-number of grains/panicle = 69.9, 1000 grain weight = 26.3, number of panicles/hill = 17.9 and number of hills/ha = 160,000.

Table 3
Spearman correlation between farmers' stem border management variables

	1	2	3	4	5	6	7
No. sprays for stem borer control	—						
Amount spent for control	0.23**	—					
Perceived loss if spray not applied	0.22**	0.97**	—				
Loss from worst stem borer attack	0.31**	0.13**	0.78**	—			
Farmers' estimate of white heads	0.09	0.03	0.01	0.09*	—		
Amount intend to spend for control	0.19**	0.78**	0.36**	0.34**	0.02	—	
Expected loss prevented	0.16**	0.95**	0.58**	0.61**	0.07	0.33**	—
Anticipated stem borer attacks	0.14**	0.17**	0.25**	0.17**	0.00	0.22**	0.06

Table 4
Regression anayses of relationships between farmers' perceived loss, their estimates of loss from the worst stem borer attack and expected loss the next season

Loss variables		Regression coefficient		Constant		F	df	p
Dependent	Independent	b	95% CL limits	c	95% CL limits			
Worst case	Perceived	0.36	($\pm$ 0.03)	15.18	($\pm$ 0.87)	960	1381	< 0.001
Expected	Perceived	0.33	($\pm$ 0.01)	3.59	($\pm$ 1.32)	1600	1366	< 0.001
Worst case	Expected	0.90	($\pm$ 0.07)	13.13	($\pm$ 2.36)	534	1368	< 0.001

the above relationships showed significance (Table 4). Farmers' estimates of worst loss were about 90% of the loss they expected to prevent, which implied that farmers' decisions were influenced by the worst case scenarios. Perceived losses, if sprays were not applied, were generally less than estimates of worst losses (about 36%) and losses farmers expected to prevent (about 33%). This probably implied farmers' lack of confidence in the efficacy of the insecticide treatments.

3.3. *Reliability analysis of composite measures*

The attitudinal and subjective norm measures were subjected to reliability analyses using the statistic, Cronbach's alpha, which is an estimation of the average of all possible split-half reliability coefficients (Frankfort-Nachmias and Nachmias, 1996). A high alpha (0.70 is an acceptable level) indicates that the items in the composite measures are highly connected. Reliability coefficients for belief measures were low, while those for measures of subjective norm were sufficiently high (Table 5). This suggested that the belief items used were not highly connected therefore we adopted the composite measure for subjective norm, $\Sigma\ nb_i\ mc_i$ and analyzed the different items in the belief measure, b_i and e_i, individually.

3.4. *Beliefs and attitudes towards using insecticides for stem borer control*

Table 6 shows the mean belief scores of 5 items related to stem borer control. Since the data in each variable

Table 5
Reliability analysis of composite measures computed from survey data

Measures	Number of items	Cronbach's alpha
Related to attributes		
Belief scores b_i	5	0.36
Belief evaluations e_i	5	0.22
Attitudinal measure $\sum b_i e_i$	10	0.33
Related to subjective norm		
Normative beliefs nb_i	5	0.86
Motivation to comply mc_i	5	0.80
Subjective norm measure $\sum nb_i mc_i$	10	0.84

Table 6
Comparison of farmers' belief and evaluation mean scores[a] in 5 attributes regarding controlling stem borers by spraying insecticides

	Beliefs (b_i)		Evaluation (e_i)	
Attributes	Mean	Median	Mean	Median
Insecticide spraying for stem borer control				
increase yields	3.55	4	4.14	4
will cause poor health	2.45	2	4.32	5
will cause more pests	3.55	4	3.08	4
will kill natural enemies	3.94	4	2.35	2
will control stem borers	3.72	4	4.04	4

[a]Scores ranged from 1 to 5 and higher values indicate strong beliefs or evaluated as highly important.

fitted the normal distribution in all cases using the one sample Kolmogorov–Smirnov test, we used the mean scores for comparisons. As the score of 3 suggests indifference, scores greater than 3 would imply strong beliefs and scores lower than 3, weak beliefs. Farmers strongly believed that controlling stem borers would increase yields and that spraying would control stem borers. Farmers placed high yields as a very important objective of spraying but their belief that spraying could harm their health was relatively low although the importance of health was evaluated highly. The belief that chemicals would kill natural enemies was strong however protecting natural enemies was rated with lower importance. The belief that spraying could cause more pests was high but evaluated by farmers with only moderate importance. These observations imply farmers' strong beliefs in the need to control stem borers and were prepared to compromise health risks and killing of natural enemies.

3.5. Beliefs and attitudes towards subjective norms

The impact of reference groups (or peer groups) influencing farmers' insecticide decisions is shown in Table 7. Data in each variable fitted the normal distribution and mean scores were used for comparisons. Influences of all reference groups on farmer decisions were very high with mean scores significantly higher than 9, the score for indifference. Among these groups, the chemical company agents had the highest influence, followed by extension technicians, spouses, neighbors and village heads, respectively (Table 7). The mean composite subjective norm index was 76.1 with a mode of 100, which represented the 70% percentile, implying that pressure to spray by peer groups was very high.

4. Discussion

The pest belief model we introduced provided a convenient framework to quantify elements of perception in pest management. We measured farmers' perceived benefits, perceived susceptibility and perceived severity regarding stem borer management. Perceived benefit and severity were similar implying that farmers would often act to prevent the worst case occurring which they believed to be worth about \$415/ha. Since farmers spent about \$39/ha, the cost–benefit ratio was above 10, and thus spraying was perceived to be an economically rational behavior. This observation is further supported by the positive correlation between various stem borer management variables as shown in Table 8. We obtained farmers' estimates of the worst stem borer attack and found it to average about 19.1 white heads/m^2. As the variety IR64 was most commonly grown, we used the variety's agronomic characteristics[1] and computed a grain weight of 351 kg/ha from 19.1 panicles/m^2 or about one per hill, which represents potential yield loss with no compensation. Rubia-Sanchez et al. (1997) showed that hills of IR64 inflicted with one white head had higher yields than hills with no white heads. Similarly, Rubia et al. (1989) also showed that plants with 1 or 2 dead panicles yielded the same as plants without dead panicles. The rice crop can often compensate from stem borer injuries through reallocation of carbohydrates (Rubia et al., 1996) and it is likely that the actual loss will be less than the calculated loss of 351 kg/ha. Furthermore, in reality stem borer infestations above 5% white heads are very rare. Recent data from fields at IRRI showed that less than 10% hills in unsprayed fields had one or more white heads (Schoenly, 1998 pers. comm.) and white head was well below 1%. It is thus quite unlikely that the farmers we interviewed had experienced such high infestations and we suggest that farmers' perceived benefits from insecticide use are overestimated. Their estimates of white heads in fields may be realistic, but yield losses associated with them were overestimated. We did not measure perceived barriers to spraying, which include variables such as costs, side effects and difficulties in performing the task. However, since insecticide spraying is familiar to farmers, relatively inexpensive and easy to perform, perceived barriers to spraying are unlikely to discourage insecticide decisions.

Perceived susceptibility of loss to farmers was high, as 59% believed that the chances of getting high infestations were "very or extremely likely". Farmers' perceived severity and perceived susceptibility determine belief in crop loss threat. Since infestations greater than 5% white heads rarely occur, perhaps one way for farmers to modify this belief is to motivate them to participate in an experiment to measure and record the number of white

Table 7
Subjective norm components and measure

Reference groups		Mean	95% CL limits	Mode	Median
Neighbors	nb_1mc_1	15.05	(+ 0.78)	20	20
Village heads	nb_2mc_2	14.13	(+ 0.93)	20	10
Spouses	nb_3mc_3	15.76	(+ 0.76)	20	20
Extension technicians	nb_4mc_4	15.86	(+ 0.81)	25	20
Chemical company agents	nb_5mc_5	17.67	(+ 0.73)	20	20
Subjective norm measures	$\sum nb_imc_i$	76.15	(+ 3.98)	100	77.5

[1] Agronomic characteristics of IR64 : 1000 grain weight = 26.3 g, number grains m^{-1} = 26,543; number of grain/panicle = 69.9, number of panicle/hill = 17.9 (S.B. Peng, pers. comm. 1997). Yield (kg/ha) = Weight per grain × number of grains/m^2 × 10.

Table 8
Correlation between stem borer management variables and the subjective norm measure and its components

	Subjective norm measures of 5 reference groups					Composite measure
	nb_1mc_1	nb_2mc_2	nb_3mc_3	nb_4mc_4	nb_5mc_5	$\sum nb_imc_i$
Number of insecticides/season	0.35**	0.35**	0.33**	0.35**	0.24**	0.37**
Number sprays for stem borers	0.27**	0.27**	0.29**	0.20**	0.23**	0.26**
Amount spent (US$/ha)	0.19**	0.16*	0.16**	0.16**	0.20**	0.13
Loss if stem borer not controlled	0.32**	0.24**	0.27**	0.32**	0.24**	0.29**
Loss from worst stem borer	0.17**	0.19**	0.15**	0.21**	0.11**	0.23**
Amount intend to spend (US$/ha)	0.21**	0.20**	0.15**	0.19**	0.21**	0.12
Yield expected to prevent	0.20**	0.10	0.19**	0.24**	0.18**	0.14*

heads/m^2 every season. Participatory experiments (Heong and Escalada, 1997a,1998) had been used to help farmers reduce exaggerated perceived benefits from insecticide control actions. In public health, researchers found that some cue is often necessary to trigger behavior change (Rosenstock, 1974). This "cue to action" could be through a mass media campaign as shown by Adhikarya (1994), Ho (1996) and Heong et al. (1998).

The high values in farmers' belief scores and correlation between beliefs and decision actions further suggest that farmers' pest management decisions were based on perceptions. Farmers strongly believe that insecticides were effective against stem borers and would increase yields and not using them would result in poor yields. Generally, farmers believed that insecticides would destroy natural enemies but they placed only moderate importance on conserving them. High importance was placed on health, but most farmers did not seem to have strong belief that spraying could bring about poor health. Farmers did not believe that spraying significantly increased pest problems or caused pest resurgence. These beliefs and attitudes did not seem to differ from descriptions from an earlier work carried out in Leyte (Heong et al., 1994) implying that there has been little change since.

According to the theory of reasoned action, decisions are also influenced by attitudes towards subjective norm (or peer pressure) from various reference groups. This study provided evidence suggesting that the influence of normative beliefs and motivations to comply of 5 reference groups on farmers' insecticide spray decisions are very high. The positive correlation between the stem borer management variables of farmers and the composite subjective norm measure as well as the measures of the different reference groups also suggests direct influence of the referents on decisions. The social referents directly influenced farmers' number of sprays used, perceived benefits from sprays and insecticide spending. It seems to suggest that insecticide spraying is the social norm among farmers and any information or training program will need to focus on reestablishing the norm by finding ways to create more support for the preferred norm (McAlister, 1981). Such social changes had been described in programs related to birth control and smoking cessation, where the social norms were changed to a societal preference for a smaller family and no smoking (Rice and Paisley, 1981; Rogers, 1973).

Theories and research results underlying pest management in rice have been well documented over the years in the scientific literature. However, recent research on farmers' knowledge, attitudes and practices (e.g. Rubia et al., 1996; Heong and Escalada, 1997a), has shown that farmers' pest management decisions remain far from optimal and in many cases contradictory to research findings. This is often attributed to lack of adoption, lack of training and lack of extension. In this study we used a social psychology framework to quantify variables and cause–effect relationships, which can be used for comparative analyses and evaluations of intervention approaches, such as training systems, information delivery techniques and farmer participatory methods. Such analyses can help extension and training programmes identify the main constraints to change, which may be useful in modifying approaches, methods and materials in extension and farmer training. For instance, as peer pressure is an important force against change and community approaches, in addition to imparting knowledge and skills to individual farmers, one may need to take into account strategies to modify peer pressure in order to build a new belief and value system among farmers.

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