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Rice farmers' background, perceptions of pests, and pest management actions: a case study in the Philippines

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Abstract

Farmers' perceptions of pests were analysed as one component of the integrated rice pest survey conducted by IRRI in Central Luzon, Philippines, with a historical perspective. Correspondence analysis was applied to different groups of descriptors: farmers' socio-economic background, perceptions, and actions to control pests in their past farming experience. The results were interpreted using a modified version of Mumford and Norton (1984) behavioral model. They indicate associations between backgrounds, perceptions, and actions. The results also suggest the major role of informal information channels in the development of farmers' attitude towards pests which could be used to develop integrated pest management methods.

Additional keywords: decision-making, rice tungro virus disease, brown planthopper, *Nilaparvata lugens*, correspondence analysis, Integrated Pest Management.

Introduction

As part of a systems approach to characterize, understand, and manage constraints to sustainable rice production, a survey of rice pests was conducted by the International Rice Research Institute (IRRI) in Central Luzon, Philippines (Elazegui et al., 1990). The survey was primarily intended to describe farmers' crop husbandry practices, to quantify rice pest constraints (diseases, insects, and weeds), and to measure the corresponding yield variation (Teng and Elazegui, pers. comm.). It generated a series of data sets on various aspects of the system.

Another objective was to relate the socio-economic background of farmers with their pest management practices. The result of interviews with farmers on the pest problems they might have been encountering throughout their farming experience are of particular interest, as it could provide a better insight into the perception (Zadoks, 1985) of pest problems, and document the current understanding on how integrated pest management programmes should be implemented (Kenmore et al., 1985). Analyses of these interviews can help in interpreting farmers' experience, and decisions they made in the past. This paper deals with the analysis of this particular piece of information: a historical perspective, from a rice farmer's point of view, of pest problems.

Materials and methods

Survey procedure and survey data. Several objectives were considered in IRRI's survey of rice pests in Central Luzon, and a series of data sets on diseases, insect pests, weed infestation, cropping practices, and yield variation were generated (Elazegui et al., 1990). The survey was conducted from the 1987 rainy season to the 1988–89 dry season. It involved 89 farmers whose fields were monitored by IRRI scientists for pests and diseases, weeds and weed management, crop development and cropping practices. In a separate phase of the survey, interviews were individually conducted with these farmers. Although conducted in a rather informal way, and encompassing a whole farmer's professional life, the interviews were focused on the main pest problems they might have been facing during their whole farming experience.

When a particular pest problem was mentioned by a farmer, the control actions that had been taken were then enquired. These interviews resulted in a data set where each farmer was represented by three groups of attributes: his general background (together with the farm itself), his perception of pests (whether they had been of concern to him or not), and the actions that had been taken.

Each farmer and his farm were described using several variables: the age of the farmer, his education level, the type of land ownership, the source of water supply, the size of the farm, and the availability of spray equipment (Table 1). These variables were assumed to be related to farmers' perceptions (Zadoks, 1985) of pests. Age might, for instance, be associated with increased experience of outbreaks; education might have increased the awareness of pests, and of possible control measures; the type of land ownership might influence perceptions due to differing consequences of outbreaks on household budgets. These variables are predominantly categorical in nature. The quantitative ones (age and size of farm) were categorized in three groups each (young to elderly, small to large; Table 1).

Only the pests that had been mentioned by farmers during the interviews were considered: rice tungro virus disease, defoliators (as a group), brown planthopper (BPH), rice bugs, white heads and dead hearts (caused by stem borers), whorl maggot, and weeds (Table 1). Perception of pests were encoded using two categories: mentioned as a problem (_P, e.g., for tungro: TP), or not mentioned (_NP, e.g., TNP). Particular attention was paid to the description of a problem by a farmer. When mentioned, a discussion would be initiated to clarify its nature. Identifying tungro is difficult. It was generally described by farmers as a complex syndrome, involving stunting of the plant, a discoloration of the leaves, which later become dry, and the absence of panicles (Elazegui, pers. comm.). Each farmer may have mentioned one or several pests during the interview, and the coded outcome of an interview included a list of mentioned pests.

The types of action were further enquired. These were categorized into seven types, where different patterns of pesticides usage were distinguished. Some actions that constitute departures from conventional handling of pest problems involving current technologies were represented by very few farmers only. They were pooled together, and considered as 'traditional' practices.

Multiple correspondence analysis. The reasons for considering categorical, non parametric methods, rather than conventional parametric methods to analyse this type of information are many (Benzécri, 1973; Dervin, 1988). Two of them are particularly apparent in the case of this study. First, the information considered is, predominantly, categorical. It is therefore simplest to categorize the few quantitative variables into classes, and retain the others in their integrity, without transformations. Second, decison-

Table 1. Variables used to characterize farmers' background, perceptions of pests, and actions.

Farm and farmers' background:

age
young: from 18 to 43 years old
middle-aged: from 43 to 58 years old
elderly: more than 58 years old

education level
elementary school
elementary school graduate
high school
high school graduate

farm size
small: less than 2.5 ha
medium: less than 4.0 ha
large: more than 4.0 ha

land ownership
owner
tenant: pays the landlord a fixed rent (in grain, or money)
leaser: pays the landlord a given proportion of the harvest

water supply
dam
pump
rainfed

spray equipment
owned
borrowed

Perception of pests, with two categories: considered as a problem (_P), or not (_NP):

tungro (T)
brown plant hoper (BHP)
defoliators (D)
weeds (W)
rice bugs (B)
white heads (WH)
dead hearts (DH)
whorl maggot (WM)

Actions:

1 – no action taken
2 – insecticide spray(s)
3 – drainage of field for a few days and spray of insecticide
4 – other pratices, including traditional practices
5 – insecticide spray(s) and insecticide broadcasting
6 – application of firtilizer (and herbicide)
7 – handweeding

making is categorical by nature. As this type of attribute represents the ultimate variable to be considered, the analysis should address it in the most adapted way.

To analyse these data, three groups of variables were considered, representing farmers' background, their perceptions of pests, and pest management actions. The two first groups may be seen as major contributors to decision-making (Mumford and Norton, 1984; Zadoks, 1985). Farmers' background and perceptions were therefore considered as explanatory variables with respect to actions.

Multiple correspondence analysis (Benzécri, 1973; Greenacre, 1984; Dervin, 1988) is one means to address a series of variables in two phases: variables that are directly involved in establishing an analytical framework, and variables that are projected on this framework. While the first phase allows to address associations among explanatory variables, the second allows to consider the pattern of relationships among these variables and additional ('independent') variables. Emphasis was therefore given to farmers' background and perceptions in the first phase, and actions were involved in the second.

Variables that are represented by very low frequencies should not be involved in the first phase, as they might strongly distort the analytical framework, and lead to misinterpretations. They may however be considered in the second phase, where individual interpretations may – with caution – be forwarded. For this reason, perceptions of defoliators, weeds, rice bugs, white heads, dead hearts, and whorl maggot were not included in the first phase, but were documented as additional variables in the second. As a summary, the first phase involved farmers' background and perceptions with high frequencies, and the second phase involved perceptions with low frequencies, and pest management actions.

Contingency tables (i.e., bivariate frequency distribution tables) between each pair of variables were constructed, e.g. land ownership (represented by three categories), and BPH (represented by two categories: 'problem' or 'not a problem'). A contingency table is one convenient means to represent the relationships between two variables. A contingency table relating BPH perception (as columns) and land ownership (as rows) would show the distribution of individuals (farmers) according to these two classification factors. The table can be read following the columns, in order to compare vertical profiles of BPH perception in the different types of access to land, or following the rows, in order to compare horizontal profiles of access to land in differing BPH perceptions. Differences in the profiles were tested using Chi-square tests.

Correspondence analysis, as other techniques, allows to analyse a multidimentional data set (here, a series of contingency tables) by reducing it to a limited number of new, independent variables (eigenvectors). It was used to represent graphically the set of contingency tables generated from the survey data (Table 2). In this analysis, each category (e.g. 'BPH not a problem', or 'tenant') is considered as new, individual variable, represented by its vertical (BPH) or horizontal ('tenant') profile, in terms of distribution frequencies using the other categories (Table 2).

The result can be seen as maps, where categories that share similarities in their profiles are close to one another, whereas dissimilar profiles translate into increased distances (De Lagarde, 1983). These maps can be drawn using the axes (eigenvectors) generated from the combination of classes that are selected to define the framework of the analysis, and a Chi-square distance, as it is based on contingency tables.

Results and discussion

Some dominant features. A particular feature of this survey is the outstanding concern of farmers about rice tungro (Table 2, 59 farmers, i.e. 66.3%) or BPH (23 farmers, i.e. 25.8%). The case of BPH is particularly telling, as it indicates a memory that traces some

Table 2. Set of contingency tables used to conduct a multiple correspondence analysis. Only the contingency tables involved in the definition of axes are shown. The other contingency tables were used to project additional classes (other pest problems and actions, see text) on the framework of axes. Pest problems are represented by two categories: 'a problem' (_P), or 'not a problem' (_NP). Entries are absolute frequencies. Accumulated frequencies are shown in italics.

Famers' background variables	Perceptions					
	tungro (T)			brown plant hopper (BPH)		
	TP	TNP		BPHP	BPHNP	
Age						
young	**15**	**11**	*26*	**7**	**19**	*26*
middle-aged	**23**	**9**	*32*	**7**	**25**	*32*
elderly	**21**	**10**	*31*	**9**	**22**	*31*
	59	*30*	*89*	*23*	*86*	*89*
Education level						
elementary	**20**	**11**	*31*	**9**	**22**	*31*
elementery graduate	**17**	**11**	*28*	**5**	**23**	*28*
high school	**9**	**5**	*14*	**5**	**9**	*14*
high school graduate	**13**	**3**	*16*	**4**	**12**	*16*
	59	*30*	*89*	*23*	*86*	*89*
Farm size						
small	**22**	**16**	*38*	**9**	**29**	*38*
medium	**19**	**6**	*25*	**6**	**19**	*25*
large	**18**	**8**	*26*	**8**	**18**	*26*
	59	*30*	*89*	*23*	*86*	*89*
Land ownership						
owner	**21**	**12**	*33*	**8**	**25**	*33*
tenant	**15**	**3**	*18*	**5**	**13**	*18*
leaser	**23**	**15**	*38*	**10**	**28**	*38*
	59	*30*	*89*	*23*	*86*	*89*
Water supply						
dam	**32**	**19**	*51*	**16**	**35**	*51*
pump	**10**	**7**	*17*	**1**	**16**	*17*
rainfed	**17**	**4**	*21*	**6**	**15**	*21*
	59	*30*	*89*	*23*	*86*	*89*
Spray equipment						
owned	**46**	**25**	*71*	**18**	**53**	*71*
borrowed	**13**	**5**	*18*	**5**	**13**	*18*
	59	*30*	*89*	*23*	*86*	*89*

15 years back in their farming experience (Dyck, 1977). There are good reasons to question whether what farmers observed in their fields was actually rice tungro virus disease (RTV). The description which was provided in many cases however strongly suggests that RTV – and not, for example, zinc deficiency – was the predominant cause of the disorder.

All the farmers involved in the survey used insecticides in their current, routine farming practices. Insecticides, however, were part of only 55.1% of farmers' actions (action 2, action 3, and action 5) against perceived pest threats. The gap between 55.1% insecticide use in emergency, threatening situations, and 100% insecticide use in routine practice may reflect two types of reasons for insecticide applications. A direct reason is to eliminate a threat by means of a chemical compound. A more subjective reason is to comply with the standards associated with progressive, modern rice production (Kenmore et al., 1987). From the farmers' point of view (Elazegui, pers. comm.), the use of pesticides is one component only of a whole process – high yield rice production –, and spraying insecticides as an elementary component of the process does not require specific justification. The subjective reason appears stronger than the direct one.

Correspondence analysis. Two axes were generated by correspondence analysis, that accounted for almost all (99.0%) the information involved in the generation of the framework of the analysis (Table 2). These axes were used to plot the different variables (Fig. 1). Three subsets, backgrounds (Fig. 2A), perceptions (Fig. 2B), and actions (Fig. 2C) are also represented.

Examination of the diagram for the variables representing the farmers' background (Fig. 2A) indicates that young farmers are less concerned about (distant from) BPH and

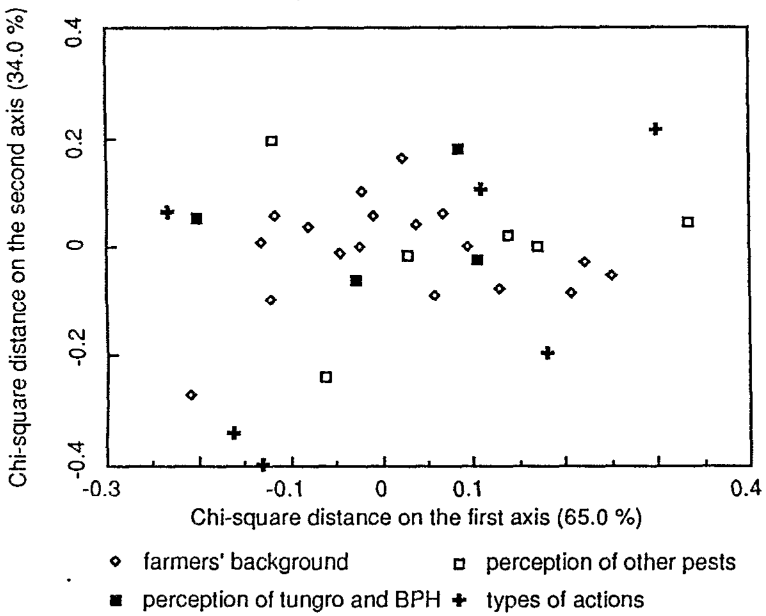

Fig. 1. A correspondence analysis of farmers' background, perceptions, and pest management actions in Central Luzon, Philippines. Plot of all variables. All variables are shown on the diagram: farmer's background (diamonds), perceptions with high frequencies (solid squares), perceptions with low frequencies (open squares), and actions (crosses). Symbols indicate the location of variables, using a chi-square distance along the two first axes generated in the analysis. The percentages of information contained in Table 2 that are accounted for by each axis are indicated.

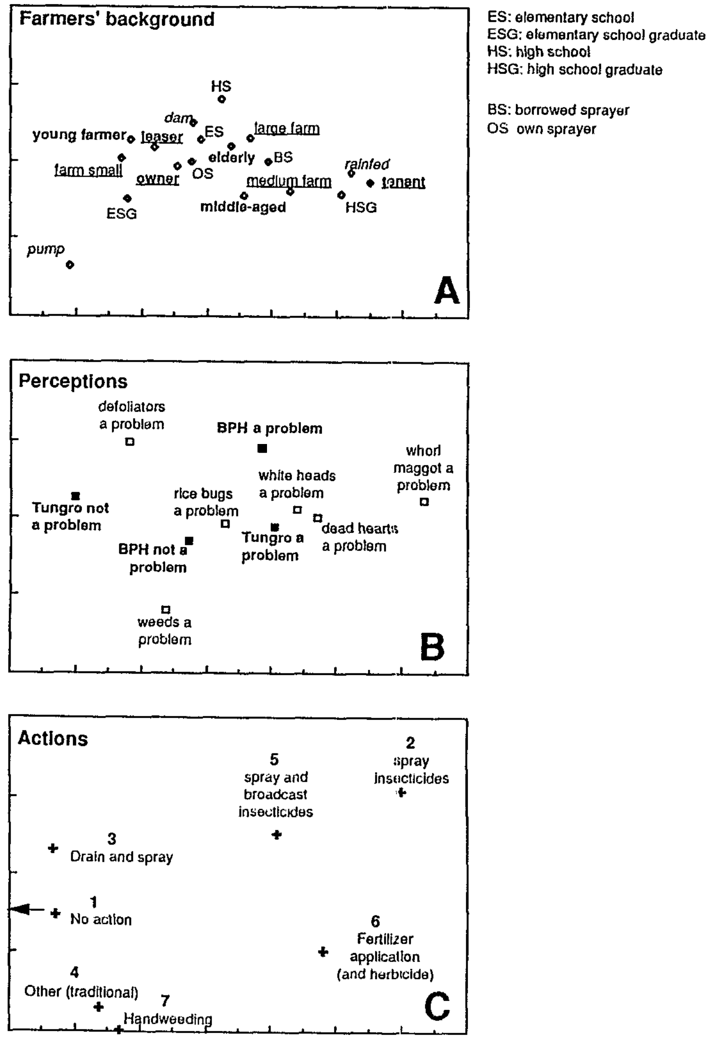

Fig. 2. A correspondence analysis of farmers' background, perceptions, and pest management actions in Central Luzon, Philippines. Associations within groups of variables. A: farmers' background (all the variables are involved in the definition of axes); B: farmers' perceptions (only the variables materialized by solid squares are involved in the definition of axes, those materialized by open squares were superimposed to the axes); C: farmers' decisions (variables to be explained, all were superimposed to the axes). Proximity of attributes indicates correspondence, the more so when distance to the origin of axes increases.

tungro (Fig. 2B) than other groups (middle-aged and elderly). In general, they have had less pest problems on their farms, possibly because of shorter farming experience. If so, this pattern would indicate that concerns about pests among this population of farmers do not disappear quickly, as both tungro (Savary et al., 1993) and BPH (Litsinger, 1993) outbreaks have been sporadic in Central Luzon. Leasers and owners (Fig. 2A) appear to have less pest concerns than tenants, who are usually concerned with both tungro and BPH. The distribution of perception of pest problems with low frequencies (especially whorl maggot, dead hearts, and white heads) suggests that they are predominently associated with tenants and rainfed farms.

Although differences in education levels in terms of perceptions are suggested, they do not translate into easily interpretable relations with pest control actions (Fig. 2C). For instance, 'high school' is close to 'elementary school', and these two categories are predominantly using insecticides in their pest control actions (Actions 5 and 2). The consideration of tungro, and even more so, of BPH, as a problem is closely associated with insecticide use.

Behavioral models. Mumford and Norton (1984) developed two behavioral models – termed static and dynamic – to represent tactical and strategic decision-making in plant protection. The analysis of these survey data was based on three sets of variables that represent components, or groups of components, of a behavioral system. Fig. 3 is a representation of this system, using a state-rate approach (Forrester, 1961), that strongly draws upon Mumford and Norton's models, and encompasses their main features: perceptions, goals, action, and outcome. It also incorporates a flow of information which, from an initial state of accumulated knowledge, is converted into attitude, and perception (Zadoks, 1985). The successive stages represent how raw information is progressively transformed, and distilled into the ready-to-use information needed for decision. The ACCUMulation rate incorporates training, personal experience (through assessment of outcomes), and information channels (Zadoks, 1981). The TRANSformation rate converts knowledge into an attitude state, i.e., a mental environment for decision. It is made of management

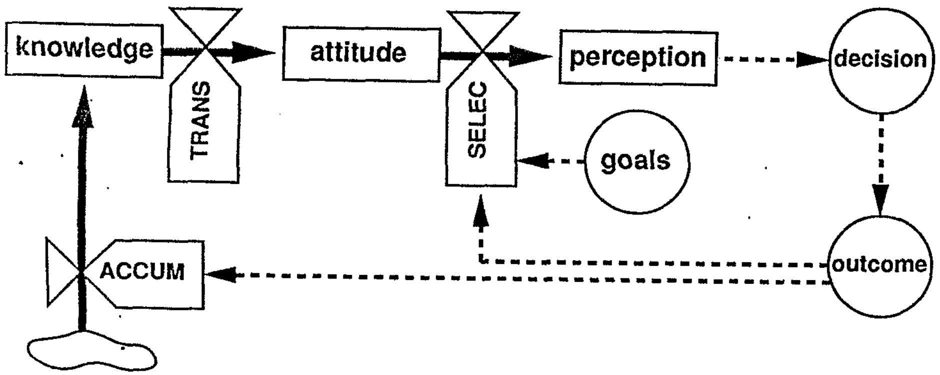

Fig. 3. Outline of a systems model for decision-making in crop protection. Knowledge: pool of information accumulated by farmers through training, experience, and information channels. Attitude: pool of information that makes the mental environment for decision: concepts, standards, and references. Perception: pool of information directly involved in decision-making: problem definition, and options (See text for details).

options, standards, and references – farmers do have strong standards in pest management (Kenmore et al., 1985). From the pool of concepts that make an attitude, a few are SELECTed as components of a perception – whether a pest is a problem or not, and what are the options –, from which a decision is derived. The SELECtion is strongly influenced by goals, and previous outcomes.

This flow diagram illustrates, for example, the (simplified) succession of events: a young farmer learns (ACCUM) from a more experienced neighbor that (a) 'insects' (such as BPH) can cause devastating effects on a rice crop, but (b) can be killed with a pesticide. He may then consider (TRANS) that (c) spraying is an easy field operation to conduct, which (d) corresponds to the status of progressive, active farmer he wishes to sustain among his community. The expectation of a reasonably good yield may then lead him to judge (SELECT) that (e) any threat such as 'insects' (BPH) on his crop cannot be tolerated, and (f) that spraying is the most convenient way to eliminate it.

The analysis dealt with the end-product of the process, actions, as influenced by perceptions and a number of factors that may affect the accumulation of knowledge, and the development of attitude. The survey concentrated on individual farmers, but the diagram of Fig. 3 does not imply specified limits: it might be considered at the household, or at the farming community level as well. The analysis could not indicate whether the structure outlined in Fig. 3 is valid, but showed a pattern of relationships that are not contradicting it. Further surveys might consider this structure as a framework for sampling and analysis.

Conclusion. The formal exploitation of information of categorical nature using multiple correspondence analysis allowed to produce a 'map' (Fig. 1) of the relationships between the farmers' backgrounds, perceptions of pests, and actions which were taken to control them. This analysis illustrates the relationship between concerns about pests – especially BPH and tungro –, and the use of insecticides. The close association between outbreaks of BPH and insecticide misuse has been extensively documented (Reissig et al., 1982; Heinrichs and Mochida, 1984; Litsinger, 1993). The case of tungro is not as illustrative; there is, however, a building body of circumstancial evidences suggesting that insecticide sprays against tungro often are of little efficacy, if not useless (Litsinger, 1993; Savary et al., 1993).

The association of 'high school' and 'elementary school' farmers, together with the perception of BPH and tungro as problems, and with the use insecticides, suggests that the duration of formal education has little to do with perceptions and actions. The origin of shared attitude and perception in these two groups might be found in shared channels of information. These chanels might be explored to introduce principles of integrated pest management among farmers efficiently.

Farmers' perceptions and actions do vary strongly depending on their background. The analysis demonstrates that farmers should be approached accordingly in order to develop integrated pest management methods.

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