Decision analysis techniques[1]

In an agricultural system, apart from farmers, policy, research, extension, and industry decision makers, play key roles in improving pest management. Each group requires different types of information, framed in different ways, on which respective decisions are based (Heong 1989). A useful framework to consider is the basic decision model developed by Mumford and Norton (1984) (Fig 5.1). On the basis of perceptions of the problem and the options available, the decision maker assesses the expected outcomes and the choice of action is dependent on evaluations in terms of personal objectives.

As illustrated in Figure 5.1, the decision making process is an amalgam of both rational and sociopsychological factors. Agricultural decision analysis (Raiffa 1970, Halter and Dean 1971, Anderson et al 1977) or modern decision analysis (Kaufmann and Thomas 1975) studies the rational factor in order to clarify ways in which decisions should be made. It is an approach that allows a decision maker to carry out a thorough and logical evaluation of alternative strategies in order to determine systematically the "best" available strategy in terms of an objective criterion. This approach is sometimes called prescriptive analysis, whereas the analysis of the socio-psychological factors is called descriptive or behavioral analysis (Kleindorfer et al 1993).

Simon's (1959) concept of bounded rationality is a useful means to think about decision making and, recently Gigerenzer et al (1999) added an extension to bounded rationality (Fig 5.2). This framework views rationality as unbounded and bounded. Unbounded rationality involves models that optimize based on Bayesian approaches, while bounded rationality involves models that reflect real life decisions. Recent studies on human judgment and choices have shown that the prescriptive models are unable to account for how people actually make decisions (Slovic et al 1977, Simon 1978, Rabia and Thaker 2001). Most people violate the prescriptive principles because decision making is behavioral in nature (Einhorn and Hogarth 1981). In this chapter, we shall discuss concepts and techniques used to understand both the prescriptive and descriptive aspects of decision making.

2.1 Decision trees

Participants contemplating a problem often see a range of possible decisions spread over a period of time. A tree diagram is useful in structuring the sequence of decisions and allows ones to break down a big decision problem into a series of smaller problems that may be solved separately. This device enables participants to see an array of possible options as well as the sequential nature of decisions. Figure 5.3 illustrates a series of pest management decisions a rice farmer may need to make at each stage in a crop cycle.

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[1] M.M. Escalada and K.L. Heong. 2009. *Training Manual for the Workshop/Training on Decision Making, Sociological Tools and Impact Assessment in Pest Management.* IRRI-ADB RETA 6849. Reducing Vulnerability of Crops to Pre-Harvest Losses Caused by Planthopper Pest Outbreaks.

Ideally, the farmer examines his crop and decides on whether control action is needed, based on his recognition of the pests and knowledge. If control is needed, he will decide on which type of control to use. For considering pre-planting options such as the choice of resistant varieties, a strategic decision tree may be useful (Fig 5.4). Further details on decision trees and their applications may be found in Moore and Thomas (1976) and Kaufman and Thomas (1977).

Rule-based advisory matrix

Norton (1987) developed this tool to structure knowledge required to make recommendations for a stored grain pest. It has been applied to structure information for expertise system building in brown planthopper management in China (Holt et al 1990) (Fig 5.5). The matrix was applied in a workshop to consider recommendations for a series of situations where various factors were present. In Fig 5.6 a dot in the matrix cell means that the factor was present and one of nine recommendations could be chosen. For instance, in situation 6, if the rice variety was susceptible to rice blast, weather was favorable, nitrogenous fertilizer was overused, and the crop is at heading stage, then the recommendation was to spray with the fungicide, isoprothiolane.

Policy option matrix

The policy option matrix provides a means for participants to consider various options with respect to different objectives (Norton and Heong 1988). The example in Fig 5.7 concerns options available to the Department of Agriculture in Malaysia to respond to an outbreak of the brown planthopper. This framework provides a means for discussion among officials in the Department to collectively arrive at an option that best fits the situation in the technical, economic, and political contexts. Aside from helping the analysts identify politically unfeasible options, the matrix can also help determine the most sensitive criteria on which further analysis should concentrate.

Pest belief model

The pest belief model (Fig 5.8) provides a framework for understanding and quantifying relationships between beliefs and pest management decisions (Heong and Escalada 1999). Four basic beliefs determine farmers' decisions:

(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.

By using farmer survey techniques discussed in the next chapter, we can obtain estimates of these beliefs, quantify them, and establish relationships with dependent variables such as spray frequencies and pesticide expenditures.

2.2 Understanding social contexts

In analyzing decision making, social contexts are important considerations. As pointed out by Gigerenzer (1996), traditional axioms and rules are insufficient to explain behavioral choices as they depend on social objectives, values and motivations. Social emotions also play a significant role in decision-making (Elster 1999).

2.2.1 Theory of Reasoned Action/Theory of Planned Behavior

Fishbein and Azjen (1975) first formulated the Theory of Reasoned Action (TRA) and Heong and Escalada (1999) used it to analyze rice farmers' stemborer management decisions. This model provides a framework for understanding motivational influences on decision behaviors and to help identify how and where to target strategies for changing behaviors. The TRA suggested that a person's behavior is determined by his/her intention to perform the behavior and that this intention is in turn a function of his/her attitudes towards the behavior and his/her subjective norm attitudes. Thus in addition to pest beliefs as outlined in the pest belief model discussed earlier, the TRA suggests that equally important are attitudes related to social pressures which make up the subjective norm components. In some cases, subjective norm attitudes may have stronger influence than belief attitudes in farmers' decisions as shown in Lao farmers (Heong et al 2002).

The TRA assumes that behavior is voluntary and decision-makers have full control of taking the preferred action. However, often this may not be the case and Ajzen (1991) revised the TRA model by adding the component, perceived behavioral control, and formulated the Theory of Planned Behavior (TpB) (Fig 5.9). This model provides additional power to analyze farmers' pest management decisions, especially in understanding the constraint to adopting certain management options. Numerous applications of the TpB are reported in health sciences (Godin and Kok 1996, http://hsc.usf.edu/~kmbrown/TRA_TPB.htm) and further details are available in http://www.people.umass.edu/aizen/

2.2.2 Ethnoscience techniques

Ethnoscience is the study of perceptions, knowledge, and classification of the world as reflected in their use of language. Ethnoscience has been used by many different disciplines; thus there are studies in ethnobotany, ethnopedology, ethnoforestry, ethnoveterinary medicine, and ethnoecology. Most ethnoscience research has dealt with specific domains, such as folk medicine; classifications of plants, fish, and birds; and pest management (Bentley and Rodriguez 2001).

In the field of economics, the use of local taxonomic categories has been applied to analyze the effects of different types of soil on the adoption of new maize seed varieties. Bellon and Taylor (1993) asked farmers about the various soil types on their land, what characteristics they attributed to each type, and how they ranked those soils in terms of their suitability for maize production. Their hypothesis was that farmers' perceptions of the soil qualities on their farms significantly affect their decision on whether to adopt new technology. Their results showed that the perceptions of land qualities did indeed affect the adoption of new seed varieties. It was suggested that this type of analysis can be taken one step further by examining local classifications of such economic terms as benefits, costs, insurance, interest, security, and risk, in order to determine whether these are locally meaningful concepts.

Since decision-making is defined as the intentional and reflective choice in response to perceived needs, understanding farmers' perceptions and how they name and classify nature is an important first step toward improving decisions. To obtain some insights into farmers' cognitive structures, we found two ethnoscience tools very useful (Bentley 1999).

Folk taxonomy

Folk taxonomy is considered an important indicator of diversity relating to how crop populations may be treated differently. Eyzaguirre (2003) noted that by developing many names for crop types, farmers are effectively segregating populations and often treating them differently. Local knowledge about a crop variety helps to transmit plant knowledge around the community such as knowledge of associated pests and diseases. Folk taxonomies have hierarchical levels similar to formal biological classifications of kingdom, phylum, class, order, family, genus, and species (Berlin 1992). In folk taxonomy, the common levels are:

Life-form -a high level of plants or animals that share some general shape or characteristic in morphology. Examples: tree, vine, bush, fish, snake, bird, mammal.

Generic - the most common basic level. Examples are dog, grass, and rice ant. Folk genera often do not correspond to scientific genera but sometimes to Linnaean species or family. For instance, "dog" is a folk genus and a Linnaean species; "ant" is a folk genus and belongs to Linnaean family formicidae.

Specific - usually separated from each other by a few characteristics. In some languages, such as Spanish, Bahasa Indonesia, and Malaysia, the generic name comes first, as in a Linnaean name. In English, Filipino, Chinese, Vietnamese and Thai, it is the other way around. Specific names tend to be a pneumonic device -- like color, shape, and utility -- that makes the names easy to remember. Figure 5.10 shows farmers' classification of leaf-feeding insects in Leyte, Philippines

Besides being hierarchical, folk taxonomy may be applied in naming parts of an object or stages of the crop (partonomy). Farmers may have names that lump groups of parts that biologists differentiate or they may have finer definitions of parts than what biologists describe. For instance, Figure 5.11 illustrates stages of the rice crop named by Filipino farmers.

Emic-Etic framework

Etic and emic are terms coined by linguistic anthropologist Kenneth Pike (see Franklin 1996), which were derived from an analogy with the terms "phonemic" and "phonetic". *Etic* categories involve a classification according to some external system of analysis considered as appropriate by science. This is the approach of biology where the Linnaean classification system is used to define new species. It assumes that ultimately, there is an objective reality that is seen to be more important than cultural perceptions of it. In contrast, *emic* categories involve a classification according to the way in which members of a society perceive and classify their own world.

Thus *emic-etic* roughly means local versus scientific knowledge and this framework provides a convenient tool for researchers to obtain accurate descriptions of farmers' knowledge or concepts and compare it with scientific knowledge or concepts on the same topic (Fig. 5.12).

Figure 3.1

***Emic - Etic* Framework**

Location : ______________________________ Date: _______________________

Topic : ____

Variable/Character Descriptions	Emic (Local Knowledge)	Etic (Research Knowledge)