THE DECISION MAKING PROCESSES OF SEMI-COMMERCIAL FARMERS: A CASE STUDY OF TECHNOLOGY ADOPTION IN INDONESIA

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An exploration of the creation and use of farmers' commonly used "rules of thumb" is required to conceptualize farmers' decision making processes. While farmers face complex situations, particularly when subsistence is an issue, they do appear to use simple rules in their decision making. To date inadequate attention has been given to understanding their reasoning processes in creating the rules, so this study traces the origins of farmers' beliefs, and extracts the decisive and dynamic elements in their decision making systems to provide this understanding.

The analysis was structured by using a model based on the Theory of Planned Behaviour (TPB). Modifications included recognizing a bargaining process (BP) and other decision stimuli to represent socio-cultural influences and sources of perception, respectively. Two analyses based on the Personal Construct Theory (PCT) and the Ethnographic Decision Tree Modelling (EDTM) were also applied to help elaborate the farmers' cognitive process and actual decision criteria. The method involved interviews in two villages in Lamongan Regency in East Java Province of Indonesia, where the farmers adopted an improved paddy-prawn system ("pandu").

The results highlighted that farmers use rational strategies, and that socio-cultural factors influence decision making. This was represented by interactions between the farmers' perceptions, their bargaining effort, and various background factors. The TPB model revealed that the farmers' perceptions about the potential of "pandu", and the interaction with their "significant others", influenced their intention to adopt "pandu". The farmers appeared to prefer a steady income and familiar practices at the same time as obtaining new information, mainly from their peers. When "pandu" failed to show sufficiently profitable results, most farmers decided to ignore or discontinue "pandu". This became the biggest disincentive to a wide and sustainable adoption. However, the PCT analysis showed that part of this problem also stemmed from the farmers' lack of resources and knowledge.

The farmers' restrictive conditions also led them to seek socio-cultural and practical support for their actions. This was highlighted by a bargaining process (BP) that integrated what the farmers had learned, and believed, into their adoption behaviour. The BP also captured the farmers' communication strategies when dealing with "pandu" as its adoption affected resource allocation within the family and required cooperation with neighbours. The PCT and EDTM analyses also confirmed how the BP accommodated different sets of decision criteria to form different adoption behaviours. Such a process indicated the importance of considering the adoption decision and the relevant changes resulting from the farmers' cognition. This provided a more dynamic and realistic description of the farmers' decision-making process than has previously been attempted.

Overall, the results suggested that semi-commercial farmers need to know, and confirm, that a new technology is significantly superior to the existing system, and can provide a secure income. The introduction of a new technology should use a participatory approach allowing negotiation, conflict mitigation and the creation of consensus among the relevant parties. This can be supported through better access to knowledge, information and financing. A specific and well-targeted policy intervention may also be needed to accommodate the diversity in the farmers' ways of learning and making decisions. Ways to improve the current analytical approaches are also suggested.

Keywords: decision, adoption, semi-commercial farmers, planned behaviour, bargaining process, personal construct, decision tree, Indonesia

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABREVIATIONS

AARD	Agency for Agricultural Research and Development
ADF	Asymptotically Distribution Free
AEA	Agro-ecosystem Analysis
AIAT	Assessment Institute for Agricultural Technology
AIEC	Agricultural Information and Extension Center
AMOS	Analysis of Moment Structure
ANOVA	Analysis of Variance
B/C	Benefit-cost ratio
BIMAS	*Bimbingan Massal* (Mass Guidance)
EDTM	Ethnographic Decision Tree Modelling
FEW	Field Extension Workers
FFS	Farmer Field School
FPR	Farmer Participatory Research
FSR	Farming System Research
FTT	Farmer Terms of Trade
GDRP	Gross Regional Domestic Products
IDR	Indonesian Rupiah
IPM	Integrated Pest Management
INMAS	*Intensifikasi Massal* (Mass Intensification)
INSUS/SUPRA-INSUS	*Intensifikasi Khusus* (Special Intensification)
KEPAS	*Kelompok Peneliti Agro-ecosystem* (Agro-ecosystem Research Group)
LAP	Land Administration Project
MLE	Maximum Likelihood estimation

PAR	Participatory Action Research
PCT	Personal Construct Theory
PRA	Participatory Rural Appraisal
PTD	Participatory Technology Development
RMSEA	Root Mean Square Error of Approximation
RRA	Rapid Rural Appraisal
RepGrid	Repertory Grid
SEM	Structural Equation Modelling
TLI	Tucker-Lewis Index
TPB	Theory of Planned Behaviour
USD	United States Dollar

CHAPTER ONE: INTRODUCTION AND STUDY OUTLINE

1.1 Motivation

The structure of the agricultural decision making process in technology adoption in developing countries is inadequately understood. The reason may relate to the complexity of the farmers' conditions, particularly when subsistence is an issue. It may also relate to discrepancies in categorizing farmers' adoption-decision behaviour. While farmers may perceive their decision as satisfactory considering their situations, they may be other than rational in an economic sense, in defining their goals and in evaluating a problem or an opportunity (Ohlmer, Olson, & Brehmer, 1998). Their decisions may be viewed by others, such as economic researchers, as less than optimal.

Such discrepancies may stem from the fact that much of the research on adoption-decisions has concentrated only on the decision outcome (e.g. adoption behaviour), and ignores the actual process that farmers undertake. The actual process may involve various decision stimuli. Examples may include the level of physical assets, human capital, access to productive resources, risk attitudes (Feder, Just, & Zilberman, 1985); agro-ecosystem and types of technology (Pingali, Rozelle, & Gerpacio, 2001), the particular farming season (Moser & Barrett, 2003), as well as chance factors such as who their neighbours and village colleagues are (Case, 1992; Munshi, 2004; Pomp & Burger, 1995; Zhang, Fan, & Cai, 2002). How these factors are involved in shaping the farmers' adoption-decision seems to vary. Therefore, individual farmers seem to show unique adoption behaviour. This also makes conceptualizing the farmers' decision making pattern difficult.

In the real world, farmers' decision making process often appears to be simple, even if the underlying processes are complex. Part of this simple process probably relates to the fact that farmers perceive farming as a way of life (Ohlmer et al., 1998) and that farmers use simple criteria and approaches as rational strategies in dealing with uncertainties in decision making (Murray-Prior, 1998; Ohlmer et al., 1998). These findings resulted from studying Western farmers. However, semi-commercial farmers in developing countries may apply different approaches due to their limited access to information and low level of education.

To understand semi-commercial farmers' actual decisions, one might need to explore how farmers' simple decision rules give rise to a particular decision or behaviour. Ajzen's (1991; 2002a) Theory of Planned Behaviour (TPB) has provided a useful framework for explaining the relationships between farmers' decision variables and behaviour. The TPB may help elicit the farmers' rules of thumb (heuristics), which often determine the final decision but are latent in nature. Using this model, farmers' decision rules can be distinguished according to their perceptions and attitudes, to their belief that they have the power to deal with problems and opportunities, as well as to the extent of socio-cultural influences.

However, the standard TPB model still has limitations in that it generally falls short of a successful prediction. For example, it cannot deal with the doubts (e.g. Burton, 2004) about whether an attitude always leads to the same actual behaviour, through the influence of people close to the decision maker. To enhance the model, it seems logical to add a bargaining process to the model to represent the farmers' continuous effort to find social justification. The bargaining process, thus, may become the decisive factor directing the farmers' intention and final decision, especially if the socio-cultural influences are still strong.

Another limitation is that a standard TPB questionnaire only captures the surface variables behind one's behaviour in contrast to an individual's basic structural characteristics (Nuthall, 2005)[1]. The questionnaire frames the subject's behavioural beliefs, normative beliefs and control beliefs that are supposed to be unique. All of these are dependent on a person's experience, personality, intelligence and culture as

[1] Personal communication, 1 April 2005

well as chance events. One way of overcoming this limitation is through employing an interview based on Kelly's (1955) Personal Construct Theory (PCT). The interview has proven to be an effective way of delineating a farmer's personal constructs in detail. The results may help explain the way farmers interpret and use simple clues when making decisions. In addition, the shared rules identified from the PCT interview would help explain how a farmer influences others and, at the same time, learns from others, and how their interactions influence the farmer's usage of decision rules and behaviour.

The focus of the TPB analysis may also be expanded to go beyond decision heuristics. The analysis should also investigate the method(s) farmers use to create their decision rules. One way of achieving this is by using Ethnographic Decision Tree Modelling (EDTM, Gladwin, 1989a), in which farmers' decision criteria are identified through direct and hierarchical processes. The results show the farmers' actual decision criteria and the different paths used by different farmers to evaluate a technology and make an adoption or non-adoption decision. The latter, in particular, will explain differences in the adoption and non-adoption behaviour among farmers. The results may also improve the standard TPB model by showing that the relationships between farmers' beliefs, attitudes and behaviour may not always be direct and linear.

In summary, further research is needed to better understand and predict adoption behaviour in semi-commercial agriculture. This can be done through integrating different approaches, such as TPB, PCT and EDTM. The combination is expected to provide a more thorough analysis of semi-commercial farmers' decision making processes than was hitherto available.

1.2 Background

The next four subsections will present a brief background to this study. Some important decision making analyses will be summarized, and this is followed by an overview of the concept of heuristic analyses. The analytical approach of this study will also be outlined, with the last subsection covering the experience of agricultural technology adoption in Indonesia.

1.2.1 Decision Making Analysis

Rogers (1993) and Ohlmer et al. (1998) have provided a basis for analyzing a realistic and complete decision making process. Rogers (1993, p. 164-191) postulates the infamous five sequential steps of the "*innovation-decision process*", which include knowledge (awareness), persuasion, decision choice, implementation and confirmation. Meanwhile, Ohlmer et al. (1998, p. 285) suggest a non-sequential decision concept involving a matrix relationship between four main decision stages (problem detection, problem definition, analysis and choice, and implementation) and four sub-stages (searching and paying attention, planning, evaluating and choosing, and bearing responsibility).

The matrix concept, in particular, seems to be more robust because it describes the decision making process as a non-static, non-linear, inconsistent process and, hence, non-sequential, which is in contrast to Rogers's concept. However, the concept was formulated based on commercially oriented farmers in a developed country and, thus, may not always apply in the case of farmers in developing countries who may have different orientations, capacity and environments.

The latter premise leads to the need to elaborate on the two concepts further. For example, it may be important to assess how poor farmers search and exploit information in their decision making process using Rogers's concept. This is critical in developing countries where information is not equally distributed and most farmers have poor learning skills (Just, Wolf, & Zilberman, 2003). Rogers's concept may also be expanded to consider the role of socio-cultural factors. This can be based on social norms and relationships which still play an important role in developing countries (Conway, 1987; Sejati et al., 2002; Suradisastra, Sejati, Supriatna, & Hidayat, 2002). In the case of technology adoption, this is shown in the form of peer copying. Such practices occur because farmers have limited resources, and poor access to information and skills (Munshi, 2004; Pomp & Burger, 1995). The neighbour effect, however, varies since each farmer influences, and is influenced by, others in different ways (Case, 1992; Zhang et al., 2002). This may imply the existence of social learning and bargaining processes.

Many studies (e.g. Asfaw & Admassie, 2004; Kaliba, Featherstone, & Norman, 1997; Lawrence, Sanders, & Ramaswamy, 1999; Savadogo, Reardon, & Pietola, 1998; Sejati et al., 2002; Sulaiman, 2002) suggest that a bargaining process among household members may influence and complicate a farm household's decision making process. This is neglected in the analyses of Ohlmer et al. (1998) and Rogers (1993). Lawrence et al. (1999) argue that the bargaining process is an important part of the household strategy for survival. The process moderates the conflict of interests among the family members, as well as between the household's internal needs and the changes in environment (McGregor, Rola-Rubzen, & Murray-Prior, 2001; Romero & Rehman, 2003). This process results in a collective decision.

The bargaining process may also occur within a community. This kind of social bargaining process may result from certain types of behaviour, such as social affiliation, social comparison and social imitation (Marsh, 2002). In the case of agricultural technology adoption, the social bargaining is usually evident in a risky environment, where farmers have limited resources and poor access to information and skills (see IDS Workshop, 1989b; Munshi, 2004; Pomp & Burger, 1995). These farmers may rely on direct observation, comparison and peer copying practices (Feder et al., 1985; Neill & Lee, 2001; Pomp & Burger, 1995) to bypass the risk of faults and, at the same time, they may endeavour to find social reinforcement and negotiate their interests against social values.

The recognition of both an intra-household and a social bargaining process, thus, would clarify the dynamic nature of the farmers' decision making process. It may expand the scope of the "responsibility bearing" sub-stage in the matrix concept of Ohlmer et al., especially in less-developed farming communities where the role of social norms and relationships is still important. It may also elucidate how farmers learn from others and their environment to create a simpler, more manageable and more directive way of making decisions.

Nevertheless, it is still difficult to recognize the pattern of farmers' decision making process because it may be intuitively modified according to the decision contexts. A proper analytical framework, hence, is needed. This starts with the exploration of the farmers' preference on simple rules (heuristics) in making decisions. This subject will be briefly discussed next.

1.2.2 Heuristic Analysis

The study may also usefully be expanded to assess how farmers strategically and repeatedly seek and use information in decision making. This process may relate to the concept of "heuristics" or "*informal rules-of-thumb*" (Kahneman & Tversky, 1974, cited in Heong & Escalada, 1999).

There are many definitions of heuristics in the literature. For example, Marsh (2002) defines heuristics as "*cognitive shortcuts that enable individuals to make evaluations on the basis of one or a few simple rules or cues, thereby avoiding the processing and time costs related to exploring an exhaustive set of possibilities*" (p. 49). A very similar definition is also provided by Collentine, Larsson and Hannerz (2004), who define heuristics as "*... a cognitive method for reducing the decision fields of complex problems to make them tractable, a technique associated with rationally bounded decision makers* (p. 307), … *a type of simple decision rule that lowers the cost of accessing and processing information* (p. 304)." A more complete definition can also be found in http://www.learningframework.com/define-heuristic.html (Learning Framework, retrieved 14 January 2005):

> *"A heuristic (hyu-'ris-tik) is the art and science of discovery and invention. The word comes from the same Greek root as "eureka" meaning "to find". A heuristic for a given problem is a way of directing your attention fruitfully to a solution. It is different from an algorithm in that a heuristic merely serves as a rule-of-thumb or guideline, as opposed to an invariant procedure. Heuristics may not always achieve the desired outcome, but can be extremely valuable to problem-solving processes. Good heuristics can dramatically reduce the time*

> *required to solve a problem by eliminating the need to consider unlikely possibilities or irrelevant states. As such, it is particularly useful to those in the process of discovery and they are constantly rethinking their strategies in the face of a stubborn unknown."*

All the definitions seem to refer to rules that allow the evaluation of a particular decision in a simpler, more manageable and, at the same time, directive way. The rules are conceived by the decision maker and are constantly being reviewed.

The heuristics mainly stem from the decision maker's observations, perception and past experiences (Antonides, 1996; Marsh, 2002; Tversky & Kahneman, 1982). In agriculture, the heuristics may reflect the farmers' individual way of learning about, and responding to, a particular event. Farmers' reliance on mind-based record systems and their past experience (see IDS Workshop, 1989b; Ohlmer et al., 1998) in making decisions may reflect the application of individual heuristics. On a wider scale, peer observation and small-scale trials are examples of a social heuristic application in agricultural technology adoption (Collentine et al., 2004).

There are four key principles in studying the application of decision heuristics (decision rules of thumb) by farmers in developing countries. First, the farmers are assumed to operate within the context of bounded rationality as they face structural problems such as a low quality of human capital and limited access to inputs, labour, credit and information (Feder et al., 1985; Mukhopadhyay, 1994; Pingali et al., 2001; Shiferaw & Holden, 1998). Another bound relates to the farmers' efforts to preserve their existing working pattern, reflecting the view of farming as a way of life. This may be observed from the farmers' "*satisficing*" behaviour and preferences for a "*quick and simple*" decision making approach (Ohlmer et al., 1998). Although the use of decision heuristics may not always result in an optimal outcome, the decision is still realistic (Simon, 1987).

The second principle is that the type and pattern of decision heuristics are assumed to vary across farmers, type of technology/policy/institutional structure, as well as levels of resource endowment. This implies that the farmers may not be consistent in using decision heuristics due to differences in the extent of information usage and the process of construing the information (Collentine et al., 2004). Heuristic analysis may deal with this issue by detecting the quantity, quality and cost of information involved in the farmers' decision making process.

The last premise also justifies the third principle which refers to the need to analyze the consequences of decision heuristics. Relative to following formal investment analysis decisions, decision heuristics will most likely increase the transaction costs, especially the costs of accessing and construing the information (Collentine et al., 2004), but will not be nearly as costly in time and resources as full analyses. Nevertheless, the costs may be substantial since most farmers have limited access to information or capacity to process and record information (see IDS Workshop, 1989b; Just et al., 2003). The use of decision heuristics may also conceal biases, particularly related to the reliability in the methods of heuristic formulation. This is quite crucial in the case of farmers in the developing world, since according to Bentley (1989, cited in Heong & Escalada, 1999, p. 316), these farmers often make inaccurate judgments when using indigenous knowledge as their decision heuristic.

Finally, the fourth principle assumes that a decision heuristic approach may permit the analysis of the farmers' risk attitudes. An experimental study by Muller (2001) shows that risk aversion may cause people to ignore some information and take a short-cut procedure in problem solving. Muller (2001, pp. 503-508) classifies seven behavioural patterns related to risk attitudes, examples being *qualitatively optimal behaviour*, *consistent but not qualitatively optimal behaviour*, '*go-for-the maximum*' *policy*, *cautious policy*, *wait-and-see policy*, *'2'-heuristic*, and *trial policy*". These behavioural patterns appear to confirm the types of decision heuristics identified by other analysts (see Antonides, 1996; Marsh, 2002; Tversky & Kahneman, 1982), Simon's (1987) bounded rationality concept, and some adoption behaviour (see Jangu, 1997; Rogers, 1993). Thus, there may be a close link between the farmers' risk preferences, decision heuristics and adoption behaviour.

It may be difficult, however, to recognize the general pattern of heuristic application in adoption-decision making. This may relate to unconscious stages in the heuristic formulation (Collentine et al., 2004; Marsh, 2002) involving the arbitrary creation and selection of heuristics. These stages may cause an inconsistent heuristic application over time. Some (e.g. Marsh, 2002; Muller, 2001) also argue that, even if a general pattern of heuristics is observed, the pattern may be intuitively modified or changed as the decision makers continuously add to their stock of knowledge. Thus, a proper analytical framework is needed to estimate the pattern of heuristic usage in adoption-decision making. This will be briefly outlined next.

1.2.3 Analytical Approach

A model based on the Theory of Planned Behaviour (TPB, Ajzen, 1991; 2002a) can be used as a general framework for analyzing farmers' mental processes and the latent factors in their behaviour. The TPB model assumes that a person's behaviour is affected by her/his attitudes, social pressures ("*subjective norms*") and "*perceived behavioural control*". Her/his attitudes are developed based on the beliefs of the likely benefits and consequences of the behaviour. The social pressures may reflect social expectations and the person's motivation to comply with the norms. Meanwhile, perceived behavioural control depicts the person's beliefs of her/his own capacity to handle the behaviour. The relationships between behaviour and its precursors are mediated by the person's intention. It is believed that the development process of one's attitudes, the actualization of social pressures ("*subjective norms*") and the interpretation of "*perceived behavioural control*" may indicate the process of heuristic development. Therefore, the TPB model can be used as a general framework for analyzing farmers' mental processes and the latent factors in their behaviour.

The applications of a TPB model in agricultural related areas are still limited, but so far they have shown promising results (see Beedell & Rehman, 2000; Bergevoet, Ondersteijn, Saatkamp, Van Woerkum, & Huirne, 2004; Chetsumon, 2005; Coleman, McGregor, Hemsworth, Boyce, & Dowling, 2003; Hrubes, Ajzen, & Daigle, 2001; Zubair & Garforth, 2006). The study by Zubair & Garforth (2006) appears to be the only study that has applied the TPB concept to the case of farmers in developing countries (tree planting).

The applications of TPB also appear to vary according to the case situation under study. Some modifications to the TPB framework are also suggested for this study because the behaviour under study has occurred in the past, and strong socio-cultural influences among the respondents are still apparent. The modification includes:

a) the use of actual behaviour, represented by the farmers' recent application and future plan. Other studies usually use an intention as a proxy of a behaviour;
b) the inclusion of some adoption stimuli or variables underlying the farmers' attitudinal and control perceptions, and social pressures;
c) the use of some measures of a bargaining process for representing the role of the individual learning process or socio-cultural influences in the farmers' decision making process.

The modifications are expected to expand the focus of the analysis not only to the motives underlying the farmers' adoption behaviour, but also on the decisive mechanisms that may change the direction of the farmers' beliefs and intentions. Such mechanisms may be explained through the recognition of the bargaining process involved, although this has not been considered in previous studies using a TPB model.

The TPB model should also be supported by a more thorough measurement procedure. This is because the TPB questionnaire can only provide a general sense of the latent variables of a person's mental process (Nuthall, 2005)[2]. The questionnaires also cannot explain why each farmer seeks and construes information in different ways and, hence, acts differently from one another. In other words, the TPB questionnaire cannot measure the processes of heuristic formulation and application, and different degrees of adoption and non-adoption behaviour.

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[2] Personal communication, 1 April 2005

Use of the Ethnographic Decision Tree Modelling (EDTM) and an interview based on the Personal Construct Theory (PCT) may overcome limitations in the TPB procedures. These methods can elicit more definite personal constructs; and combining these methods with the TPB questionnaire can improve the efficacy of the TPB model. This has been confirmed by some studies (e.g. Jangu, 1997; Murray-Prior, 1998) that sought explanations of different adoption behaviour among farmers.

The EDTM can directly reveal the hierarchical relationships among farmers' decision criteria, and between the decision criteria and the decision. These relationships may also reflect the methods used by farmers to process information and formulate heuristics (rules of thumb) to deal with new technology adoption. The different routes also help explain differences in the farmers' cognitive process and, hence, differences in the adoption and non-adoption behaviour among farmers. The results can confirm and improve the TPB model.

The use of a PCT interview may reveal a more detailed description of farmers' underlying motives, constructs, or heuristics related to their adoption or non-adoption behaviour. The constructs include both personal and shared constructs reflecting the farmers' behavioural, normative and control beliefs in the TPB model. The interview can also reveal a pattern of constructs that may indicate the structure of a farmer's attitude toward new technology adoption. The focus of the interview, thus, includes the elicitation of constructs related to the farmers' attitudes toward new technology adoption and their control beliefs; and of the heuristics involved in the bargaining process. The results may confirm and/or improve the EDTM and TPB model.

All the modifications are believed to strengthen the analysis of heuristic usage at each decision making step. The combination of TPB, PCT and EDTM is expected to improve the understanding of how farmers formulate rational decisions. The results may also allow the assessment of the relative efficacy of each method in measuring farmers' personal constructs.

1.2.4 Agricultural Technology Adoption in Indonesia

Considerable effort is needed to improve the productivity of Indonesian farmers. One approach is through technology application which can help the farmers deal with their structural problems and with the increasing pressures in agricultural resources and trade. However, the adoption rate of agricultural technologies in Indonesia is still low (see Ekalindo, Mardawilis, & Kardiyono, 2000; Kanro, Lestari, Rauf, Atekan, & Malik, 2002; Priyono, Purwoko, & Irawan, 2003; Sarasutha, 2002; Supriatna, 2003). The adoption practices also vary, and there may not be an increase in productivity and income (Kanro et al., 2002; Supriatna, 2003).

The lack of effective policies may be the cause of low technology adoption among farmers. Programs such as Mass Guidance (BIMAS), Mass Intensification (INMAS), Special Intensification (INSUS) and others, despite their comprehensive approaches, appeared to be short-lived. The results of such programs were not distributed equally and failed to overcome the issues of a limited access to productive resources and limited managerial capacity. Meanwhile, the restructuring of agricultural research and extension services into farmer-based collaboration (Sawit and Manwan, 1991, cited in Rubia et al., 1996; Soepardi, 2000) and the decentralization of services has not produced satisfactory results because it has led to the decreasing availability of field extension services (Sejati et al., 2002). These conditions may imply that a more effective approach is needed in order to boost the technology application among farmers and, at the same time, to help tackle outstanding issues faced by the farmers, such as a low level of human and financial capacity.

One possible starting point is to improve the adoption analysis through exploring the way farmers learn and make decisions. So far this has not been fully explored in the case of semi-commercial farmers in Indonesia. For example, a few studies (e.g. Ekalindo et al., 2000; Priyono et al., 2003; Sulaiman, 2002) have attempted to explain farmers' adoption decisions using several underlying factors related to (i) the technical, environmental, socioeconomic and socio-cultural aspects; (ii) current problems; and (iii) skills and assets. However, the results still overlook the mechanisms of how the decision variables affect and are transformed into adoption behaviour. This justifies the need to analyze farmers' perceptions and learning method in order to better understand their behaviour.

1.3 Objectives and Possible Hypotheses

This study relates to both qualitative and quantitative research. It is aimed at discovering the structure of semi-commercial farmers' decision making about technology adoption. This objective will be achieved through exploring the motives underlying the farmers' attitudes toward new technology adoption. A special focus will be given to the pattern that farmers use in creating and applying their rules of thumb, or heuristics, in making decisions. This study will be based on the framework that develops during the research. Some possible hypotheses may include:

a) farmers rely on rules of thumb (heuristics) for making decisions on whether to adopt, delay or reject a new technology, and these rules are constantly under review, i.e. dynamic;

b) farmers' decision heuristics are related to their attitudes and perceptions of control, as well as their socio-cultural influences;

c) farmers use different decision heuristics according to their physical, technical and socioeconomic contexts, as well as different degrees of adoption;

d) a certain degree of intra-household and social bargaining processes influences the structure of farmers' personal construct system; and

e) the bargaining processes may occur repeatedly as the farmers obtain new information and/or seek collective reinforcement at each decision step.

The theoretical basis of this study is the concept of the decision making process introduced by Ohlmer et al. (1998), the Theory of Planned Behaviour (TPB), the Ethnographic Decision Tree Modelling (EDTM), and the Personal Construct Theory (PCT). The integration of different approaches in this study is expected to improve the elicitation procedures of farmers' heuristic patterns. The integration of EDTM and PCT with a TPB model, in particular, is expected to result in a more realistic concept of semi-commercial farmers' decision making process.

This study used the improved rice-prawn system introduced to farmers in Lamongan District in East Java Province of Indonesia as a case study. This system consists of four components which are an improved (i) land preparation technique; (ii) rice and prawn sowing technique; (iii) fertilizer application; and (iv) pest management (Muhariyanto & Arianto, 2005). This system was based on modifications to the system traditionally used by the farmers. An evaluation of this system was conducted in 2003, and the results showed that the adoption rate was still low and farmers did not completely adopt all components of the system (Santoso et al., 2003). The limited adoption did not improve land productivity. For various reasons, farmers may have different degrees of adoption. However, this has not been fully explored and may confirm the need to further investigate the farmers' motives.

1.4 Main Contributions

In general, this study is expected to delineate a more realistic and thorough description of a farm household's decision making process in developing countries. The main contribution relates to an improved understanding of the mental processes involved in farmers' decision making systems. This is represented by the elaboration of farmers' decision heuristics as well as the way farmers create and utilize decision heuristics in adoption-decision making. The results, thus, may explain the functioning of the farmers' managerial strategy within the framework of bounded rationality and, possibly, the farmers' risk attitudes. The identification of the heuristic pattern may also provide a better understanding of the relationships between the farmers' attitude, intention and behaviour.

Another contribution may relate to an improved conceptualization of a dynamic agricultural decision making process. This involves the recognition of the bargaining process and social justification as a decisive and dynamic element in farmers' decision making systems.

Finally, the study will contribute to the advancement of agricultural extension and policy approaches, particularly with respect to Indonesia. The knowledge of the farmers' heuristics and bargaining process may help the extension workers deliver better assistance to farmers.

1.5 Organization of Thesis

This thesis continues with a discussion of the concept of technology adoption including the variables related to agricultural technology adoption. This will be based on the existing premises and the results from empirical studies in developing countries. In Chapter 3, the background to technology adoption among farmers in Indonesia is reviewed. Chapter 4 presents a discussion on the theories underlying the objectives of this thesis. This chapter also contains the development of the model and approach taken in this research. The methods and procedures of the analyses are presented in Chapter 5, while the results are presented and discussed in Chapters 6, 7 and 8. Finally, Chapter 9 concludes this thesis by presenting a summary, implications and suggestions for the future direction of research in this area.

CHAPTER TWO: DETERMINANTS OF FARMERS' TECHNOLOGY ADOPTION DECISIONS

2.1 Introduction

In the case of technology adoption, farmers have been perceived as rational decision makers (Feder, Just, & Zilberman, 1985; Gladwin, 1989b; Reardon, 1989). However, the farmers' decision making structure appears to be complex. The composition of, and the interaction between, farmers' decision factors varies according to the types of technologies, agro-ecosystems (Feder et al., 1985; Pingali, Rozelle, & Gerpacio, 2001) and season (Moser & Barrett, 2003). Differences in resource endowment also influences the structure and complexity of farmers' decision making (Bellows, Hildebrand, & Hubbell, 1996; Hossain & Crouch, 1992; Kaliba, Featherstone, & Norman, 1997; Pingali et al., 2001). All these factors have triggered efforts to elucidate the farmers' decision determinants about technology adoption.

In this chapter, empirical findings with regard to the adoption-decision variables of smallholder farmers in some developing countries are presented. The discussion helps develop an analytical framework for this study, and may lead to results relevant to the majority of the Indonesian farmers. The discussion will begin with the concept of technology diffusion and adoption. It will be followed by a review of technology adoption determinants. A summary will be presented to conclude this chapter.

2.2 The Concept of Technology Adoption

Rogers (1993) provides different definitions for technology and innovation. He defines technology as "*a design for instrumental action that reduces the uncertainty in the causal-effect relationships involved in achieving a desired outcome*" (p. 12). An innovation is defined as "*an idea, practice, or object that is perceived as new to an individual or another unit of adoption*" (Rogers, 1993, p. 11). Innovation seems to cover a broader definition than technology. The idea of innovation also puts an emphasis on the process of creation, both new developments and modification, while technology is more related to the function. However, since the essence of both terms is quite similar, they are often perceived as being identical (Rogers, 1993).

Technology materializes from the combination of physical objects (the hardware) and the associated information (the software) (Rogers, 1993). According to Feder et al. (1985), the hardware includes indivisible technologies such as machinery and other tools, and divisible technologies such as high-yield seeds and fertilizers. The software comes in the form of information (Rogers, 1993), such as communication approaches and marketing strategies. Most technologies contain these two components.

Technology is usually developed through several stages (Rogers, 1993), such as the exploration of new ideas, trials and the actual technology development process. The processes may be informal (Biggs, 1978, cited in IDS Workshop, 1989a), and this refers to the development of indigenous technologies. The innovators are usually local people who blend their customs, traditions (Farrington & Martin, 1987, cited in Haverkort, 1991) and inherited knowledge as well as socio-cultural values, with their observations on changes in the surroundings (Sunaryo & Joshi, 2003).

Once a technology is developed, it needs to be transferred to the users. The transfer process connects the motive of the innovator(s) (supply side) and the interest of the users (demand side) (Negatu & Parikh, 1999). This process can refer to technology diffusion or adoption process. This will be discussed in the next two subsections.

2.2.1 Technology Diffusion

According to Rogers (1993, p. 5), technology diffusion is a communication process that mainly involves information exchanges, new ideas, observations and objects, which then result in some effect in the society. Therefore, technology diffusion plays a critical role in making a technology widely known and used by people.

Technology diffusion can take place spontaneously or in a planned way. In the latter case, technology can be disseminated through vertical or horizontal channels (Rogers, 1993). A vertical channel usually involves agents who decide on the diffusion process, such as government bodies, scientists, or extension personnel who conduct the diffusion process (Rogers, 1993). In addition, middlemen (Sandee & Rietveld, 2001), or the head of a farmer group (Bunch, 1991; Current, Lutz, & Scherr, 1995) may also stimulate diffusion. In contrast, a horizontal channel occurs through direct observation, comparison, copying and informal experimentation among potential adopters (Neill & Lee, 2001; Pomp & Burger, 1995; Rogers, 1993; Sandee & Rietveld, 2001). The role of agents of change in the horizontal channel is optional.

The horizontal diffusion channel has recently attracted more attention. Many studies have demonstrated that technology introduction is not only a matter of the adopter's behaviour but also involves interactions among different actors in the process (Wadsworth, 1995). This puts forward the importance of a participatory approach in order to increase the efficacy of technology development and diffusion processes.

In this regard, Chambers (1989) introduced the "Farmer First" approach, in which farmers' needs, challenges and knowledge become the focus in the technology development and diffusion processes. Farmers are encouraged to experiment, observe and evaluate the technology and, thus, their participation is crucial. The extension service and agricultural research and development can also be improved to become more bottom-up, demand-oriented and communicative (Chambers, 1989). Farmer-to-farmer knowledge transmission also becomes an important medium of technology transfer. The "Farmer First" approach leads to the development of other participatory methods such as farming system research (FSR), agro-ecosystem analysis (AEA) and rapid rural appraisal (RRA) (Scoones & Thompson, 1994).

Scoones & Thompson (1994) further expanded the "Farmer First" approach by taking into account the impact of differences in socio-cultural, socioeconomic and political elements in the rural community, as well as in the extent of command and control among different groups of people in the community. The focus is placed on the actors involved and the impact of their network, within a multi-aspect rural setting. These analysts label their concept as “Beyond Farmer First”, which acknowledges the following aspects (Scoones & Thompson, 1994, pp. 20-23):

a) different capacities in innovation, knowledge application and information exchange among different groups of people;

b) the interaction processes among the actors involved, especially in terms of different levels of “*access to and control of resources and processes*” (p. 21); how the actors negotiate their differences; how the actors learn from each other; and how their differences can converge into a common outcome;

c) different roles of local and non-local people as they negotiate their differences in interests, objectives and socio-political status; and

d) the interrelationships among the actors, including the effects of interaction itself, affiliations among some actors, and external changes.

Some improved participatory methods are then engineered from this concept, such as farmer participatory research (FPR), participatory rural appraisal (PRA), participatory action research (PAR) (Cornwall, Guijt, & Webourn, 1994), and participatory technology development (PTD) (Bunch, 1991; Haverkort, 1991).

Looking back over the vertical and horizontal diffusion channels, none of them, including the participatory approach, can predict the time of adoption. This is because the diffusion process largely depends on the adopters’ perceptions towards the technology characteristics. According to Rogers (1993), the perception results from the adopters’ assessment of the following criteria (pp. 15-16):

a) “*relative advantage*”, in which the benefit of applying the technology is compared to that of the previous or current technologies;

b) “*compatibility*”, which represents the evaluation whether a technology fits with current values in the society;

c) “*complexity*”, which indicates whether a technology is easy to adopt and use;

d) “*trialability*”, which indicates the possibility of applying a technology based on a sample experimentation; and

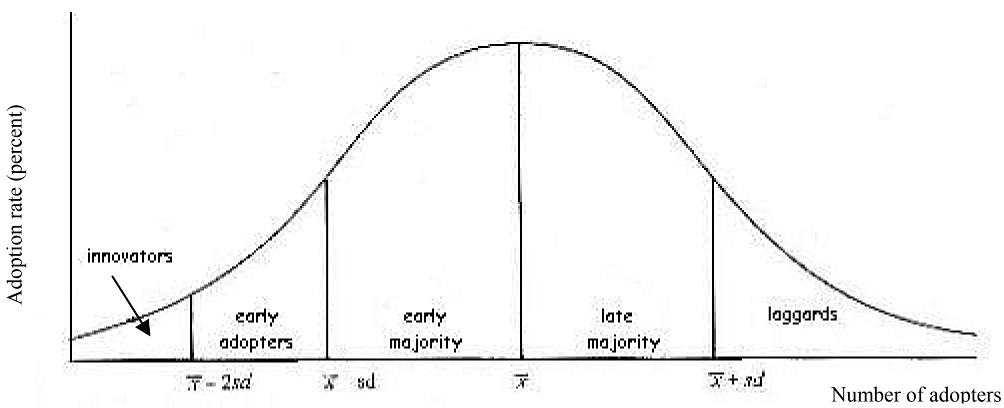
e) “*observability*”, which indicates whether a technology can produce a quick and visible result.

These criteria apply even when the adoption decision may be bound to happen due to some urgent needs (Rogers, 1993). For that reason, the technology diffusion process should always take into account these criteria in order to secure users’ positive perception about the technology characteristics.

2.2.2 Technology Adoption

Technology adoption is almost equivalent to technology diffusion. The difference is that technology adoption comes from the users’ standpoint. The adoption process cannot occur all at once and it is described as following a normal distribution pattern over the long run (Rogers, 1993). The first adoption will induce an increasing stock of knowledge among a group of potential adopters and lead to familiarity with the technology attributes and potentials. Rogers (1993) refers this process as the “*diffusion effect*”.

Figure 2.1. A conceptualized distribution of adopters (Rogers, 1993, p. 247)



Note: x= mean, sd = standard deviation of the number of adopters

Based on the distribution of adopters (Figure 2.1), Rogers (1993) categorizes adopters into "*innovators, early adopters, early majority, late majority and laggard*", and each has a different characteristic described as follows (pp. 247-250):

a) "*innovators*" have passion for trying new things;

b) "*early adopters*" have leadership traits in their action;

c) "*early majority adopters*" have full awareness about adopting new things;

d) "*late majority adopters*" eventually adopt new things due to pressure from their peers and necessity; and

e) "*laggards*" (last or minority adopters) usually have a strong hold on traditional values and, at the same time, are risk averse due to limited resources.

In addition, Rogers (1993) compiled empirical evidence with regard to the characteristics of adopters based on "*socioeconomic status, personality variables, and communication behaviour*", as follows:

a) "*socioeconomic*" (pp. 251-257): the age difference between earlier and later adopters is not great, but the earlier adopters are usually more educated, respectable, and wealthier, to some extent, as they have market-oriented economic activities and more access to resources (due to wider social activities);

b) "*personality variables*" (pp. 257-258): earlier adopters are usually more open to new things, less risk averse, have a rational approach toward changes, value education and science highly, and have high motivation in their activities; and

c) "*communication behaviour*" (pp. 258-259): earlier adopters are more socially active, have wider social networks, are more aware of information and, thus, always follow the progress of information, knowledge and innovations.

From Rogers' technology diffusion/adoption paradigm, it can be inferred that the decision making structure of an adopter is influenced by her/his perception of the technology characteristics and her/his own traits. The concept of '*laggard*', however, has been criticized as unnecessarily exaggerating the impression of late adopters (see Pannell et al., 2006; Wilson, Sherry, Dobrovolny, Batty, & Ryder, 2000). Using the Personal Construct Theory, Jangu (1997) also proved that non-adopters or late adopters have logical motives in their adoption-decision making. This group of people actually reflects the differences in how every person learns and deals with their situations. This leads to the next discussion on various factors that can influence adoption-decisions.

2.3 Determinants of the Adoption Decision: International Lessons Learned

Many studies have attempted to explain the technology adoption process among smallholder farmers. Generalizations, however, are difficult due to differences in farmer characteristics and backgrounds. Feder et al. (1985), for example, attempted to make a list of farmers' adoption variables based on some previous studies. They concluded that the adoption of a particular technology depends on the farmers' relative resource endowment (labour availability, access to credit, farm size and the status of land ownership), market access (information, infrastructure and distribution systems), the existing risks faced by farmers, and the quality of human capital (education and risk management ability).

Recent studies have confirmed the roles of adoption factors, as identified by Feder et al. (1985); and others have also added some new factors to the list. However, some variations appear in the way each factor influences the adoption decision, and so makes some factors debatable. Thus, it is possible that each individual farmer tends to have a unique adoption attitude.

In this section, some of the adoption variables will be discussed in more detail. Table 2.1 presents the list of the adoption factors based on Rogers' paradigms, the review by Feder et al. (1985), and the hypotheses of Shiferaw and Holden (1998). Some modifications are devised. For example, Rogers's *compatibility* aspects are expanded to cover the evaluation not only of the existing social values, but also of the current farming, agro-ecosystem and institutional conditions, and the riskiness of the technology. Two additional groups are also devised. These are farm attributes and institutional requirements for implementing the technology. Appendix A (Table A.1) presents a summary of the methods, findings, and the model goodness of fit for some of the empirical studies that are discussed in this chapter.

Table 2.1. Factors affecting farmers' decisions towards new technologies

	Factors	Descriptions
1.	Technology characteristics	
	1.1 Economic criteria (relative advantage)	Profit (short- and long-term) Initial implementation costs Yield Price of outputs Marketability
	1.2 Socio-technical criteria	
	1.2.1 Compatibility	Social values Current farming practices Current problems and needs Agro-ecosystem conditions Riskiness of the technology
	1.2.2 Complexity	Procedures, including: the number of activities required; the degree of difficulty; the availability of related information; and input requirements
	1.2.3 Trialability and observability	Small-scale trials Timely and observable yield Incremental adoption
2.	Farm and farm household characteristics	
	2.1 Farm characteristics	Farm size (the size of cultivated land)
	2.2 Farm household characteristics	
	2.2.1 Socioeconomic aspects	Resource endowment: income; family composition (size, age and gender); size of land owned; and other assets (savings, livestock, etc.) Off-farm employment Quality of human capital: level of education (schooling years; literacy); learning capacity; and managerial expertise Farming experience Age of head of household Family background: local vs non-local, ethnicity Social position of head or other family members
	2.2.2 Farmers' goals and orientation	
	2.2.3 Farmers' risk attitudes, motivation and innovativeness	
	2.2.4 Communication behaviour	Intra-household interaction Networking and external contact
3.	Government policy	Policies, regulations and services particularly related to: - improved capacity building; and - access to market, credit, labour and information

Sources: Feder et al. (1985), Rogers (1993), Shiferaw & Holden (1998) and other studies

2.3.1 Technology Characteristics

Technology characteristics are believed to shape farmers' positive or negative perceptions towards adoption (Adesina & Zinnah, 1993; Batz, Janssen, & Peters, 2003; Herath & Takeya, 2003). The perception results from farmers' evaluation of the economic and socio-technical aspects of the technology attributes. The economic aspects may include profitability and cost; while the socio-technical aspects may include criteria asserted by Rogers (1993), such as *compatibility, complexity, trialability* and *observability*.

2.3.1.1 Economic criteria

Rogers (1993) and Wadsworth (1995) assert that farmers may be willing to give up their current practices in favour of potential future benefits brought by new technologies. The benefits usually refer to clearly obtainable **profitability** from applying the technology (Feder et al., 1985). Clear short-term profitability is preferable (Baidu-Forson, 1999), and this, particularly, will attract more resource-poor farmers to invest in the new technology (Harrington, 1994, cited in Lapar & Ehui, 2004). Besides profitability, farmers are also concerned about the **costs** of implementing new technologies (Akinola, 1986; Batz et al., 2003; Current et al., 1995; Pingali et al., 2001; Reardon, 1989), as they usually have limited capital.

Table 2.2. A summary of the influence of economic perceptions

Perception of	Relationship with adoption	Remark
Profitability	Positive	
Initial cost	Negative	
Yield/productivity	Positive	Affected by soil quality (+), distance to cities (+), local market scope (-), outside market activity (+)
Output price	Positive	
Marketability	Positive	Affected by distance to cities (+), local market scope (-), outside market activity (+)

Sources: the various references that are quoted in the text.

Farmers' willingness to adopt also depends on whether new technologies can result in an observable **yield increase**, higher **output price** and improved **marketability**. Adesina and Zinnah (1993) discovered that farmers' beliefs about the potential yield of the improved swamp rice varieties had a positive and significant impact on their adoption decisions. Negatu and Parikh (1999) also found that small-scale farmers perceived the yield and marketability as the most important incentives for adopting a new wheat variety. The analysis by Akinola (1986) also shows a positive and significant effect of product prices on technology uptake. Farmers' positive perceptions about yield and marketability of a technology, however, seemed to be interrelated with other factors, such as income, the closeness of the village to the city, the extent of outside market interactions and, in some cases, soil quality (Negatu & Parikh, 1999). Other studies confirm the findings (e.g. Gockowski & Ndoumbe, 2004; Shiferaw & Holden, 1998), including the associations among the determinants (e.g. Current et al., 1995; Hintze, Renkow, & Sain, 2003). Table 2.2 provides the summary of the discussion.

2.3.1.2 Socio-technical factors

2.3.1.2.1 Compatibility

Although new technologies may have provided a clear economic benefit, farmers are often required to make adjustments so that the technology is compatible with their **social values** (Bunch, 1989; Gladwin, 1989b; Rhoades, 1989; Rogers, 1993). Nevertheless, no studies have clearly indicated a definite measure of farmers' social values. This may be due to the diverse definitions of social values, or different ways farmers make adjustments.

Farmers have also been found to evaluate the technology based on its compatibility with their **current farming practices** (Akinola, 1986; Bunch, 1989; Herath & Takeya, 2003; Lapar & Ehui, 2004; Moser & Barrett, 2003; Neill & Lee, 2001; Rhoades, 1989). Moser and Barrett (2003), for example, noticed that farmers in Madagascar were reluctant to adopt a rice intensification package despite low external-input requirements. They presumed the reasons related to the incompatibility of the technology with the seasonal patterns of labour supply and the farmers' cash flow.

Different locations may also influence farmers' preferences. This refers to the compatibility of a new technology with the **local agro-ecosystem**. Farmers usually prefer a technology that is suitable for local climatic conditions, quality of land and water availability (see Adesina, Abbott, & Sanders, 1988; Doss & Morris, 2001;

Feder et al., 1985; Lapar & Ehui, 2004; Mukhopadhyay, 1994; Shiferaw & Holden, 1998). For specific technologies, latitude (Ransom, Paudyal, & Adhikari, 2003) and topography (Neill & Lee, 2001) also strongly influence the adoption rate. Some variations, however, are also observed. For example, Kaliba et al. (1997) observed that the effect of location on the adoption of stall-fed cattle technologies in Tanzania depends on the interrelationships between agro-ecosystem conditions (especially water availability), farm attributes, and the availability of incentives. Thus, the effect of agro-ecosystem compatibility on farmers' adoption behaviour may depend on the type of technology, farm household characteristics, and socioeconomic conditions.

Finally, farmers evaluate the feasibility of technology adoption based on their current **problems** and **specific needs** (Baidu-Forson, 1999; Neill & Lee, 2001; Shapiro, Sanders, Reddy, & Baker, 1993; Shiferaw & Holden, 1998), as well as **the degree of riskiness of the technology** (Adesina & Baidu-Forson, 1995; Batz et al., 2003; Current et al., 1995; Pingali et al., 2001; Reardon, 1989). Farmers tend to reject new technologies if they think that the technologies may add to the current uncertainties. In many cases, farmers prefer to gradually adopt the technology so that they can minimize the risk from applying the technology (Savadogo, Reardon, & Pietola, 1998).

Table 2.3. A summary of the impact of compatibility aspects

Compatibility with	Relationship with adoption	Remark
Social values	Unknown, but may be assumed positive	No definite indicator of social values recommended by previous studies
Farming pattern and timing	Unknown, but may be assumed positive	Influenced by differences in agro-ecosystem and custom
Current problems and needs	Positive	The link may vary depending on locations, gender and levels of income
Agro-ecosystem		Depend on the type of technology, farmers' attributes, and socioeconomic conditions
Soil quality	Positive	
Latitude	Positive	
Water availability	Positive	
Topography	Positive/negative	
Current institutional conditions	Positive	Related to current government policies and access to credit, market, inputs and infrastructure
Perception of risk mitigation benefits	Negative	Risk effect may represent the overall effect of incompatibility of a technology with farmers' conditions.

Sources: the various references that are quoted in the text.

Overall, the discussion shows various ways of describing the compatibility aspects. Some studies have explained the relationship between the compatibility aspect and the farmers' adoption practices; while others do not provide any clues about the statistical correlations (Table 2.3). A clearer indicator of social compatibility is also called for in order to better understand the role of social values in technology adoption.

2.3.1.2.2 Complexity

The complexity of a technology indicates whether the technology is **easy to apply** (Batz et al., 2003; Bunch, 1991; Reardon, 1989; Rogers, 1993) or to learn (Kaliba et al., 1997). Batz et al. (2003), in particular, observed that dairy farmers in Kenya evaluate the complexity of a technology based on the **level of difficulty** and the **number of procedures** required for its implementation. Adesina and Zinnah (1993) also found that farmers' adoption of improved swamp rice varieties was influenced by their beliefs about whether the new varieties were *easy to cook* and *thresh*.

Some analysts also suggest the importance of acknowledging the interrelationships between farmers' perception of the complexity of a new technology with the **farmers' access to inputs**, and **the availability of information**. Akinola (1986) and Lapar and Ehui (2004) observed a significant increase in farmers' perception of their ability to implement a new technology when they have access to the necessary inputs. In addition, farmers are more willing to adopt a new technology if they have sufficient information about the requirements of the technology (Just, Wolf, & Zilberman, 2003; Wake, Kiker, & Hildebrand, 1988). The discussion, thus, implies the need for incentives to improve farmers' confidence in dealing with new technologies.

2.3.1.2.3 Trialability and observability

Potential adopters also examine the feasibility of a new technology based on *trialability* and *observability* criteria. According to Rogers (1993, pp. 15-16), *trialability* refers to the feasibility of applying a technology based on a small trial; and *observability* indicates whether a technology can produce a quick and visible result.

Trialability and *observability*, hence, may indicate that farmers value flexibility (Herath & Takeya, 2003; Ohlmer, Olson, & Brehmer, 1998; Scoones & Thompson, 1994) and prefer a learning-by-doing experience for familiarizing themselves with new technologies (Wake et al., 1988). Farmers may try a new innovation in a **small plot**, **continuously monitor and evaluate** the performance, and **gradually increase the application** if the results are favourable (Adesina & Baidu-Forson, 1995; Savadogo et al., 1998). This process may reflect farmers' rational responses to the changes in their environment (Feder et al., 1985; Gladwin, 1989b; Reardon, 1989).

The *trialability* and *observability* criteria may show information is not equally distributed and this means the farmers have to experiment with the technology themselves. The efficacy of these practices, however, may depend on the farmers' relative assets, skills and other attributes. This leads to the next discussion on the adoption variables that relate to the farm and farmers' attributes.

2.3.2 Farm and Farm Household Characteristics

2.3.2.1 <u>Farm characteristics</u>

The most common indicator used is **farm size**. Many studies define 'farm size' as the area of cultivated land. However, Feder et al. (1985), in their review, did not differentiate between (i) the area of cultivated land and (ii) the area of landholding to refer to 'farm size' characteristic. In this section, the first definition is preferred since it is more practical because there are landless farmers who often rent a piece of land and apply new technologies. The effect of land tenure on technology adoption will be discussed in a latter subsection.

Most studies (e.g. Akinola, 1986; Hossain & Crouch, 1992; Negatu & Parikh, 1999; Neill & Lee, 2001) show a positive and strong relationship between the size of cultivated land and the probability of technology adoption among farmers. Neill and Lee (2001) found that if farmers had access to more than three hectares of land, the adoption rate would increase by almost 0.5 percent. The study by Negatu and Parikh

(1999), however, showed a lower impact. This suggests that the impact is moderate. This may also support the findings of other studies which show an ambiguous impact of farm size. For example, Polson and Spenser (1991) found a weak effect of farm size, but observed a certain farm size threshold that differentiates between the decision to adopt or reject new cassava varieties in Nigeria. Meanwhile, Kaliba et al. (1997) discovered a negative relationship between farm size and the farmers' perceptions of the adoption of a stall-feeding management system for dairy cattle in Tanzania (two probit models, 80 percent correct prediction).

According to Feder et al. (1985), the ambiguous impact of farm size on farmers' adoption practices may be caused by influences of other factors, such as "*fixed adoption costs, risk preferences, human capital, credit constraints, labour requirements, tenure arrangement*" (p. 271), *location, agro-climatic conditions, types of technology, and different farming orientations* (pp. 272-273). Pingali et al. (2001) also observed interrelationships between farm size, location and types of technology in influencing farmers' choice of technology[1] (see Appendix A, Table A.2).

Feder et al. (1985) therefore suggest combining the analysis of farm size with other adoption factors in order to ensure the correct interpretation. In this regard, some analysts (e.g. Baidu-Forson, 1999; Lapar & Ehui, 2004; Shiferaw & Holden, 1998) employ a **land-man ratio** (a proxy for labour availability) to address the interconnection between farm size and labour availability in affecting technology adoption. However, the results are varied. For example, Shiferaw and Holden (1998) found that the impact of labour availability on adoption appeared to be direct and positive, but at the same time indirect but negative, and this was mediated by the farmers' perceptions of the problem (-2 log likelihood = 302.9, significance at 0.1 percent). Baidu-Forson (1999) and Lapar and Ehui (2004), however, found a negative but insignificant impact from the land-man ratio on the adoption practices.

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[1] Pingali et al. (2001) evaluate the preference of farmers in the Philippines, China, India and Vietnam of a high-yielding variety of rice, a high-quality variety of rice, integrated pest management and a harvester.

2.3.2.2 Farm household characteristics

This group comprises socioeconomic aspects, personality and communication behaviour of the farm household. The socioeconomic aspects relate to the household's assets, sources of income, relative access to market and productive resources, level of education, age, experience and skills, family background and social position. Other factors discussed include farmers' goals, orientation, risk attitudes, motivation and innovativeness. Meanwhile, the communication behaviour is represented by the pattern of intra-household interaction and the level of external contacts.

2.3.2.2.1 Socioeconomic aspects

Farmers often perceive that the changes in resource allocation required by the new technology will put their livelihoods at risk (Bellows et al., 1996; Current et al., 1995; Gladwin, 1989b; Moser & Barrett, 2003; Neill & Lee, 2001; Pingali et al., 2001). Farmers may evaluate the opportunity cost of applying the technology against the value of their land, a common asset that smallholder farmers lack. Neill and Lee (2001) found that the closer a farm land is to a road, the greater chance that farmers will sell the land and abandon/reject the technology.

Landholding is important not only to secure the farm household's continuous existence (Adesina et al., 1988), but also to improve farmers' capacity to access inputs and the capital needed for applying new technologies (Feder et al., 1985; Neill & Lee, 2001; Shively, 1997). However, the effect of landholding on the adoption rate appears to depend on the types of technology, location and the types of adoption decisions. Pingali et al. (2001) observed that land tenure had only a positive and significant effect on the adoption of integrated pest management (IPM) in India; while the effect on other types of technology, and in different countries, was weak (see Appendix A). Doss and Morris (2001) also found a positive effect of land ownership on the adoption of improved maize varieties among farmers in Ghana, but most of their models showed a less significant effect in the case of fertilizer adoption. Meanwhile, Neil and Lee (2001) found that smallholder farmers always consider their landholding in their adoption decision of new cover crops, but they do not consider it when they want to abandon the adoption.

Income is another indicator of farmers' assets that has a positive and substantial effect on farmers' adoption decisions (Hossain & Crouch, 1992; Lapar & Ehui, 2004; Negatu & Parikh, 1999). Farmers with higher income usually have a positive perception about new technologies (Negatu & Parikh, 1999) and are more capable of purchasing sufficient inputs for implementing the technologies (Lapar & Ehui, 2004). In the case of smallholder farmers, income may hinder farmers from applying new innovations as it often fluctuates across different planting seasons (Moser & Barrett, 2003; Wadsworth, 1995). Nevertheless, smallholder farmers usually have **other types of assets**, such as livestock, which allow them to reduce the seasonal cash flows and to adopt new technologies (Asfaw & Admassie, 2004).

Some studies also point out the importance of a **farm household structure** in determining the adoption decision. Family size reflects the family's consumption needs and the **supply of family labour** which, to some extent, affects the capability of the household's technology uptake. Some studies (e.g. Neill & Lee, 2001; Savadogo et al., 1998) found a strong and positive relationship between family size and technology adoption. Nevertheless, some variations occur. For example, Hintze et al. (2003), and Shiferaw and Holden (1998), discovered a negative and significant effect of family size on farmers' adoption behaviour. Herath and Takeya (2003) also found a weak link between family size and the rate of intercropping technology adoption among smallholder rubber farmers in Sri Lanka.

Besides family size, the effect of household structure can be represented by the **gender and age structure** within the household. Doss and Morris (2001) and Gockowski and Ndoumbe (2004) found a significant and positive adoption rate resulting from a large proportion of adult males in the farm household. These analysts also observed the opposing effect in the case of the proportion of women in the family. They figured that this might relate to the different roles, and access to resources, of men and women in the village. Contrary to the above analyses, Kaliba et al. (1997) found that the higher the number of women and male children in a farm household appeared to result in a more rapid adoption rate. This is because most of the men migrate and work outside the village and the demand for labour is mainly fulfilled by women and children. The discussions, hence, might suggest that the effect of family composition on technology adoption may depend on socio-cultural values, labour availability and the opportunity cost of the farming activities.

The increasing trend of male involvement in off-farm activities also leads to an assessment of the effect of off-farm occupation on the adoption rate. For example, Pingali et al. (2001) found a strong impact of the number of farmers with **off-farm jobs** on the farmers' positive perception about integrated pest management in China. Ransom et al. (2003) also discovered that Nepalese farmers with a high off-farm income tended to adopt new maize varieties. However, other studies show a range of results. Herath and Takeya (2003) discovered that smallholder rubber farmers in Sri Lanka tended to be less responsive to the introduction of an intercropping system when they had more off-farm activities. This might be caused by the decrease in farmers' availability in the rubber field as the intercropping system was labour intensive. Other studies (Baidu-Forson, 1999; Neill & Lee, 2001; Shiferaw & Holden, 1998; Shively, 1997) also show a negative or positive, but weak, effect of off-farm employment on technology adoption.

Despite such differences, the role of off-farm jobs is still considered important for technology adoption. According to Savadogo et al. (1998), off-farm jobs provide a source of additional income and enable the farmers to afford new technology. The effect, however, might be interrelated with the relative access to other productive resources since, according to Pingali et al. (2001), farmers with off-farm jobs usually have a relatively limited access to markets, credit, non-family labour and information. The latter issue has also been found to affect technology adoption, and it relates to farmers' cognitive capacity. This calls for the need to evaluate the impact of human capital in agricultural technology adoption.

Education is commonly used as one of the human capital indicators for explaining technology adoption behaviour. Most studies use the number of years of formal education of the farm household head as a proxy (Walters & Norton, 1988), while a few others use the literacy rate (e.g. Kaliba et al., 1997; Ransom et al., 2003).

Farmers with more formal schooling years usually have a more positive attitude toward technology adoption (Asfaw & Admassie, 2004; Feder et al., 1985; Herath & Takeya, 2003; Hossain & Crouch, 1992; Just et al., 2003; Lapar & Ehui, 2004; Zhang et al., 2002). The more educated farmers are usually more familiar with information seeking and processing strategies that will assist them to make better decisions, including technology application. Asfaw and Admassie (2004) also found the "*intra-household spill-over effect of education*" (p. 215) indicating the influence of other, more educated, farm family members in adoption-decisions. They concluded that an improved education system in the rural community should first be implemented before expecting extensive technology adoptions to occur.

The effect of education on technology adoption, however, is not always consistent. Kaliba et al. (1997) and Ransom et al. (2003) found a negative and weak effect of education. An analysis by Doss and Morris (2001) also confirms the same variations, in which education was found to significantly increase the adoption rate of new maize varieties, but not in the case of fertilizer. Such variation may relate to the types of technology and the relative problems faced by farmers (Pingali et al., 2001).

Besides education, some analysts also evaluated the association between farmers' **learning and managerial capacities** and technology adoption. Mosser and Barret (2003), for example, found that 'a labour-saving technology' had actually increased the work demand. They presumed this event was due to the farmers' lack of competency. Just et al. (2003) found that farmers in developing countries usually have limited information seeking and processing skills which makes readily available information poorly utilized. Wadsworth (1995), in his analysis of commercial-oriented farmers, also observed the interconnection between farmers' managerial capacity, farmers' access to socioeconomic resources and technology adoption. He noted that in an environment where access to socioeconomic resources was limited, farmers judiciously reviewed the compatibility of new technologies with their skills and experiences. On the other hand, farmers with sufficient access to resources usually have more opportunities to improve their capacity; and they are active in seeking new innovations. Wadsworth's analysis may suggest the importance of removing the socioeconomic problems and, at the same time, improving farmers' capacity in order to secure rapid adoption practices.

One may also look into farmers' **experience** as one of the human factors affecting technology adoption. The effect of experience, however, appears to be varied. Some studies (e.g. Akinola, 1986; Doss & Morris, 2001; Herath & Takeya, 2003; Ransom et al., 2003; Shapiro et al., 1993) observed that farmers with previous experience in dealing with innovations showed a positive attitude towards new technologies. On the contrary, Damianos and Skuras (1996) discovered that farmers with a strong belief in their own knowledge, which had been accumulated through continuous day-to-day learning, were more reluctant to adopt new innovations. Herath and Takeya (2003) also found that farmers who were experienced in multi-cropping practices had a positive response to the introduction of an intercropping system; while mono-cropping farmers tended to reject the new system. These findings may suggest that farming experience will only improve adoption if it is relevant to the nature of the technology.

Some researchers also use the **age of the farm household head** for predicting the effect of experience on adoption behaviour; however, their findings vary. Savadogo et al. (1998), for example, suggested a positive relationship between farmers' adoption practices and the age of the household head. Other studies found that the effects of farmers' age on the adoption rate varied according to the types of technology (e.g. Doss & Morris, 2001; Pingali et al., 2001), farming communities (Hossain & Crouch, 1992) and countries (Pingali et al., 2001). Other studies also show that younger farmers are significantly more responsive to new innovations than older farmers (Gockowski & Ndoumbe, 2004; Polson & Spencer, 1991; Shiferaw & Holden, 1998). The reason relates to the long exposure of farming practices experienced by the children in a farm household (Polson & Spencer, 1991). Thus, one may need to check the time-span of the farmer's involvement in farming decision making practices when using age as an indicator of a farmer's experience.

Family background and social position are the last of socioeconomic characteristics of the farm household that are commonly used for predicting the adoption rate. Ransom et al. (2003) discovered a strong association between ethnicity and the adoption behaviour among maize farmers in Nepal. Polson and Spencer (1991) also found that a new cassava variety was accepted more easily among non-native farmers. They believed that technology adoption was one strategy that non-native farmers used to support their existence in the new environment. In addition, Grisley (1994) and Hossain and Crouch (1992) also observed connections between a farm household's background and social position, and technology adoption practices.

To conclude the discussion in this section, the socioeconomic aspects of the farm household characteristics appear to have an important effect on technology adoption. Some variations do occur as these socioeconomic factors are dependent on farmers' technological preferences, location and time period (season). Table 2.4 provides the summary of the discussion. The next subsections will outline the effects of farmers' goals and orientation, personality related aspects and communication behaviour.

Table 2.4. A summary of the socioeconomic aspects of farm household characteristics

Indicator	Relationship with adoption	Remark
Resource endowment		
landholding	Positive	Depends on type of technology, location and adoption-related decision
income & other assets	Positive	Influenced by seasonal production and farmers' preference for technology
family structure	Family labour (+) Gender and age composition (+/-)	Depends on the roles of men, women and children in the family and society
Non-farm job	Positive	Especially in the case of resource-poor farmers, but the link also depends on the current practices
Human capital:		
education	Positive	Level of education of all family members, but in some cases, the effect is influenced by the type of technology and location
learning & managerial capacity	Assumed positive	No definite recommendation from previous studies
Farming experience	Positive	Provided that the experience is relevant
Age of head of household	Positive/negative	Depends on the types of technology and location
Family background	Positive (certain ethnicity, migrant)	
Social position	Assumed positive	No definite recommendation from previous studies

Sources: The various references that are quoted in the text.

2.3.2.2.2 Farmers' goals and orientation

Some analysts have found correlations between farmers' **goals**, their **orientation** and the propensity for technology adoption. Farmers' goals and orientation may refer to whether they have a subsistence or market orientation. For example, many adopters have been found to have had a market orientation relative to subsistence situations (Current et al., 1995; Gladwin, 1989b; Pingali et al., 2001; Polson & Spenser, 1991). Other studies use the degree of involvement in farming activities for explaining the role of farmers' goals on technology adoption. For example, Herath and Takeya (2003), and Hossain and Crouch (1992), observed that **full-time farmers** were more responsive to new technologies than part-time farmers (or farmers with non-farm activities).

Despite the above findings, many studies (e.g. Baidu-Forson, 1999; Gockowski & Ndoumbe, 2004; Neill & Lee, 2001; Shiferaw & Holden, 1998) discovered only a weak association with goals and, hence, the effect is assumed to be unclear. According to Ohlmer et al. (1998), the weak correlation between farmers' goals and their adoption attitudes may result from biases in the survey procedures. Farmers who participated in a survey often do not have sufficient information at hand during the interview and they may feel pressured to give an answer. Thus, a better data collection procedure for eliciting farmers' goals may be called for.

2.3.2.2.3 Farmers' risk attitudes, motivation and innovativeness

Farmers are always concerned about their survival when dealing with new technologies and, thus, these farmers may have risk aversion attitudes (Current et al., 1995; Gladwin, 1989b; Neill and Lee, 2001; Pingali et al., 2001). Feder et al. (1985) in their review also concluded that **farmers' risk preferences** and their risk mitigation strategy had a strong influence on the propensity for technology adoption. Other studies also confirm this evidence (e.g. Adesina et al., 1988; Baidu-Forson, 1999; Batz et al., 2003; Shively, 1997).

Grisley and Kellog (1987) tried to find out the source of farmers' risk aversion attitudes. They found that farmers' risk attitudes were directly influenced by their perception of yield and the size of their landholding; and indirectly affected by non-land assets and skills (represented by farmers' mathematical ability) and current diversification practices. Ghadim and Pannell (1999), and Just et al. (2003), also add that farmers' information seeking and processing capacity can also influence farmers' risk attitudes. Despite these findings, there are still only a few studies explaining farmers' technology adoption decision making processes in uncertain conditions (Just et al., 2003).

Farmers' motivation and innovativeness are also believed to have a significant effect on technology adoption. Polson and Spencer (1991) observed that non-native farmers usually have higher **motivation** in sustaining and expanding their business, and this includes applying new technologies. Farmers' willingness to try the new technology using their own resources may also indicate their level of **innovativeness** (Shiferaw & Holden, 1998). The effects of motivation and innovativeness, however, depend on the farmers' relative resource endowment as well as the external environment. The success of non-native farmers may result not only from their motivation, but also from their contacts with other people in the village. Farmers' innovativeness may also be dependent on farmers' access to information. This leads to the need to assess the role of communication behaviour in affecting technology adoption.

2.3.2.2.4 Communication behaviour

Rogers (1993) asserts that earlier adopters are usually more eager to seek out new information. They are actively involved in the community and have a wider social network. Rogers refers to these attributes as adopter's communication behaviour. Meanwhile, Asfaw and Admassie (2004) and Cramb (2000) assert that the communication behaviour may also be represented by the intra-household interaction. Within the **intra-household communication,** all household members contribute and actively negotiate their concerns and objectives in order to come up with a consensus. The process is affected by the household's attributes, such as gender, age and level of education (Cramb, 2000). Other studies also confirm the existence of intra-household interaction in decision making (e.g. Asfaw & Admassie, 2004; Kaliba et al., 1997; Lawrence et al., 1999; Savadogo et al., 1998). Asfaw and Admassie (2004), in particular, showed that information sharing among a farm household's members had a substantial influence on adoption-decisions.

The effect of farmers' non-family interactions on their adoption behaviour can be described through the **farmers' networking**. The correlation, however, seems to be unclear. Pingali et al. (2001) found that membership of local organizations only improved the attitude toward a mechanical stripper-harvester in the Philippines, but not in the case of high-yielding and high-quality rice varieties, nor on agricultural technologies in other countries (see Appendix A, Table A. 2). Herath and Takeya (2003) also observed a weak link between networking and technology adoption among farmers in Sri Lanka. Hossain and Crouch (1992) also found that the adoption of agricultural technologies by farmers in Bangladesh was not affected by the opinion of local/group leaders. Nevertheless, **farmers' contacts with researchers and extension workers** have been found to have a strong impact in shaping farmers' level of innovativeness (Adesina & Zinnah, 1993; Baidu-Forson, 1999; Doss & Morris, 2001; Herath & Takeya, 2003; Hossain & Crouch, 1992; Kaliba et al., 1997; Ransom et al., 2003).

2.3.3 Government Policy

Farmers often consider the current institutional conditions when evaluating the feasibility of technology adoption. This is important since most farmers in developing countries have limited access to inputs, capitals, market and infrastructure.

Ransom et al. (2003), for example, found that farmers in an area with relatively better access to seeds, information and product markets were more willing to cultivate new maize varieties. In their review, Feder et al. (1985) also concluded that farmers with better **access to markets** are usually more responsive to innovations. Various indicators can be used to measure farmers' relative access to market. For example, Gockowski and Ndoumbe (2004) used an indicator of marketing cost and found a negative relationship between marketing cost and the rate of adoption. Hintze et al. (2003), and Neil and Lee (2001), used the quality of roads as a proxy of farmers' market access. However, they found different results. Hintze et al. discovered a positive relationship suggesting better roads may increase the adoption propensity. Neill and Lee (2001), on the other hand, found that easy access to a market (better quality of roads) might increase the possibility of land conversion and a low level of technology uptake. Despite this difference, many analysts (e.g. Akinola, 1986; Bellows et al., 1996; Current et al., 1995) confirm the importance of low cost market access in farmers' adoption decision making process.

Similarly, easy **access to credit** has been found to increase technology adoption. Credit can be used to meet the additional expenses of labour and production inputs required for applying a new technology (Adesina et al., 1988; Asfaw & Admassie, 2004; Current et al., 1995; Feder et al., 1985; Lapar & Ehui, 2004). However, access to credit is still a big problem for most farmers in developing countries because they do not have sufficient collateral (Moser & Barrett, 2003; Wadsworth, 1995).

Farmers may also find it difficult to apply new technologies because of limited **access to production inputs**, such as seeds (Feder et al., 1995; Ransom et al., 2003; Wadsworth, 1995), fertilizers and pesticides (Akinola, 1986; Bellows et al., 1996; Current et al., 1995; Lapar & Ehui, 2004), and non-family labour (Adesina et al., 1988; Moser & Barrett, 2003). The latter is particularly crucial considering the seasonal production and the increasing trend of farmers taking off-farm jobs.

Lastly, the adoption decision is often made if farmers already have a full understanding of the technology (Bunch, 1989; Current et al., 1995; Feder et al., 1985; Herath & Takeya, 2003; Hintze et al., 2003; Mukhopadhyay, 1994; Pingali et al., 2001, Neill and Lee, 2001; Ransom et al., 2003; Rogers, 1993; Shapiro et al., 1993; Shiferaw & Holden, 1998; Zhang et al., 2002). This may relate to farmers' **access to information**. However, information is often unevenly distributed among farmers due to an information shortage, or farmers' limited information management capacity (Just et al., 2003).

Farmers' problems of access to productive resources may stem not only from the farmers' limited capacity, but also from the lack of a conducive business climate (Wadsworth, 1995). Thus, farmers require appropriate policies and incentives that can facilitate dealing with their problems. Such policies not only help reduce the economic barriers for accessing productive resources, but also remove social boundaries that often impede equal access of women and minorities to resources, outside contacts and innovations (Doss & Morris, 2001; Haverkort, 1991; Mukhopadhyay, 1994).

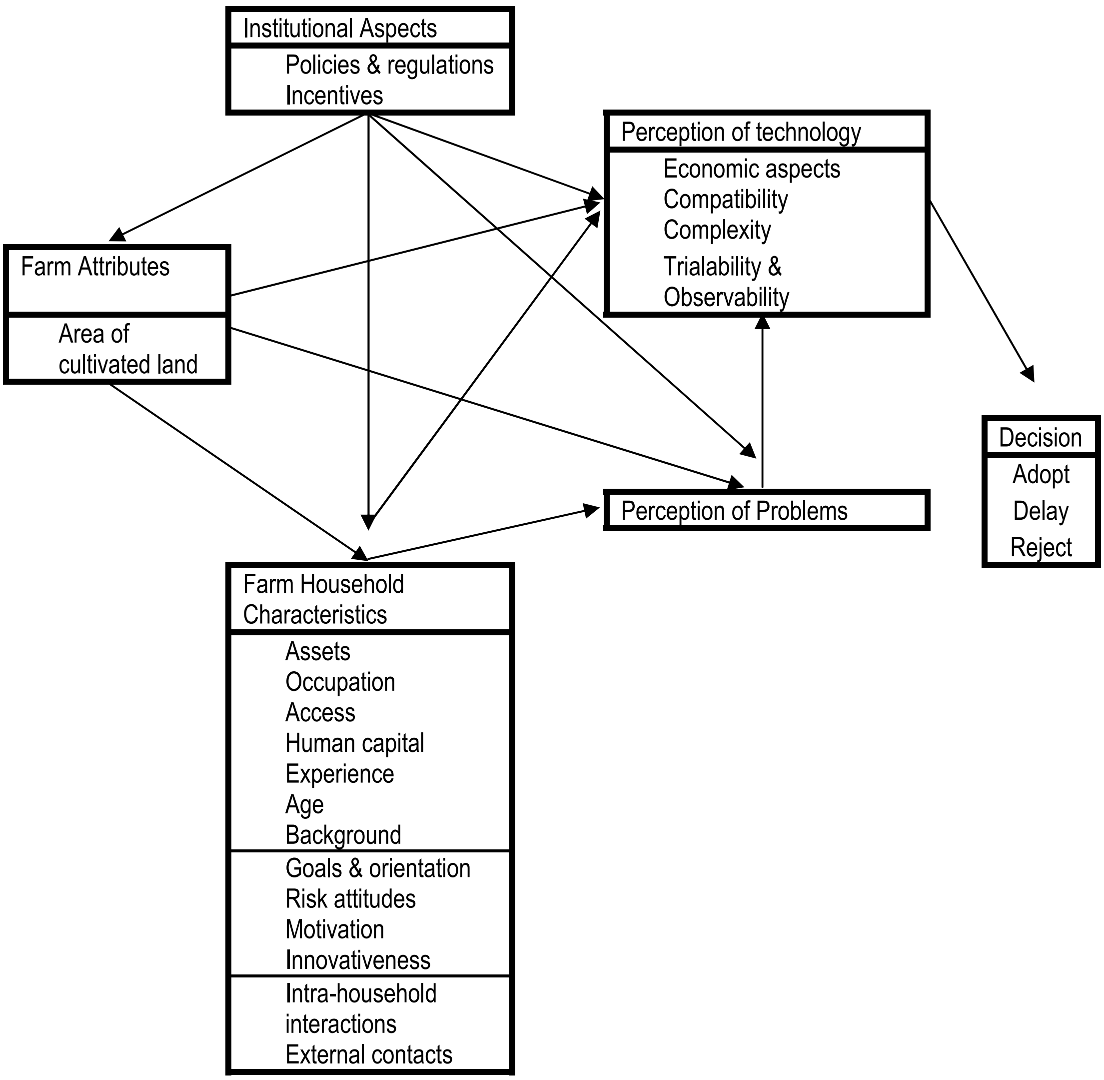
2.4 Summary

This chapter reviewed the theoretical premises and empirical evidence related to technology adoption. Special focus was given to the adoption practices of farmers in developing countries. These farmers appear to follow a logical process in making technology adoption decisions, and their rationale is influenced by the technology characteristics, farm and farmer characteristics, as well as institutional factors. The interrelationships between these variables can be described using a concept formulated by Shiferaw and Holden (1998, p. 235). Figure 2.2 presents a modification of the concept in which an evaluation stage is added to mediate the links between the adoption factors, farmers' perception of the current problem(s) and the final decision.

In the real world, a farmer may have a smaller set of adoption variables than the ones in Figure 2.2. Each farmer will have their own set. Batz (2003) and Doss and Morris (2001) refer to this situation as the farmers' autonomous rationale, which blends both internal and external inputs into a final and unique adoption decision. This is why many studies still find variation in how each adoption determinant influences farmers' actual decisions.

Some potential variables, such as socio-cultural influences, informational processes, risk attitudes and communication behaviour, appear to be poorly explored. This calls for the need to conduct a more thorough analysis of farmers' adoption-decisions. This is particularly challenging in the case of resource-poor farmers, and needs to consider the unique, but at the same time complex, farmers' rationality. Furthermore, some of the variables associated with adoption are not always consistent in their impact. Consequently an all encompassing model that uses the basic characteristics of farmers and their supporters, and of their environmental situations, that explain adoption and their relationships between these basic variables would be extremely valuable.

Figure 2.2. Interrelationships between adoption determinants (modified from Shiferaw & Holden, 1998, p. 235)



CHAPTER THREE: AGRICULTURAL TECHNOLOGY ADOPTION IN INDONESIA

3.1 Introduction

This chapter will present the experience of various efforts in diffusing technology among semi-subsistence, or semi-commercial, farmers in Indonesia. The discussion will support the premise presented in Chapter One that Indonesian farmers have a low level of technological proficiency (see Ekalindo, Mardawilis, & Kardiyono, 2000; Kanro, Lestari, Rauf, Atekan, & Malik, 2002; Priyono, Purwoko, & Irawan, 2003; Sarasutha, 2002; Supriatna, 2003). This issue seems to persist despite the government providing a range of assistance, including providing a complete package of agricultural technology, technical assistance and incentives. The productivity increase and income from applying new technologies have not been sufficient to sustain their adoption practices (Kanro et al., 2002; Supriatna, 2003). Problems, such as a low level of human capital and institutional structure, and poor agro-ecological conditions, have been seen as the main obstacles to extensive technology adoption (Ekalindo et al., 2000; Kanro et al., 2002; Priyono et al., 2003; Sejati et al., 2002; Sulaiman, 2002).

The next two sections will provide an overview of agricultural technology policies, as well as agricultural extension, research and development in Indonesia. It is followed by a discussion of why technology adoption is still an important issue in Indonesia. Finally, a summary will conclude this chapter.

3.2 Government Support in Agricultural Technology Application

Most of the Indonesian population relies on the agricultural sector as its source of income. The number of farm households was about 25.6 million in 2003, and it has been increasing at an average annual growth rate of 2.1 percent over the last 10 years

(Statistics Indonesia, 2004b). Nevertheless, the proportion of farm households to the total number of households has decreased, from 50.5 percent in 1993 to 48.7 percent in 2003.

Most farm households still live in poverty. According to Siregar (2003, cited in Sajogyo, 2003) agricultural wages and household incomes are less than non-agricultural sectors. Siregar calculated that the average wage per household of farm labourers in 1995 was only 20 percent of the average wage of non-agricultural labourers. The average income of farmers with a land-holding in the same year was only 50 percent of non-agricultural households' average income. This, however, might not include the food that the farming families obtained from their agricultural activities.

The agricultural sector has been one of the economic buffers over the 1997-1999 monetary crises. The agricultural export performance, and the flexible capacity of the agricultural sector to absorb thousands of laid-off industrial workers, has helped the economy resurge (Pribadi, 2004; Siregar, 2003, cited in Sajogyo, 2003). Between 1997 and 1999, the export value of agricultural products has increased more than four fold (BPS & Kementrian Koperasi dan UKM, 2002), and the international trade surplus of agricultural products in 2002 reached more than US$2.1 billion (Pribadi, 2004). Smallholder farmers contributed to around 78-84 percent of exports (BPS & Kementrian Koperasi dan UKM, 2002) through a marketing collaboration between smallholder farmers, middlemen and exporters.

The agricultural sector also provided more than 44 percent of employment[1] in 2005 (Statistics Indonesia, 2005b). The recent statistics also show that farmers have improved their prosperity. The value of farmer terms of trade (FTT)[2] has been increasing for the last five years, with an annual growth rate around 1.2 percent

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[1] 'Employment' comprises the population 15 years of age and over (Statistics Indonesia, 2005b)

[2] 'Farmer terms of trade' (FTT) is the ratio between the price of the produced crops received by farmers and the price of agricultural products purchased by farmers. A higher FTT value means a higher level of farmer's wealth (Statistics Indonesia, 2004b)

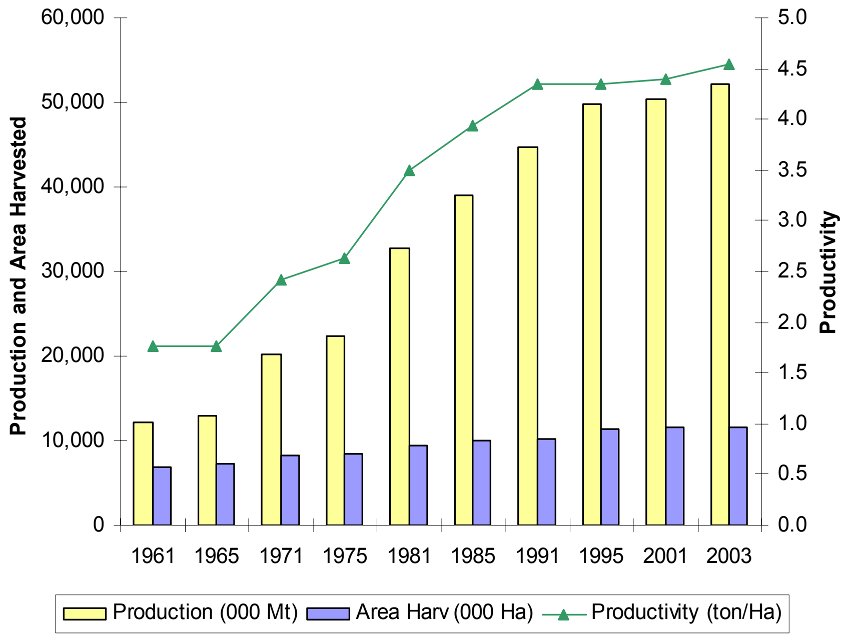
(Pribadi, 2004). The progress, however, has not occurred in rice production, where the FTT value has been decreasing in recent years due to low market prices (Pribadi, 2004; Statistics Indonesia, 2004a).

The government has provided extensive programs to improve farmers' livelihood. In 1963, the government adopted a Green Revolution policy and devised the Mass Guidance (BIMAS) program (Goto & Mayrowani, 2001; Hasan & Ayubar, 2002; Nanseki & Morooka, 1991; Oka, 1991). The program aimed at improving food crop production, particularly rice, through social engineering, capacity building and institutional development (Goto & Mayrowani, 2001). The implementation was directly coordinated by the Indonesian President up to the 1980s and, subsequently, by a special agency within the Ministry of Agriculture.

BIMAS had three main components (Hasan & Ayubar, 2002): (i) technology adoption; (ii) price policies for rice, seeds and fertilizers; and (iii) provision of support through farm/rural credit and associated infrastructures. The technology was given in a package of five farming principles (*Panca Usaha Tani*): land preparation, irrigation management, fertilizer application, plant protection and high-yielding (hybrid) varieties (Goto & Mayrowani, 2001; Oka, 1991). The price policies comprised a centralized marketing system for rice, seeds and fertilizers, as well as price subsidies (Hasan & Ayubar, 2002). The aim was to improve farmers' access to inputs and to assure farmers' income. Farm/rural credit was provided at a low interest rate and fully subsidized by the government (Goto & Mayrowani, 2001; Hasan & Ayubar, 2002; Sumantoro, 2002). In addition, the government expanded and improved the irrigation system, the rice stock management and distribution system, and provided agricultural extension services (Goto & Mayrowani, 2001; Hasan & Ayubar, 2002). The extension personnel assisted farmers in dealing with both technical and managerial issues, and in accessing information and innovations.

BIMAS resulted in a significant increase in rice production. Figure 3.1 shows the increasing trend of rice production as well as productivity. Rice production has increased more than three fold, from 12 million metric tonnes in 1961 to more than 39 million metric tonnes in 1985 (FAOSTAT data, 2004a). The productivity of rice production in 1985 was 124 percent higher than in 1961. The annual growth rate in rice production in the same period was around 9.3 percent, which is higher than the annual population growth rate (2.4 percent) (FAOSTAT data, 2004a; The World Bank, 1998). This led to self-sufficiency in rice in 1984, although it lasted only until 1986. Nevertheless, rice production continues to increase regardless of the lack of self-sufficiency and the slow expansion of farm land (Figure 3.1).

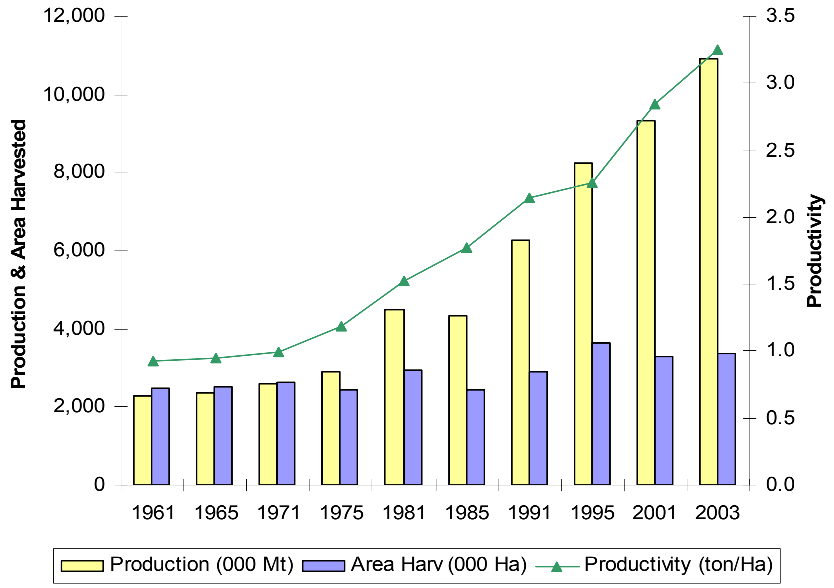
Figure 3.1. Rice production, area harvested and productivity



Source: FAO (2004a)

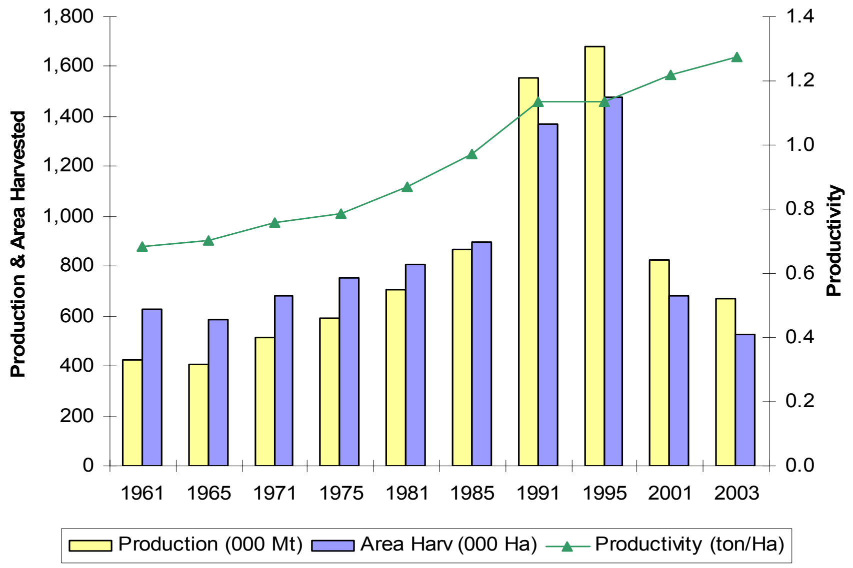
Soepardi (2000) also points out that the massive adoption of the five farming principles has boosted agricultural research and development. BIMAS has also attracted new investments in the fertilizer, pesticide, and seed industries as well as agricultural services (processing, marketing and distribution). This includes the increase in the production of paddy seeds and fertilizers. The production of paddy seeds has increased more than 100 percent in the period between 1961 and 1985 (FAOSTAT data, 2004a). Meanwhile, the production of fertilizers in 1985 was over 4,500 times higher than in 1965; and the total application has also increased almost 2000 times (FAOSTAT data, 2004b). The production of seeds and fertilizers has continued to increase in recent years. In addition, the application of the five farming practices in other food crops has also induced the expansion of other food crops, particularly maize and soybean (Figure 3.2. and 3.3.).

Figure 3.2. Maize production, area harvested and productivity



Source: FAO (2004a)

Figure 3.3. Soybean production, area harvested and productivity



Source: FAO (2004a)

Despite the success, BIMAS has been criticized for creating problems including:

a) BIMAS focused on production and put less attention on the farmers' socioeconomic conditions (Hasan & Ayubar, 2002). The technology package also tended to be biased towards large-scale farms and landowners and, thus, widened the income gap in rural communities (Hasan & Ayubar, 2002; Sajogyo, 2002);

b) the focus on rice led to a mass adoption of rice cultivation and changed the food consumption pattern in some regions where rice is not the staple food. This put a burden on domestic rice production and caused a dependency on imported rice (Krisnamurthi, 2003);

c) BIMAS has been blamed for environmental degradation, for example, reduced water and soil quality due to excessive applications of chemical fertilizers and pesticides (Conway, 1987; Hasan & Ayubar, 2002). Outbreaks of pests and diseases have also believed to have resulted from BIMAS, particularly due to its monocultural food crop practice (Conway, 1987); and

d) BIMAS seems to have altered the social arrangement in rural areas. The introduction of high-yielding varieties has reduced the opportunity for landless farmers and village women, who have a traditional role in rice milling, to work and obtain a share of the yield during the harvest season (Colloer et al., 1973 and Timmer, 1973, cited in Conway, 1987). The role of the villagers has also been replaced by contract labour and machinery (Conway, 1987), and the reliance on pesticides has taken away the traditional, but effective, plant protection methods.

Nevertheless, Soepardi (2002) argues that these side-effects are mainly caused by inconsistencies in the implementation of the five farming principles. He also asserts that ineffective and counter-productive agricultural and trade policies have distorted the potential of BIMAS. The consequences are evident, such as the short-lived rice self-sufficiency and highly fluctuating rice price.

In response to the criticisms, improvements were devised. For example, the Mass Intensification (INMAS) and Special Intensification (INSUS/SUPRA-INSUS) programs were devised to put more attention on farmer collaboration (Sawit and Manwan, 1991, cited in Rubia et al., 1996; Soepardi, 2000). The five farming principles (*Panca Usaha Tani*) have also been improved to become seven farming principles (*Sapta Usaha Pertanian*), and then ten farming principles (*Dasa Usaha Pertanian*). The improvements reflected wider cross-sectoral involvement (Soepardi, 2000) as well as the adoption of post-harvest, processing and marketing practices. Integrated Pest Management (IPM) was also introduced in 1979 and widely promoted in 1989-1991 (Oka, 1991). IPM was targeted to improve plant protection methods to include socio-cultural and ecological considerations. The government has also reduced agricultural subsidies and revoked the state monopoly on rice and fertilizer distribution, and encouraged farmers to become market-oriented (Krisnamurthi, 2003; Sajogyo, 2002). In addition, a participatory approach in agricultural research and extension services, such as decentralized agricultural research (Goto & Mayrowani, 2001) and farmer field schools in IPM (Feder, Murgai, & Quizon, 2003), is being employed to improve the program's effectiveness and to promote community-based development. Since 1999, BIMAS has focused on supporting the improvement of the national food security policy. It is also linked to the agribusiness development policy.

The recent Medium Term Development Plan for the period of 2004-2009 stresses the importance of improving the application of technology by farmers. This will be targeted through the improvement of farmers' capacity and their supporting institutions, particularly the extension services and agricultural research and development groups ("Presidential regulation no. 7: Medium-term development plan 2004-2009," 2005, pp. 19-5 - 19-7). More attention will be also given to the application of post-harvest and location specific technologies. Nevertheless, there are many issues that still need to be tackled in order to secure an improved and sustainable technology application by farmers. Before discussing these issues, details of Indonesian agricultural extension, research and development are presented.

3.3 Agricultural Extension, Research and Development in Indonesia

Many farming communities in Indonesia apply knowledge passed through the generations. This is referred to as indigenous knowledge and is usually perceived as a part of the local norms (Kanro et al., 2002; Rafieq, 2003; Uhi, 2002), and as a social capital for dealing with a local agro-ecosystem (Johnson, 1992, cited in Sunaryo & Joshi, 2003; Wastra, 2001). The knowledge usually includes local farming techniques, tools, resource management and agro-ecological knowledge. The knowledge is not static as farmers continuously learn (Sunaryo & Joshi, 2003). However, such knowledge often has limitations, such as:

a) it often fails to keep up with the changes in agro-ecosystem, socio-cultural and socioeconomic conditions (Farrington & Martin, 1987, cited in IDS Workshop, 1989b). Despite its flexible adaptation capacity, the source of inputs and the adaptation process may not produce an accurate and relevant result (Biggs & Clay, 1980; Swift, 1979, cited in IDS Workshop, 1989b; Thrupp, 1989, cited in Sunaryo & Joshi, 2003);

b) not all members of the community can develop, access and distribute the same level of indigenous knowledge due to differences in the social strata as well as in the capacity to innovate (Swift, 1979, cited in IDS Workshop, 1989b);

c) most farmers still rely on a mind-based record system and, thus, the knowledge may be easily lost, or result in many variations through the generations (Biggs & Clay, 1980; Swift, 1979, cited in IDS Workshop, 1989b); and

d) it is difficult to identify as it is integrated within the local culture and practices (Scoones & Thompson, 1994).

In this regard, the government tries to improve farmers' capacity through improving agricultural research and development, and their extension services. Farming System Research (FSR) was introduced in 1973 with the focus of improving the performance of peasant farmers through on-farm experimentation (Goto & Mayrowani, 2001). The government also created the Agency for Agricultural Research and Development (AARD), and the Agro-ecosystem Research Group (KEPAS) program in the 1980s to facilitate the networking between AARD and some major universities (Goto & Mayrowani, 2001). In the 1990s, the government strengthened, and decentralized, the role of AARD with the establishment of the Assessment Institute for Agricultural Technology (AIAT) at the provincial level (Goto & Mayrowani, 2001; Sejati et al., 2002). There were 28 AIAT in 2004. The AIAT has a responsibility to develop agricultural technologies suitable for local conditions (IAARD, 2002). The AIAT also collaborates with local government, field extension workers (FEWs), the Agricultural Information and Extension Center (AIEC) and private organizations to facilitate more participatory technology development and diffusion (Sejati et al., 2002).

Innovations from AIAT are usually delivered in the form of a technology package (Hasan & Ayubar, 2002; Hutabarat, 2002; Sejati et al., 2002; Sulaiman, 2002). The processes employ the Rural Rapid Appraisal (RRA), or Participatory Rural Appraisal (PRA) approach, in order to encourage participation from the farmers and the FEWs. For the same reason, the extension service is also delivered using several methods (Sejati et al., 2002), including the following:

a) field visits to individual farmers, or the leaders of a farmer group;
b) meeting with farmer groups and/or village community;
c) conducting a pilot experiment in a demonstration plot;
d) field or classroom training;
e) seminars and exhibitions; and
f) free printed and electronic publications, such as newspapers, tabloids, pamphlets, posters, movies, videos, and radio and television programs.

One example of the multi-approach extension service is the Farmer Field School (FFS), which combines field visits, training and demonstration plots. FFS focuses on a participatory problem-solving process, in which farmers are invited to actively interact throughout the training and field trials (Feder et al., 2003; Winarto, 1994). The participating farmers are expected to disseminate the knowledge from FFS to other farmers. These efforts have resulted in an increased innovation uptake by farmers (Hasan & Ayubar, 2002; Manwan, 1989, cited in Goto & Mayrowani, 2001; Soepardi, 2000). This includes the application of high-yielding varieties, fertilizers, and processing/post-harvest methods (Hasan & Ayubar, 2002; Manwan, 1989, cited in Goto & Mayrowani, 2001). The data from the Ministry of Agriculture (2004) also show an increasing use of agricultural machinery (Table 3.1).

Table 3.1. Agricultural machinery used by farmers (unit)

	1992	1995	1998
Two-wheel drive tractor	33,845	53,867	81,108
Four-wheel drive tractor	4,557	6,124	4,656
Hand sprayer	1,169,106	1,286,594	1,638,055
Knapsack motor sprayer	12,253	14,515	31,301
Power sprayer	2,512	3,162	4,631
Swing fog	715	786	1,729
Rat ambush	97,047	82,176	92,859
Rice husker	258,330	300,141	367,250
Rice drier	4,047	5,635	5,525
Rice cleaner	51,125	55,734	49,133
Rice polisher	14,001	13,246	15,828
Large-scale rice milling	3,403	3,957	6,462

Source: Center for Agricultural Data and Information, Ministry of Agriculture (2004)

The widespread application of Integrated Pest Management (IPM) is also deemed a successful result from the participatory approach. According to Oka (1991), farmers perceive a clear benefit from IPM application and they feel sufficiently enthusiastic to transmit their knowledge from the IPM-FFS to other farmers in the community/group. Recent studies (e.g. Supriatna, 2003; Utama, 2003) also show that farmers become more self-confident as well as aware of environmental sustainability after participating in the IPM-FFS. The adoption is expected to be sustainable.

Despite the success, many researchers have observed shortcomings of participatory research and extension. First, farmers' socio-cultural and socioeconomic conditions are often not fully taken into account (Conway, 1987; Hasan & Ayubar, 2002; Sajogyo, 2002). Secondly, the technology development process is often biased towards rice cultivation and the interests of the government or the researchers (Goto & Mayrowani, 2001; Sejati et al., 2002; Sulaiman, 2002). Feder et al. (2003) also found that FFS might not be effective due to farmers' limited learning capacity. Winarto (1994) also discovered that differences in age, religion and socio-economic status often create barriers for extensive farmer-to-farmer technology transfer. Lastly, the linkage between the AIAT and AIEC still faces some institutional problems (Hutabarat et al., 2002; Sejati et al., 2002), which may even reduce the coverage of the extension service. The latter problem has worsened as the number of FEWs has been decreasing, especially after the enactment of the Regional Autonomy Law (Sejati et al., 2002). Table 3.2 presents the recent figures on agricultural centers and workers in each province. The number of extension workers is still too small compared to the number of farm households, which is around 25.6 million. The ratio is 973 farmers for one extension worker. This is one problem among many faced in agricultural technology transfer. The next section will present a more detailed discussion of this topic.

Table 3.2. The number of agricultural extension workers and centers in Indonesia in 2003

Provinces	Workers	Centers	Provinces	Workers	Centers
Nangroe Aceh Darussalam	859	126	Bali	403	27
North Sumatra	1,160	157	West Nusa Tenggara	661	46
West Sumatra	935	96	East Nusa Tenggara	852	79
Riau	682	73	West Kalimantan	378	31
Bangka-Belitung	182	13	Central Kalimantan	674	56
Jambi	1,124	49	East Kalimantan	374	22
Bengkulu	638	18	South Kalimantan	977	67
South Sumatra	1,426	60	North Sulawesi	711	77
Lampung	661	48	Gorontalo	178	22
Banten	486	91	Central Sulawesi	878	52
DKI Jakarta	54	0	Southeast Sulawesi	980	21
West Java	1,845	275	South Sulawesi	1,971	172
DI Yogyakarta	536	40	North Maluku	263	14
Central Java	2,579	275	Maluku	289	3
East Java	2,835	401	Irian Jaya	741	57
National	26,332	2,468			

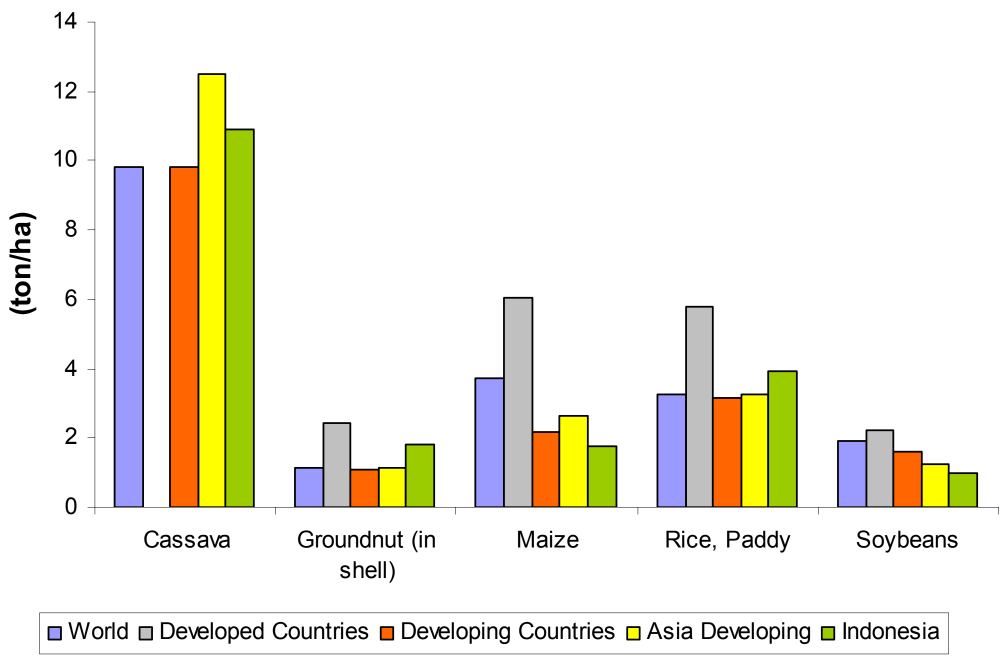
Source: Development Center for Agricultural Extension (2003). The numbers also includes estimation for centers that have not submitted a report prior to August 2003.

3.4 Technology Adoption as an Important Issue in Agricultural Development in Indonesia

The United Nations Food and Agriculture Organization (FAO, 2003) has observed an increasing trend in agricultural productivity for the last three decades. The world agricultural production has grown at a faster rate relative to the world population. Technology advancement, particularly in developed countries, is assumed to be the main factor that has contributed to this achievement. As a result, the prices of agricultural products, in general, are decreasing.

However, FAO (2003) also finds that more people are unable to access basic foods. This is caused by the widening income gap between poor and wealthier households, particularly in developing countries. In addition, world agricultural production is facing more uncertainties due to the decreasing availability of farmland and the declining quality of the agro-ecosystem. At the same time, socioeconomic conditions have not been helping farmers, particularly the poor ones in developing countries, to access productive resources, such as land, capital and technology. Therefore, although FAO suggests addressing the above issues through promoting technology and advanced farming practices, many challenges must first be overcome.

Figure 3.4. Productivity of selected food crops (1985)

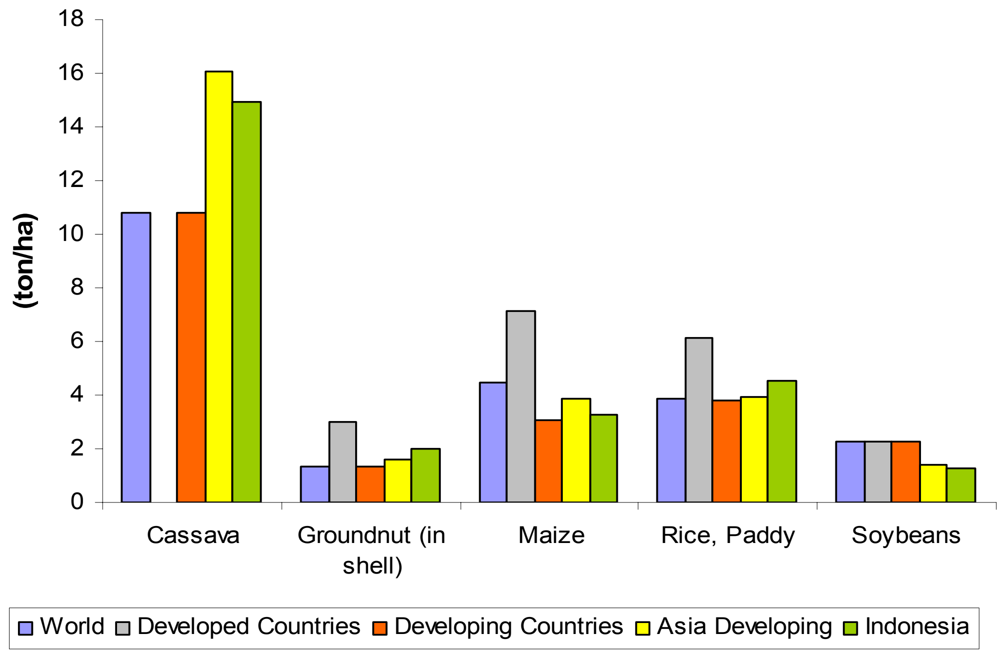


Source: FAO (2004)

This is also evident in the case of Indonesian agriculture. The production of food crops, mainly rice, maize, soybean, groundnuts and cassava, has been increasing since the introduction of BIMAS, INMAS and other technology related programs. Figures

3.4 and 3.5 show the comparison of food crop production between Indonesia and the rest of the world. The five commodities represent the main food crops produced in Indonesia. Groundnut and rice productivities in Indonesia, in particular, have been higher than that of the developing world for the last two decades. Maize productivity in Indonesia also continues to increase. This may suggest the success of technology application in the agricultural production in Indonesia.

Figure 3.5. Productivity of selected food crops (2003)



Source: FAO (2004)

However, food crop productivity in Indonesia is still lower than developed countries. This may mean a high import burden for Indonesia, particularly during unfavourable seasons such as the ones in 1997-1998 (with El Nino and La Nina), and considering that the population growth rate in Indonesia is still higher than developed countries. The difference in productivity also indicates the difference in the level of technology application.

The prospect of increasing agricultural production in Indonesia also faces more uncertainties, as agricultural resources are now approaching their limit. Agus (2004), for example, observed an increasing trend of agricultural land conversion. He found that around 1.6 million hectares of rice fields have been converted into plantations, industrial sites, public facilities and residential areas between 1981 and 1999. The inheritance customs (Statistics Indonesia, 2004b) and the entry of laid-off industrial workers to the agricultural sector (Siregar, 2003, cited in Sajogyo, 2003) has also resulted in a decrease of the average farm land holding from 1.3 hectares to 0.7 hectares during 1983-2003 ("Presidential regulation no. 7: Medium-term development plan 2004-2009," 2005). The proportion of smallholder farms[3] to total farm households has also increased from 52.1 percent to 56.2 percent during the period from 1993 to 2003 (Statistics Indonesia, 2004b). As farming income is positively correlated with the area of the cultivated land (Sumaryanto, Adnyana, Kustiari, & Djojopoespito, 2002), the figure may imply an increasing proportion of poor farmers.

The scarcity of farmland has also changed the structure of rural labour. The availability of rural labour continues to decrease as younger and more educated generations now prefer to migrate to, and work in, urban areas (Pranaji et al., 2001). Furthermore, Sajogyo (2002) and Sulaiman (2002) observed that many male members of the landless farm households work seasonally, or permanently, in urban areas in order to obtain additional income and fulfil their household needs. This has changed the division of work that was previously gender based.

Many farm households also gave up farming and became urban migrants. However, some have chosen mechanization as a solution. This is particularly evident in fringe areas surrounding an urban industrial area where the supply of rural labour is limited (Sodiq et al., 1999, cited in "Perempuan "hilang" di dalam produksi pangan (Women "lost" in food production)," 2004; Tastra, 2003). The degree of mechanization, however, is quite limited because most of these farmers have a limited human capacity and access to markets, capital and inputs.

[3] A smallholder farm household is defined as a farm household cultivating less than 0.5 hectares of own or rented land

Data collected by Munandar (2001, cited in Rivai, 2003) indicate that most farm labourers (83%) have only completed primary school education, or even less. Sulaiman (2002) also confirms a similar situation in the case of farmers in four different agro-ecosystems in South Sumatra. In addition, Feder et al. (2003) noticed a low level of information processing skills among farmers who participated in the Farmer Field School (FFS) for IPM in East Java, Indonesia. These farmers appeared to struggle to adjust their learning method and, thus, they did not fully grasp the training material.

Some other studies (e.g. Ekalindo et al., 2000; Pranaji et al., 2001; Priyono et al., 2003) indicated that the farmers' low motivation to learn, work and pursue advancement are the main causes for a low level of technology uptake. Such conclusions, however, may be misleading since none of the above studies conducted an in-depth analysis of the farmers' motivation concerning technology adoption. Farmers may have their own rationale which cannot be directly identified from a simple analysis. For example, Sejati et al. (2002) discovered that the head of the farm household does not always have the right to make the final decision as other family members, peer farmers and/or the head of a farmer group may have a say in the final decision. This shows that the socio-cultural norms have an important role in the Indonesian farm household's decision making process.

In accordance with the latter evidence, the government has promoted farmer collaboration to overcome limitations in individual farmers' decision making. The effort focuses on the empowerment of local socio-cultural networking (Conway, 1987; Suradisastra, Sejati, Supriatna, & Hidayat, 2002), which includes "*adat*"[4] institutions and farmer groups. The example of "*adat*" institutions is the Balinese "*Subak*", which is a kind of water user association that facilitates its members in

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[4] According to the Indonesian Alliance of "*Adat*" Communities (AMAN, Safitri & Bosko, 2002), there are 50 to 70 million people in Indonesia living under "*adat*" law and institutions. "*Adat*" communities are defined as:

> "*a community living together based on their origins intergenerationally in adat land, who have sovereignty over the land and the natural resources, sociocultural life regulated by adat law and adat institutions which manage the sustainability of the communities' lives.*" (p. 5)

dealing with technical issues—including technology adoption, as well as in maintaining social and religious contacts within the community (Suradisastra et al., 2002). The socio-cultural networking appears in the form of informal work sharing among farm households. The empowerment of farmer groups so far has resulted in, for example, the use of farmer group meetings as the main communication means for discussing a new technology (Sulaiman, 2002). Wahyuni (2003) also observed that farmer groups' capacity improve when the groups also collaborate with cooperatives and field extension workers (FEWs).

There are, however, few local institutions with as consistent a management style as "*Subak*" (Pranaji et al., 2001). Also, most farmer groups do not have sufficient competency. According to the Agricultural Extension Center (2001, cited in Wahyuni, 2003), among 254,822 farmer groups throughout the country, only 5 percent are categorized as advanced, while around 39 percent and 53 percent are still at the beginner and intermediate level, respectively. At the same time, the number of FEWs continues decreasing (see section 3.3). This may bring a negative impact on technology application among farmers, as many studies (e.g. Sulaiman, 2002) discovered that farmer groups rely on a face-to-face meeting with FEWs when they access and evaluate a new technology.

The above conditions are compounded as farmers in Indonesia, in general, still have limited access to markets, capital and inputs. The problem does not only relate to physical access, but also to affordability and timing. To overcome these problems, the government has devised many policies and programs. For example, the government has streamlined the marketing and distribution systems for agricultural inputs, particularly seeds and fertilizers (Hasan & Ayubar, 2002; Krisnamurthi, 2003; Soepardi, 2000), established local/ regional markets (Goto & Mayrowani, 2001; Pranaji et al., 2001), provided daily agricultural price information (Simatupang et al., 2002), and improved the quality of the infrastructure (Hasan & Ayubar, 2002). The government also launched a mass land titling project (Land Administration Project or LAP) so that farmers can have formal collateral for borrowing money from banks.

This program is also supported by the provision of microfinance schemes for rural areas (Social Monitoring and Qualitative Analysis Division, 2001).

The above policies and programs, however, have not been able to boost the rate of technology application among farmers. Some inconsistencies persist, particularly due to the enactment of the Regional Autonomy Law and a strict financial regulation toward micro and small-scale lending. In addition, the programs are still limited in coverage.

The discussion implies that considerable effort is needed to improve the production capacity of the Indonesian farmers. For this reason, and considering the increasing pressures on agricultural resources and trade, the government of Indonesia continues promoting the application of advanced agricultural technology and practices ("Presidential regulation no. 7: Medium-term development plan 2004-2009," 2005, pp. 19-5 - 19-7).

To assist this process, further improvement in the methods used are needed to boost the application of technology, particularly as the capacity of agricultural support institutions, and the effect of socioeconomic reforms, are still limited. Farmer education may be one alternative. However, following Chambers's (1989) "Farmer First" approach, understanding the farmers' needs, challenges and knowledge, including the way farmers learn and make decisions, may provide a more tangible result. This topic will be discussed in the next chapter.

3.5 Summary

This chapter has presented a general picture of policies and programs designed to improve technology uptake among farmers in Indonesia. The discussion also covers an overview of agricultural research, development and extension. In brief, the government has encouraged farmers to adopt innovations through various social engineering programs. BIMAS was the most prominent one and it contains a complete package of agricultural technology, technical assistance and incentives (credit, market and prices). BIMAS has resulted in a significant increase in food production, the expansion of agricultural research and innovation, the development of agricultural services, and new investments in agro-industries.

Nevertheless, many shortcomings continue to be observed, possibly due to the low attention given to the farmers' characteristics and socioeconomic conditions. Farmers also still face structural and complex problems, especially those related to the quality of human capital and access to markets, capital and inputs. The problems seem to be interwoven and, for technology adoption analysis, one should be fully aware of this complexity.

Despite the above problems, the government of Indonesia continues promoting the application of technology and advanced practices among farmers. The reasons for this include the decreasing availability of agricultural resources and the structural problems faced by farmers. This is expected to improve the livelihoods of the Indonesian farmers and, at the same time, prevent these farmers becoming vulnerable to severe seasons and the current changes in world agricultural production and trade. The effort, however, requires a more effective strategy considering the limitations in agricultural supporting institutions. One alternative is to explore how farmers learn and make decisions so that any technology diffusion efforts can meet the farmers' documented needs and challenges. This leads to the next discussion on decision theories and the associated analytical methods. This is presented in Chapter Four.

CHAPTER FOUR: DECISION MODELS

4.1. Introduction

Most analyses reviewed in the previous chapters (e.g. Herath & Takeya, 2003; Hintze, Renkow, & Sain, 2003; Negatu & Parikh, 1999; Neill & Lee, 2001; Pingali, Rozelle, & Gerpacio, 2001; Shiferaw & Holden, 1998) concentrated on explaining the adoption event (the outcome), especially in terms of the likely adoption variables and their correlations. Only a few studies have attempted to reveal the actual adoption process farmers take. The reason may relate to the difficulty in conceptualizing a universal adoption process as individual farmers' adoption behaviour appears to be unique, although hopefully explainable through a general encompassing theory.

As noted earlier, the diverse adoption behaviour is probably affected by differences in farmers' relative assets, access to productive resources, risk attitudes, skills and capacity (Feder, Just, & Zilberman, 1985); location (agro-ecosystem) and types of technology (Pingali et al., 2001); the farming seasons (Moser & Barrett, 2003); and chance factors such as who their neighbours and village colleagues are (Case, 1992; Munshi, 2004; Pomp & Burger, 1995; Zhang, Fan, & Cai, 2002). Therefore, explaining how these variables simultaneously or complementarily give rise to a farmer's technology adoption decision making process is likely to be complex.

In this regard, this chapter will discuss frameworks that can be used for identifying the general pattern of a farmer's adoption-decision process. The discussion will start with a brief review of the concept of a mental process involved in decision making. Then, decision making process concepts introduced by Rogers (1993) and Ohlmer, Olson & Brehmer (1998) will be more fully reviewed, and this is followed by a full discussion on the concept of heuristics (rules of thumb). A discussion on decision models and the associated procedures will also be presented. A summary will be presented to conclude this chapter.

Figure 4.1. Basic concept of consumers' decision making processes (taken from Antonides, 1996, pp. 15-16)

Objective environment	→	**Mental Processes**	→	**Behaviour**
income, assets, employment opportunities, socioeconomic status		mental processes, subjective wellbeing, economic attitudes, personal and economic expectations		consumer demand and saving

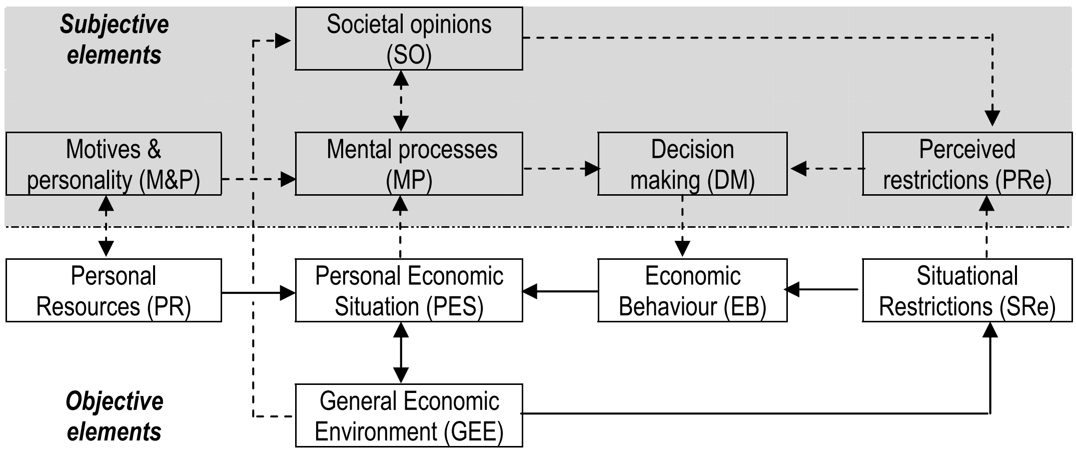
4.2. The Mental Process in Decision Making

Decision making analyses may be classified as behavioural analyses because they have the objective of explaining "*decisions people make and how people decide*" (Bell, Raiffa, & Tversky, 1988, p. 1). In other words, such analyses may focus on the reason and process people take to make sense of their decision and behaviour. In the case of agricultural decision making, Ohlmer et al. (1998) suggest the analysis should take into account a farmer's full decision making process. For example, the analysis should recognize (i) imperfection in the way a farmer defines her/his goals, objectives and values, in the way she/he exploits them while appraising one or more opportunities, and (ii) whether the farmer fully comprehends both the potential and risk in the opportunity(ies). Indeed, all the aspects mentioned may in fact relate to the farmer's mental process. However, only limited information about the structure of mental processes is available.

The relationship between one's mental process and behaviour has been widely explored in the area of consumer behaviour (Antonides, 1996). For example, Kantona (1964, cited in Antonides, 1996) developed a basic concept of consumer behaviour based on survey results (Figure 4.1), in which the decision making process starts as a response to a certain stimulus (resource endowment, status or opportunity). The stimulus will then induce a "*perceptual process*" (p. 55) that leads in sequential steps into a learning process, attitude development and finally the actual behaviour (Antonides, 1996).

Antonides (1996) then elaborated on this concept by recognizing the subjective and objective aspects of decision making (Figure 4.2). The subjective elements can be constructed based on individual judgment and preferences collected from a survey, and the objective elements can be obtained from statistical data and independent information. The objective environment from Figure 4.1 is divided into individual motivation and personality aspects (the subjective elements), and individual assets (the objective elements). The structure of mental processes, from Figure 4.1, is also elaborated to include social norms (subjective elements), and personal wellbeing and macroeconomic conditions (objective elements). Meanwhile, the transformation of mental processes into a decision and behaviour may take direct or indirect routes, involving some personal and external constraints (Figure 4.2).

Figure 4.2. The relationships between subjective and objective elements in the decision maker's behaviour (taken from Antonides, 1996, p. 19)



The concept in Figure 4.2 shows a feedback mechanism, showing that the behaviour has an effect in modifying or revising the general economic conditions, societal opinions and individual mental processes. The reciprocal interactions will continue until a new perception, decision and behaviour is created. This feedback mechanism may represent the decision maker's continuous learning and handling of the evolution of her/his environment (Raaij, 1981, cited in Antonides, 1996; Kelly, 1955; Simon, 1978), that is, a continuous mental process.

Based on this concept, and a review by Warneryd (1988), Antonides (1996, p. 3) concluded that the behaviour of economic actors are shaped by "*motivational factors, values and norms, information processing, attitudes, social comparison, rules or* *heuristics, attributions, emotional factors, bargaining process, learning process and expectation*". Some of the factors will be further elaborated in the next discussion on adoption-decision processes, decision heuristics and decision models.

4.3. Concepts of the Adoption-Decision Process

As noted earlier, Rogers (1993) has postulated the infamous five steps of "*innovation-decision process*". He argues that these stages do exist in a sequence, although some may be less apparent. The five decision steps are:

a) *knowledge* stage (pp. 164-168), which relates to the process of familiarizing (*cognitive process*) of an innovation (*awareness knowledge*), how to use it (*how-to knowledge*), and what the innovation is for (*principles knowledge*);

b) *persuasion* stage (pp. 169-172) is the psychological process where the decision maker actively searches for more information about the innovation. The focus is finding the reliable sources of information, a sufficient quantity and quality of the information and the strategy to construe the information. The benefits and costs of an innovation are evaluated and some social justifications are sought for developing her/his (negative or positive) perception on the innovation;

c) *decision choice* (pp. 172-174) is the stage where the decision maker would make a small-scale experiment or observe the trials conducted by her/his peers. The results of this trial will serve as the basis for the adoption or rejection decision;

d) *implementation* (pp. 174-182) is the stage where the innovation is applied. The decision maker also seeks further information about the source of the innovation, the application procedures and troubleshooting strategies. Some uncertainties may result in different degrees of implementation, such as "*re-invention*", in which the decision maker modifies the procedures or even the innovation as a whole. This is perceived as the decision maker's strategy to cope with uncertainties, although some may not accept this as adoption (full implementation); and

e) *confirmation* stage (pp. 184-191) is included because it is believed that the adoption or rejection decision is not final. In this stage, the decision maker seeks justification about whether it is necessary to continue or discontinue the adoption. This is important as she/he strives to make her/his attitudes and practices more favourable and in line with the current situation.

Dimara and Skuras (2003) suggest a simpler description of farmers' decision making processes. They suggest the process consists of two stages: awareness/learning and evaluation. During the awareness period, farmers may receive and/or search for information about a particular problem or opportunity, e.g. an adoption opportunity. This stage shows both the passive and active roles of farmers in information acquisition. These researchers also argue that the intensity of farmers' information seeking effort is conditional on the farmers' capacity as well as objectives. When the information is not available or simply ignored by the farmers, the awareness period may take a longer time and result in several sub-stages (Dimara & Skuras, 2003). Meanwhile, in the evaluation stage, the farmers scrutinize the expected benefits and costs from the adoption based on their goals (Dimara & Skuras, 2003).

However, as adoption is one type of managerial decision, one might want to check the standard conception of the agricultural decision making process. In some farm management texts, a decision making process in a commercially-oriented farm is believed to consist of eight stages: "*setting goals, recognizing problem, obtaining information, considering alternatives, making the decision, taking action, accepting responsibility and evaluating the decision*" (Castle, Becker, & Nelson, 1987, p. 4). A similar concept was employed by Ohlmer et al. (1998) in their study of the decision making process of market-oriented farmers in Sweden. These researchers used eight elements of the decision making process: values and goals; problem detection; problem definition; observation; analysis; development of intention; implementation; and responsibility bearing.

Nevertheless, Ohlmer et al. (1998) noticed that these elements did not occur in a sequence and that farmers' decision processes varied depending upon information availability as well as farmers' capacity and endeavour in finding information and solutions. Therefore, they suggested a non-linear concept of the decision making process (see Table 4.1) and formed a matrix format to represent the relationship between the four main decision stages (problem detection, problem definition, analysis and choice, and implementation) and four sub-stages (searching and paying attention, planning, evaluating and choosing, and bearing responsibility). Ohlmer et al. excluded the stage of defining values and goals as they argued that this stage should have occurred before the decision making process begins. Both values and goals are used by farmers as the yardsticks for assessing a problem or an opportunity.

Table 4.1. A matrix of main stages and sub-stages of a decision making process (taken from Ohlmer et al., 1998, p. 285)

Stage	Sub-stages			
	Searching & paying attention (observation)	**Planning**	**Evaluating & choosing**	**Bearing responsibility, including development of intention**
Problem detection	Information scanning & paying attention	-	Consequence evaluation, detection of problem	Checking the choice
Problem definition	Information search & finding options	-	Consequence evaluation, choose options to study	Checking the choice
Analysis & choice	Information search	planning	Consequence evaluation, choice of option	Checking the choice
Implementation	Information search & clues to outcome	-	Consequence evaluation, choice of corrective action(s)	Bearing responsibility for final outcome, & feed forward information

If the above concepts of the decision making process are compared, it is clear they have similarities (Table 4.2). All of them recognize the following steps:

a) <u>the process of building awareness</u>, which describes how the farmer first comes across a problem or an opportunity (e.g. new innovations). Here, the farmer may detect a problem from the discrepancy between her/his goals and values, and the outcome of their past decisions. The farmer may also notice some opportunities to further expand her/his business as the farmer receives and seeks new information;

b) <u>the process of clarifying events</u>, which represents the farmer's active role in obtaining more information so that the farmer can comprehend the problem or opportunity more clearly. The farmer also actively collects some information related to the available alternatives of problem solving;

Table 4.2. Comparison of several concepts of the decision making process (continued on next page)

Standard decision making steps (Castle, Becker & Nelson, 1987)	Linear model of decision making (Ohlmer, Olson & Brehmer, 1998)	Revised (matrix) model of decision making (Ohlmer, Olson & Brehmer, 1998)	Innovation-decision process (Rogers, 1993)	Dimara & Skuras (2003)	Similarity
Setting goals (in writing) as farmers are goal oriented	**Defining values and goals** as farmers are goal oriented & use their values & goals as decision benchmarks	Values and goals are set before the decision process			
Recognizing problem: identifying any discrepancy between goals & achievement	**Problem detection**: identifying problem and information seeking	**Problem detection** – information seeking & observation; – detecting any possible problem(s) & evaluating consequence(s); and – responsibility bearing, checking the choice, & development of intention.	**Knowledge stage**: – familiarizing with an innovation; and – learning the procedure to use it and its function.	**Awareness or learning period**: – information accumulation period (passive or active/ learning)	**Process of building awareness**: – knowledge accumulation; – problem detection; and – understanding consequence(s).
Obtaining information: learning about the consequences & alternative solutions	**Problem definition/ information seeking**: clarifying the problem and elaborating the available means to deal with the problem	**Problem definition** – information seeking & finding problem solving options; – evaluating consequence(s) & selecting options to further scrutinize; and – responsibility bearing, checking the choice, & development of intention.	**Persuasion stage**: – information seeking (finding the right sources, sufficient amount & quality); – finding the strategy; – considering benefits & costs; and – seeking social justifications.		**Process of clarifying event**: – more extensive information seeking; and – identifying approach to analyze.

Table 4.2. Comparison among several concepts of decision making process (continued)

Standard decision making steps (Castle, Becker & Nelson, 1987)	Linear model of decision making (Ohlmer, Olson & Brehmer, 1998)	Revised (matrix) model of decision making (Ohlmer, Olson & Brehmer, 1998)	Innovation-decision process (Rogers, 1993)	Dimara & Skuras (2003)	Similarity
Considering alternatives: comparing alternative actions based on goals and information collected **Making the decision**: selecting the most feasible solution	**Observation**: information processing **Analysis**: planning, analyzing and determining a decision **Development of intention**: mentally applying the chosen decision based on current conditions	**Analysis and choice:** – information seeking; – planning a decision; – evaluating consequence(s) & making a decision; and – responsibility bearing & development of intention to implement the decision.	**Decision choice**: – evaluating an innovation based on the performance of own small-scale experiment and/or application by peers; and – making a decision, whether to adopt, delay or reject the innovation.	**Evaluation stage**: – assessing the economic value of an adoption option through the estimation of the associated costs and benefits of the option	**Process of evaluating and selecting decision**: – planning a decision; – reviewing the benefits & costs; and – making the decision.
Taking action: implementing the decision **Accepting responsibility** for the decision **Evaluating the decision**: assessing outcome and re-assessing the decision	**Implementation** **Responsibility bearing**: determining the person(s) who will be responsible for the outcome and take a follow-up action given the feedback from the implementation	**Implementation** – daily monitoring and evaluation of the progress and outcome; – evaluating expectations & selecting future strategy to revise decision & improve performance; and – responsibility bearing for final outcome & information for future action.	**Implementation**: – information seeking on the source of the innovation, application procedures & troubleshooting strategies; – considering risks and their mitigation strategy (e.g. re-invention/modification); and – applying the innovation. **Confirmation**: – seeking justification for sustaining or revising the decision; and – developing corrective means.		**Implementation of a decision and feedback:** – information seeking on the performance; and – deciding whether to continue, change or discard the decision.

c) the process of evaluating and selecting a decision, which is the actual decision making process. Here, the farmer incorporates all relevant information into a more structured analysis, evaluates the benefits and costs of each decision alternative, and finally selects the best alternative; and

d) the implementation process, in which the decision maker applies the decision, supervises and evaluates the progress and outcomes. The farmer may take the responsibility for the outcomes and, after evaluating the outcomes, the farmer may determine a follow up action, whether to sustain, modify or discard the current decision and implementation.

The matrix concept created by Ohlmer et al. (1998) and Rogers's (1993) "*innovation-decision process*", in particular, appear to be more progressive than the standard eight-step decision making process. These concepts recognize the feedback mechanism that only exists during the implementation of the decision (including the small-scale trial). Such practices are also confirmed by some (e.g. Feder et al., 1985; Jangu, 1997; Marra, Pannell, & Abadi Ghadim, 2003; Neill & Lee, 2001) who observed that the decision is not always final as the farmer learns new things and may revise her/his decisions. These concepts, thus, present decision making as a dynamic process, different from the two-stage decision process suggested by Dimara & Skuras (2003).

Compared to Rogers's "*innovation-decision process*", the matrix concept may reflect farmers' actual decision making processes, which is often characterized as non-static, non-linear, inconsistent, arbitrary and, sometimes, unstructured. This annuls Rogers's argument of sequential decision making stages. The inclusion of four sub-stages at each of the decision processes main stages also represents the multiple loops involving repetitive activities such as information seeking, observation, planning, evaluation, development of intention and taking responsibility. This is also in accordance with Antonides's concept of a mental process. The routine activities may also represent farmers' efforts to minimize the impact of uncertainties during the decision making process (Ohlmer et al., 1998).

The matrix concept also accommodates five major attributes that become the milieu of the diverse farmers' decision making processes. The attributes are as follows (Ohlmer et al., 1998, p. 286):

a) "*farmers continually update their problem perceptions, ideas of options, plans and expectations when new information is obtained*;
b) *farmers often use a qualitative approach to forming expectations and estimating consequences expressed in directions from the current condition*;
c) *farmers prefer a "quick and simple" decision approach over a detailed, elaborate approach*;
d) *farmers prefer to collect information and avoid risk through small tests and incremental implementation*; and
e) *farmers continually check clues to form their evaluation of long-run actions in a feed forward and compensation approach, rather than a post-implementation evaluation*".

Rogers's (1993) "*innovation-decision process*", to some extent, also contains the attributes pointed out by Ohlmer et al. (1998) (see Table 4.2). Rogers clarifies the concept of information seeking and processing, as the decision maker is described as focussing her/his search on finding the right sources as well as a sufficient quantity and quality. Furthermore, the recognition of "*re-invention*" in the implementation stage shows that the decision maker can modify her/his decision right away, either just before or during the implementation. Ohlmer et al. (1998), however, did not consider the "*re-invention*" practice since they only refer to this as the farmers' daily monitoring as a means to update their expectations on the outcome, but not to modify the application procedures. In addition, Rogers's "*decision choice*" step emphasizes social or peer influences in the decision making process. This is quite relevant, especially in the case of, for example, semi-subsistence farmers who are unable to conduct their own experiment because they have limited resources, and limited access to information and skills (Munshi, 2004; Pomp & Burger, 1995). These farmers usually observe and follow the practices and experience of their neighbours.

Based on the discussion above, one may need to check whether the same decision making process also occurs in the case of resource-poor or semi-commercial farmers in developing countries. The matrix concept (Ohlmer et al., 1998) seems to have potential for explaining the dynamic process of decision making; but it is based on commercially-oriented farmers. Rogers's concept has also provided a clearer framework, but one might be keen to further elaborate the concept by taking into account the setting and attributes of farmers in developing countries. For example, in the case of technology adoption, the decision makers' information seeking and processing may be further scrutinized in terms of their association with socio-cultural influences and level of development. Another option is to investigate how poor farmers conduct repetitive activities (as suggested by Ohlmer et al., 1998), as these farmers may need to strategically adjust their limited resources to apply the new technology; while, at the same time, securing their livelihoods.

The last option may imply two sets of possible outcomes. First, this kind of analysis will help reveal more descriptions of farmers' attributes, for example: risk attitudes, entrepreneurship and information processing capacity. Abadi Ghadim and Pannell (1999) and Just et al. (2003) assert that farmers' information seeking and processing capacity is correlated with farmers' risk attitudes. This is quite critical in developing countries as information is often not equally distributed, and at the same time most farmers have a low level of skills (Just et al., 2003). Nevertheless, the interaction between risk attitudes and information in a farmers' decision making process has not yet been fully explained (Abadi Ghadim & Pannell, 1999; Grisley & Kellog, 1987; Just et al., 2003). The extent to which farmers seek and interpret information may also indicate their entrepreneurial attitudes.

Secondly, an analysis of farmers' repetitive activities in decision making may reveal the intra-relationship among the members of a farm household. Many studies (e.g. Asfaw & Admassie, 2004; Kaliba, Featherstone, & Norman, 1997; Lawrence, Sanders, & Ramaswamy, 1999; Sejati et al., 2002) have perceived the role of an intra-household bargaining process in a farm household's decision making system. The bargaining process is perceived as an important part of the household strategy for survival (Lawrence et al., 1999), and as a means to moderate the conflict of interests among the family members and between the household's internal needs and the changes in the environment (McGregor, Rola-Rubzen, & Murray-Prior, 2001; Romero & Rehman, 2003). Within the household, each member may have a different influence in the bargaining process and her/his involvement can be expected to fill the gap in the household's information seeking and processing capacity. The extent of the bargaining process is determined by the changes in the status (education, change role of each gender, or other external causes) of the household members (McGregor et al., 2001). The result of this process is a consensus (collective decision) and an equal distribution of outcomes among the household members (McGregor et al., 2001). This is neglected in the analysis by Ohlmer et al. (1998) and Rogers (1993).

Table 4.3. The proposed and improved concept of farmers' decision making process

	Sub-stages				
Stages or Steps	**Searching & paying attention (observati on)**	**<u>Intra-household bargaining process</u>**	**Plan-ning**	**Evaluating & choosing**	**Bearing responsibility, including the development of intention and <u>the assessment of social compatibility (social bargaining)</u>**
Problem detection (<u>building awareness</u>)	Information scanning & paying attention	Discussion among household members	-	Consequence evaluation, detection of problem	Checking the choice: individual & social compatibility
Problem definition (<u>clarifying event</u>)	Information search & finding options	Discussion and negotiation among household members	-	Consequence evaluation, choose options to study	Checking the choice: individual & social compatibility
Analysis & choice (evaluating & selecting decision)	Information search	Discussion and negotiation among household members	Planning	Consequence evaluation, choice of option	Checking the choice: individual & social compatibility
Decision implementation & feedback	Information search & clues to outcome	Discussion and negotiation among household members	-	Consequence evaluation, choice of correc-tive action(s)	Bearing (<u>individual & social</u>) responsibility for final outcome & feed forward information

Note: underlined texts indicate the modification

Concerning the decision making stages, it can be argued that intra-household negotiation may serve as one of the sub-stages in the matrix concept introduced by

Ohlmer et al. (1998). For example, the exchange of views and bargaining may occur when farmers first discover an opportunity to adopt new innovations. The bargaining process then continues and is repeated as the farmers and/or other household members obtain new information at each decision step (see Table 4.3).

Besides intra-household negotiations, some degree of social bargaining may also influence the farm household's decision making process. According to some analysts (e.g. Conway, 1987; Scoones & Thompson, 1994; Sejati et al., 2002; Suradisastra, Sejati, Supriatna, & Hidayat, 2002), the influence may come in the form of the social norms and relationships which play an important role in many less-developed farming communities. Social bargaining processes may reflect the farmers' endeavour to find social reinforcement as they negotiate their interests against social values. An analysis of the social bargaining process, thus, would clarify the scope of the "*responsibility bearing*" sub-stage in the matrix concept of Ohlmer et al. (1998). In addition, the analysis is expected to reveal the role and mechanism of peer observation and socioeconomic networks in influencing the decision making process.

Overall, the discussion provides a basis for developing a more realistic description of a farm household's decision making system in developing countries. Nevertheless, other aspects of the farmers' decision making system still require elaboration, particularly those related to how farmers incorporate information into a more structured analysis. This is relevant in the case of farmers in developing countries who face many structural issues and, at the same time, are in the process of moving from a subsistence to a market orientation. The discussion of this topic is presented in the next section.

4.4. Concept of Heuristics

In Chapter One, heuristics were described as rules that permit a simple, manageable and, at the same time, directive evaluation of a particular decision. The rules are continuously updated as the decision maker learns new things. The use of heuristics may also indicate the decision maker's autonomy to apply her/his own system of interpreting many relationships between events in the past, current and future. The last premise shows an intersection between the concept of heuristics with the assumptions made by several analysts (e.g. Chambers, 1989; Gladwin, 1989a; Kelly, 1955; Scoones & Thompson, 1994) that the decision maker is an expert in interpreting her/his problems and finding solutions.

The heuristics may stem from the decision maker's past decisions as well as future expectations (Antonides, 1996; Tversky & Kahnemann, 1974; Slovic et al., 1977, the latter two are cited by Heong & Escalada, 1999). Some characteristics of heuristics include:

a) *representativeness*, which refers to the generalization of an event based on some recognized categorization of past experience, belief, observation and perception (Tversky & Kahneman, 1982);

b) *availability* is defined as "*a useful clue for assessing frequency of probability, because instances of large classes are usually reached better and faster than instances of less frequent class*" (Tversky & Kahneman, 1982, p. 11);

c) *adjustment and anchoring*, in which the decision maker generates a preliminary calculation of a possible outcome and continuously adjusts the calculation as they obtain more information (Tversky & Kahneman, 1982);

d) *event matching*, in which an individual tones her/his acts with their past successful experiences and this relates to the "*minimaxing regret (minimizing the maximum expected loss)*" (Simon, 1959, cited in Antonides, 1996);

e) *melioration*, in which an individual is selecting a less-than optimal alternative in order to preserve the benefit of using the alternative in the future or over a longer time period (Hernstein & Prelec, 1991, cited in Antonides, 1996); and

f) *simulation*, in which the decision maker simply takes a behavioural reference based on a past or current successful example and this may appear in the form of peer copying and/or seeking expert's advice (Antonides, 1996).

Marsh (2002) asserts that social heuristics also exists as the decision maker interacts with others. This heuristic may be observed in the form of long-term hierarchical and established social rules, such as socio-cultural norms. A social heuristic applies only within a society that uses it, but it can change as long as a social consensus endorses the change(s). Some types of social heuristics according to Marsh (2002, pp. 52-53) include:

a) *social affiliation*, in which an individual tries to find a reference person or a group of people (i) with whom she/he can confer when facing complex options, or (ii) who can provide the sense of togetherness, while otherwise she/he cannot deal with the situation by her/himself;

b) *social comparison*, in which an individual seeks an example (a person or a group of people) in the community to set an acceptable measure for evaluating her/himself or a particular complex problem; and

c) *social imitation*, in which an individual shares the same perception and behaviour towards a particular situation with others in the community as a form of social harmony.

The characteristics of heuristics may suggest that the use of decision heuristics represents the decision maker's strategy to cope with her/his situation. Anderhub et al. (2000, cited in Muller, 2001) assert that heuristics are commonly used in risky situations. Muller (2001) also confirmed the above premise when conducting an experimental study on the relationship between people's approach, heuristics and risk preferences in the case of complex consumption choices. Muller found that people, in general, respond qualitatively according to a theoretical "*benchmark solution*" (p. 494), and he classified people's decision heuristics as follows (pp. 503-508):

a) *qualitatively optimal behaviour*: adopt optimal solution and react correctly;

b) *consistent but not qualitatively optimal behaviour*: adopt optimal solution but do not react correctly;

c) *"go-for-the maximum" policy*: endeavour to achieve optimal solution but still pay attention to limitations;

d) *cautious policy*: choose a less than optimal solution to preserve benefits for the future, which, however, may be unreasonable;

e) *wait-and-see policy*: generally overlook the limitations and delay the response until the sources of risk recede;

f) *"2"-heuristic*: take an average response from several experiences;

g) *trial policy*: apply a test, observe the progress, move forward to another trial, and so on; but simply ignore information and/or do not perceive ex-ante estimation as useful.

Muller's findings may also confirm the observation by Ohlmer et al. (1998) on how farmers prefer (i) a qualitative, quick and simple approach; (ii) small trials; and (iii) day-to-day monitoring, learning and updating. Muller's classification of "*cautious policy*" is also similar to the heuristic of "*melioration*"; while the "*cautious policy*" and "*go-for-the maximum*" patterns may confirm Simon's (1987) concept of bounded rationality. The "*trial policy*" also confirms Rogers's (1993) "*trialability*" and "*observability*" requirements for technology adoption. In addition, these behavioural patterns appear to be similar to Jangu's (1993) classification of non-adopters which are "*discontinued*" (adopt but later discontinue for some reason), "*wait-and-see*" (receive information about the innovation but decide to delay for some reason), "*constrained*" (some problems impede intention to adopt), and "*would never adopt*" (no intention or possibility to adopt). Jangu's classification is developed based on the Ethnographic Decision Tree Modelling.

Muller noted that the behavioural patterns are not always consistent. The decision makers might apply different strategies for different degrees of riskiness in the environment. Muller also noticed that even a forward-looking decision maker often overlooks information in order to simplify the problem. Collentine, Larsson and Hannerz (2004) interpreted this variation to be as a result of the decision makers' lack of information seeking and processing skills. Therefore, risk and informational issues may cause a poor decision making capacity.

The impact of risk and information may also be observed from the application of decision heuristics by farmers in developing countries. These farmers operate in a risky environment and rely on their memory and experience when making decisions (see IDS Workshop, 1989b). To cope with their problems, these farmers use direct observation, comparison and copying practices (Feder et al., 1985; Neill & Lee, 2001; Pomp & Burger, 1995) which help them bypass the risk of faults in small-scale trials, incrementally apply a technology, and simplify the procedure of information seeking and processing (Collentine et al., 2004; Marsh, 2002). These practices also permit the farmers to check the compatibility of a technology with their socio-cultural values.

The use of decision heuristics, however, does not always result in an optimal outcome (Collentine et al., 2004; Muller, 2001) because both individual and social heuristics may contain biases. Tversky and Kahneman (1982)[1] assert that *representativeness* may lack validity since the generalization of an event may stem from (i) ignorance of prior propensity and insignificant examples; (ii) false estimation (including the procedure); as well as (iii) insufficient samples and information. These analysts also indicate the pitfall of *availability*, in which the decision maker tends to believe that a memorable event is more likely to be repeated, although such an event is not always applicable in all situations. The biases in *adjustment and anchoring* are related to the decision maker's inability to set an accurate starting value as well as to acquire reliable information for the adjustment.

Marsh (2002) also indicates that the social heuristics may suffer from the same biases, especially related to (i) the trade-off between practicality and precision; (ii) the reliability of the reference group and information in terms of commonality and fair judgment; and (iii) the rigidity of socio-cultural values towards changes. Related to the latter bias, social heuristics may result in "*polarization*" and "*stereotypes*" (Marsh, 2002), which may be viewed by outsiders as a potential hindrance to behavioural or decision changes (March, 1988). However, Tversky and Kahneman (1982) as well as Marsh (2002) do not rule out the possibility that the decision maker may modify or change her/his own heuristics or position towards socio-cultural norms.

The discussion above may further lead to the questions of how the decision maker formulates and uses the decision heuristics. Marsh (2002) points out that so far only a few studies have attempted to explore the use of heuristics in the case of social relationships. In the case of agricultural decision making, Ohlmer et al. (1998)

[1] See Tversky and Kahneman (1982) page 4-18 for a complete review.

indicate the tendency of Swedish farmers to devise a qualitative and "*quick and simple*" decision making approach, which is a rule of thumb (heuristic). In the case of agricultural technology adoption, opinions of leaders, peer observation and small-scale trials (Rogers, 1993) are among the most frequently cited evidence of heuristic use. If studies (e.g. Batz, Janssen, & Peters, 2003; Berger, 2001; Case, 1992; Polson & Spencer, 1991) were able to detect adoption-decision thresholds among different farmers, the thresholds might be based on the interpolation of the data, and not on the farmers' own estimation. The latter issue may stem from the lack of information on the procedure(s) that farmers use in developing their decision heuristics.

There are several reasons why it is difficult to recognize the general pattern of decision heuristic formulation and utilization. Some researchers (e.g. Collentine et al., 2004; Marsh, 2002) assert that heuristics, mainly, do not involve conscious stages. They may, however, be followed by a brief conscious "*double-check*" procedure (Marsh, 2002). Thus, in the first stage, the decision heuristics may be apparently an arbitrary process and vary greatly among individuals (Marsh, 2002); each individual may not be consistent in creating and using her/his decision heuristics over time (Muller, 2001). Some also argue that even if a general pattern of decision heuristics is observed, the pattern may be intuitively modified or changed as the decision makers continuously add to their stock of knowledge.

Therefore, it may be important to investigate types of decision heuristic and the procedure(s) used in decision heuristic formulation. This will be of relevance in the case of semi-subsistence farmers in developing countries who may face a tough challenge from a technology adoption opportunity. Bentley (1989, cited in Heong & Escalada, 1999, p. 316) also confirms the need for such an analysis because farmers in the developing world often make inaccurate judgments, especially if they use indigenous knowledge as their decision heuristic.

The analysis may include the process of selecting decision parameters and reference persons or groups, as well as the process of self-construing (information processing or learning process). For example, if the farmers use profitability as an adoption-decision rule, one may need to check whether the farmers have a correct perception of profitability, search for and use correct information in calculating the profit, and use a correct calculation procedure. In addition, the analysis needs to take into account the farmers' decision making context, including the farmers' strategies for achieving their economic and non-economic goals.

According to Simon (1978), such an analysis may relate to *procedural rationality*, which covers "*the effectiveness, in light of human cognitive powers and limitations, of the procedures used to choose actions*", including "*the means they* (the decision makers) *use to cope with uncertainty and cognitive complexity*," and "*the characteristics of the objective environment in which they make their decisions*" (pp. 8-9). This leads to the next discussion on decision models that can be used for analyzing the farmers' decision making structure, including decision heuristic formulation and application.

4.5. Decision Models

There are many decision models that can be used for an adoption-decision analysis. Here, the discussion will cover single equation models, multi-equation models, Ethnographic Decision Tree Modelling (EDTM) and Personal Construct Theory (PCT). The discussion on single equation models is based on the review by Feder et al. (1985). Meanwhile, adoption-models based on the Theory of Planned Behaviour (TPB) will become the focus in the discussion of multi-equation models. The discussion on EDTM and PCT will include their basic principles as well as calculation procedures.

4.5.1. Single Equation Models

According to Feder et al. (1985), a basic adoption-decision model often takes the form of a utility function assuming an optimal trajectory of income. The model reflects the farmers' distinct choices from several opportunities, including technology application. The expected income is assumed to vary according to the availability of land or other adoption determinants and, hence, the extent of these relationships also represents both subjective and objective uncertainties related to the farmers' objectives.

Most adoption analyses perceive limitations in some of the adoption variables, such as land, labour, inputs and credit (Feder et al., 1985). The models, thus, vary according to different technologies (divisible or non-divisible), environments, time, locations and levels of risk. For example, the models may reflect changes in farmers' attitudes toward technology adoption that result from changes in some of the adoption variables. The focus of the analysis is farmers' adoption propensity based on future expectations from applying a technology (Batz et al., 2003; Besley & Case, 1993; Marra et al., 2003).

In this regard, Feder et al. (1985) suggest three possible approaches. First, the model may apply learning rules, such as Bayesian modelling, to explain the effect of learning on farmers' adoption attitudes. The variables highlighted include extension services, the quality of human capital and other variables reflecting farmers' information seeking and processing behaviour. The second approach considers that farmers change their adoption attitudes because they become more experienced through daily trials and monitoring. This approach focuses on the effects of extension services, the quality of human capital, the length of time of learning and trying a technology, the availability of land and the practices of other farmers. The last approach considers the changes in farmers' attitude as a result of the changes in the market such as output and input prices, initial costs for implementing a technology, and marketing networks.

All of these approaches can be plotted in one equation reflecting a dynamic technology adoption process that at the end indicates the accumulative proportion of adopters. Most adoption studies, however, focus only on adoption behaviour at one point of time for a particular technology in a particular farm setting. These studies, thus, may only present a snapshot explanation of farmers' adoption behaviour.

Analyses, such as logit, probit and tobit, are commonly used for calculating the relationships between the independent and dependent variables in single equation models. The descriptions are as follows (Garson, 1998a, see http://www2.chass.ncsu.edu/garson/pa765/logit.htm):

> "*... logit, and probit models extend the principles of generalized linear models (ex., regression) to better treat the case of dichotomous and polytomous dependent variables. It focuses on association of grouped data, looking at all levels of possible interaction effects…These methods differ from standard regression in substituting maximum likelihood estimation of a link function of the dependent for regression's use of least squares estimation of the dependent itself… The function used in logit is the natural log of the odds ratio. The function used in probit is the inverse of the standard normal cumulative distribution function.*"

That is, the logit and probit models are developed to deal with categorical (binary or ordinal) dependent variables that are common in behavioural or rational choice studies (Aldrich, 1984). Both models allow the normalization of the subjective responses and, with similar attributes, both produce similar estimations (Aldrich, 1984). Meanwhile, the tobit model deals with dependent variables with values within a certain and limited interval (Aldrich, 1984) that exists due to the "*extreme*" skewness of some variables (Garson, 1998a; Hintze et al., 2003). The tobit model is an expansion of the probit model created by Tobin in the 1950s (Aldrich, 1984). In the case of agricultural technology adoption, logit, probit and tobit models are used for predicting the rate and intensity of adoption among farmers (e.g. Adesina & Zinnah, 1993; Herath & Takeya, 2003; Kaliba et al., 1997; Neill & Lee, 2001; Pomp & Burger, 1995, see Appendix A).

Most of the logit, probit and tobit adoption models are based on an individual farmer's ex-post decision and use a combination of both primary and secondary data. The dependent variable is usually either binary (adopt or not adopt) or ordinal (based on the characteristics of a technology, e.g. in the study by Negatu & Parikh, 1999). The independent variables are selected based on previous studies, the analysts' own premises, field observations, and/or the type of technologies (see Appendix A). Within the models, farmers' adoption behaviour is often assumed to reflect the goal of maximizing utility (e.g. Adesina & Zinnah, 1993; Hintze et al., 2003; Lapar & Ehui, 2004; Munshi, 2004; Negatu & Parikh, 1999; Neill & Lee, 2001).

The results from these models are not without problems. The use of binary variables is often criticized for concealing farmers' dynamic decision making processes and adoption practices. The dualistic approach may only capture the initial stage, or a snapshot, of the adoption process (Besley & Case, 1993; Feder et al., 1985). The actual adoption-decision appears to be flexible as farmers often make seasonal decisions following the fluctuations of labour supply, land availability (Damianos & Skuras, 1996; Moser & Barrett, 2003), and income (Adesina, Abbott, & Sanders, 1988; Damianos & Skuras, 1996; Moser & Barrett, 2003; Shapiro, Sanders, Reddy, & Baker, 1993). These result in several types of adopter and non-adopters (see Jangu, 1997 and Rogers, 1993).

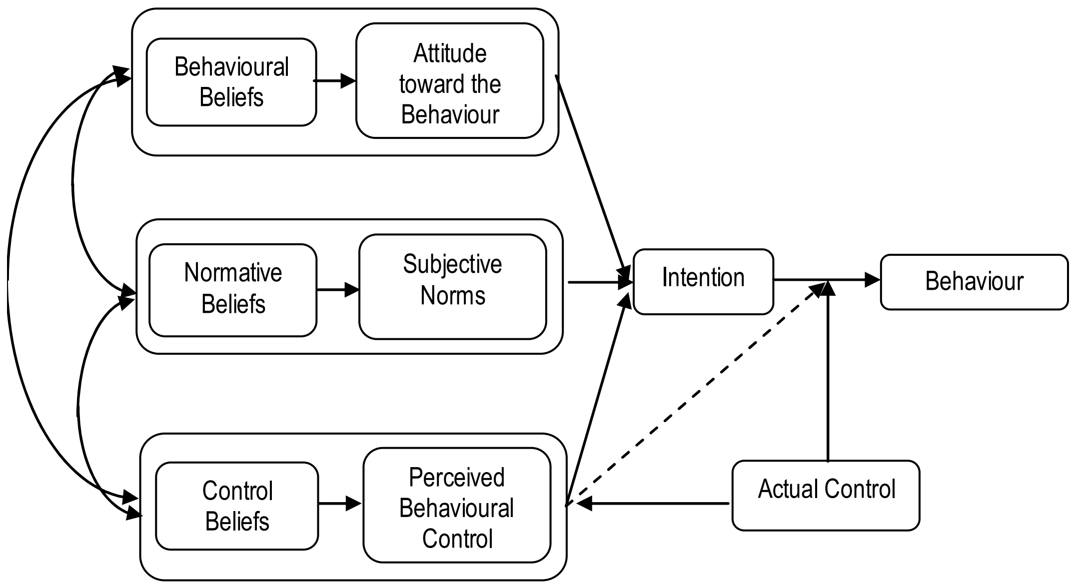
Another issue relates to the assumption in binomial logit, probit and tobit analyses that only aggregate adopters or non-adopters exist, despite the use of data on individual farmers. The results might be useful for policy planning, but they may have little impact at the micro level, such as in extension services where a bottom-up approach is more useful (Jangu, 1997; McGregor et al., 2001). To address this issue, multi-equation modelling is recommended; and this will be discussed next.

4.5.2. Multi-equation Models

Multi-equation models may help explain a sequential and/or dynamic process of adoption-decision making. They may stem from a single equation model which is extended to cover interrelationships among the variables involved. One example is the study by Negatu and Parikh (1999), in which binary probit and ordered probit models were employed to explain the sequential learning process among farmers relating to improved wheat varieties. The learning process was described as a two-way effect between farmers' perceptions and adoption behaviour. The ordered probit models were used for testing the effect of perceptions given the predicted adoption behaviour; while the binary probit models were used for estimating adoption behaviour given the predicted perception on market or yield. The high explanatory power of these models (between 79 and 94 percent) shows a good estimation and explanation of the farmers' adoption behaviour.

The other approach is using structural equation modelling (SEM), which is a multivariate statistical modelling technique that usually combines several methods such as factor analysis, path (causal) analysis and regression analysis (Austin et al., 1998; Rigdon). The combination is targeted at more thoroughly explaining the interrelationships among the variables involved. The structure of SEM may be constructed, for example, based on the Theory of Planned Behaviour (TPB). This topic is presented next.

Figure 4.3 Theory of Planned Behaviour (Ajzen, 2002a)



Source: http://www-unix.oit.umass.edu/~aizen/pdf/TPB.measurement.pdf (updated January, 2006)

4.5.2.1 Theory of Planned Behaviour (TPB)

The TPB was created in order to incorporate socioeconomic, socio-cultural, psychological and economic approaches in behavioural analysis (Burton, 2004). This theory assumes that person's behaviour is affected by the variation in the person's attitudes, social pressures ("*subjective norms*") and "*perceived behavioural control*" (Ajzen, 1991; 2002a, see Figure 4.3). Here, attitudes are defined as "*a person's overall evaluation of performing the behaviour in question*" (Ajzen, 2002a, p. 5). They reflect the person's positive and negative judgment about the effects brought by the behaviour. The subjective norms reflect an individual's "*perceived social pressure*" that may emerge in the form of her/his "*beliefs about the normative expectations of others and motivation to comply with these expectations*" (Ajzen, 2002a, p. 1). The perceived behavioural control represents an individual's belief in their own capacity to deal with an event (Burton, 2004). The relationships between behaviour and its precursors are mediated by the person's intention. These relationships are considered to help delineate the person's learning and mental process, the latent determinants of one's behaviour (Ajzen, 1991, 2002a). This theory is in accord with the concept of mental process outlined by Antonides (1996), in which an objective environment (stimuli, e.g. socioeconomic and personal conditions) induces mental processes (attitudes, expectations, social norms) and, in the end, results in an action (outcome, behaviour). Thus, the TPB may provide a clearer explanation of differences in how farmers behave.

The procedures for quantifying a TPB model involve interviews and statistical analyses. The interview involves a questionnaire that is constructed based on a standardized procedure (see Ajzen, 2002b). The questions reflect the complexity associated with the behaviour, and contain scaling techniques to quantify different degree of responses (Ajzen, 2002b; Beedell & Rehman, 2000). The most common scale used is 7-point contrasting adjective scale, e.g. from strongly agree to strongly disagree, but fewer points and/or other scaling procedures may also be used (Ajzen, 2002c). The responses are then tested for internal consistency (Ajzen, 2002b) in order to make sure that the responses can be added up into reliable indexes for a regression analysis. This test can be based on Cronbach's alpha (Ajzen, 2002b; Hair, Anderson, Tatham, & Black, 1998), where the acceptable scale for high consistency is 0.7 or above, or 0.6 or above for exploratory analyses (Hair et al., 1998).

Structural equation models (SEMs), then, will be constructed based on the interview results and the consistency test. The SEMs are constructed to identify latent interrelationships among variables (Austin et al., 1998; Babbie, 2004; Hair et al., 1998; Rauniyar & Goode, 1992). This kind of model is termed a structural model, in which the "*path*" (Hair et al., 1998, p. 17) of multi-correlations between dependent and independent variables is explained. The variables may be determined based on, for example, the results and recommendation from previous studies (Hair et al., 1998).

Another type of SEMs is a "*measurement*" model (Hair et al., 1998, p. 17) which provides the basis for categorizing farmers' responses to a number of adoption-decision variables and assesses the correlation among these variables. This model is often replaced by factor analysis because both have the same function. According to Hair et al. (1998, p. 14), factor analysis is targeted to "*find a way of condensing the information contained in a number of original variables into a smaller set of varieties (factors) with a minimum loss of information*". Babbie (2004, p. 455) also asserts that factor analysis can also help identify "*patterns among the variations in values of several variables*". In the case of technology adoption, factor analysis can help determine the adoption patterns, whether independent, sequential, or simultaneous, and create a single factor accordingly (Rauniyar & Goode, 1992). Therefore, the results from the factor analysis can be used to determine the optimal combination of the farmers' adoption-decision variables, including the heuristic patterns.

The applications of a TPB model in agricultural related areas are still limited, but so far they have shown promising results. The applications also appear to vary according to the case situation under study (see Beedell & Rehman, 2000; Bergevoet, Ondersteijn, Saatkamp, Van Woerkum, & Huirne, 2004; Chetsumon, 2005; Coleman, McGregor, Hemsworth, Boyce, & Dowling, 2003; Hrubes, Ajzen, & Daigle, 2001; Zubair & Garforth, 2006). Some introduce new components to the original TPB concept, while others prefer to use a simpler version of the concept. Beedell &

Rehman (2000), for example, used a TPB model to explain the motives behind different conservation behaviours among different groups of farmers and found the relationships between the farmers' behaviour, beliefs, attitudes and motivations (intentions), and social pressures. Bergevoet et al. (2004) have also successfully applied a model derived from the TPB concept for examining the relationships between Dutch dairy farmers' entrepreneurship and their goals, objectives and attitudes. Hrubes et al. (2001) also introduced some personal characteristics, i.e. self-transcendence, self-enhancement, openness and conservation to the TPB concept, and reported a strong applicability of the model for predicting the rate of hunting behaviour among outdoor recreationists. Using SEM, Chetsumon (2005) analyzed the combination of the TPB components and some personal factors (a measure of intelligence, openness and extraversion) to explain extension agents' intention to adopt an expert system. In contrast, Coleman et al. (2003) used a simpler TPB model to estimate the behaviour of abattoir stockpeople, which was affected mainly by attitudes and the "tough-mindedness" character. A study by Zubair and Garforth (2006) also limited the measures of perceived behavioural control to include only the perceptions on the impediments relevant to the Pakistani farmers' intention and behaviour towards growing trees. The latter appears to be the only study that has applied the TPB concept in the case of farmers in developing countries.

Some argue, however, that there are pitfalls in the TPB. Burton (2004), for example, argues that the TPB may not be effective as a predictive model, rather it is best used for quantifying some qualitative determinants of behaviour (e.g. socio-cultural or socio-psychological factors). Such an argument is reasonable, since according to Nuthall (2005)[2], the TPB questionnaire "*merely asks superficial questions for putting in the model*" and, hence, it can only provide a general sense of the latent variables (behavioural beliefs, normative beliefs and control beliefs). This calls for other models and methods that can help reveal a more detailed description of the basic structure of the latent variables behind one's behaviour. The Ethnographic Decision Tree Modelling (EDTM) and the Personal Construct Theory (PCT), for example, may

[2] Personal communication, 1 April 2005

provide more definite personal constructs in decision making and, thus, their results may be complementary to the TPB model. These will be discussed next.

4.5.3. Ethnographic Decision Tree Models (EDTM)

The underlying principles of this model relate to the need to describe people's decision making structure based on their own criteria (Gladwin, 1989a). The criteria may come in cultural or native forms, and people use the criteria as the basis of their beliefs. Thus, EDTM may help define the rules of thumb or heuristics that people use in making decisions.

The main assumption in this model is that people (farmers) are experts in making decisions (Gladwin, 1989a). People may have limitations in accessing and processing information, but they are the ones that know best about their situation and capacity. Another assumption is that the decision makers construct their decisions in a hierarchical procedure, but without any effort to rank the options (Gladwin, 1989a). Finally, it is also assumed that people often use simple rules of thumb (heuristics), which may reflect their inability to sort out several choices all at once, and their strategies to deal with uncertainties (Gladwin, 1980). All principles and assumptions of this model, thus, reject the assumption of perfect access to, and availability of, information (Gladwin, 1980; Murray-Prior, 1998).

EDTM is an interview-based model. The interview is aimed at revealing the path of decision making, which is assumed to contain two stages as follows (Gladwin, 1980, 1989a):

a) The first stage is often perceived to occur unconsciously as the decision makers quickly limit choices by taking out the ones that do not meet their criteria. This stage leaves one or more choices to be scrutinized further in the second stage.

b) The second stage is known as the conscious stage of decision making. It contains at least six steps, which are:

    - Step 1: several aspects of the choice are arranged in order.

- Step 2: the decision makers take out some aspects based on the criteria of whether the aspects have (i) little or no subjective values, (ii) equal or equivalent values, (iii) equal values but in opposite order, or (iv) indirect and non-separable effects on other aspects.
- Step 3: the decision maker selects one aspect from the remaining aspects based on the following criteria: (i) highest utility or subjective values; and (ii) whether the aspects are mutually or non-mutually exclusive.
- Step 4: the decision makers set minimum conditions for each of the remaining aspects and the choice should comply with these constraints.
- Step 5: the decision makers evaluate the choices based on the constraints using a flowchart, decision tree or table. A choice that passes all constraints is likely to be selected.
- Step 6: in the case where no choices pass the constraints, the decision makers may take a strategy of (i) reassessing the aspects, or (ii) seeking new choices.

These stages may occur instantly in the decision makers' mind, and with an in-depth individual or group interview, these stages can be formally constructed. The construction involves the generalization of individual interviews into one pattern or tree of the decision making process. The model is then tested using a set of samples, other than the ones used in the individual interviews, in order to check the reliability of the model for predicting a typical decision or behaviour in the real world.

The testing procedure shows the advantage of using EDTM as compared to "*quantitative decision models such as linear-additive models* (e.g. probit and logit analyses) *and often normative (linear programming, expected-value and expected-utility models, stochastic-dominance models)*", which are "*not cognitively-realistic*" and involve complicated tests (Gladwin, 1989a, p. 10). From various applications, the model is found to be able to predict around 80-90 percent of individual choices (Fairweather, 1996; Gladwin, 1989a; Jangu, 1993; Murray-Prior, 1998). Such a high percentage of prediction requires an accurate specification of the decision criteria or aspects. Otherwise, the criteria may only represent the decision makers' beliefs not their decision rules (McGregor et al., 2001).

The latter observation shows one of the pitfalls in using the EDTM. Gladwin (1989a) and Murray-Prior (1994, cited in McGregor et al., 2001; and in Murray-Prior, 1998) assert that the process of interpreting and combining the individual interview is often time consuming and complicated which results in limited decision criteria. The real process may also not take all the stages, steps and/or conditions considered in the model, as the model is only a simplified picture of a part of the real world (Gladwin, 1989a). To overcome those issues, Murray-Prior (1994, cited in McGregor et al., 2001; and in Murray-Prior, 1998) suggested the model should be augmented with Kelly's Personal Construct Theory. This procedure has been proven especially useful for distinguishing different behaviour among individuals (Jangu, 1997; McGregor et al., 2001; Murray-Prior, 1994, cited in McGregor et al., 2001). This leads to the next discussion on the Personal Construct Theory.

4.5.4. Personal Construct Theory (PCT)

The basic idea of Kelly's (1955) Personal Construct Theory (PCT) is that "*a person's processes are psychologically channelized by the ways in which he anticipates events*" (p. 46). Walker (1996) refers to the above postulate as the act of construing, which he defines as the act of "*meaning making, appraising, applying a theoretical framework, ways you are likely to make sense of things, or adopting new perspective*" (p. 8). This implies that a person is constantly striving to develop his view towards himself and his environment as he learns new things. This indicates the main assumption of PCT which views the decision maker as a scientist (Salmon, 1980; Walker, 1996). Thus, PCT views the decision maker not as an object (Walker, 1996), and recognizes the autonomy of the decision maker to control events based on her/his own experience. For an individual, the result of considering a problem is the formation of a 'construct' that guides actions. Thus, a construct is akin to a heuristic, or rule of thumb.

There are 11 corollaries within PCT, and they indicate a hierarchical relationship of how a person evaluates events, develops and tests some hypotheses (constructs) and, finally, shapes her/his own values and perception of the events. The summary of PCT's corollaries is as follows (adapted from Jangu, 1997, pp. 47-58):

a) *construction*: a person identifies the pattern or order of events and construes accordingly;

b) *individuality*: each person construes and discriminates events based on his unique ways of construing and ordering;

c) *organization*: people develop different ways of discriminating different constructs;

d) *dichotomy*: a person compares constructs based on similarities and differences;

e) *choice*: a person chooses an alternative that enables her/him to deal with future complexities and to anticipate future events;

f) *range*: a person selects an alternative based on a certain range, whether it is related to relative ease, extent of ease and circumstances;

g) *experience*: a person construes, learns new things and re-plans his construct in an evolving way;

h) *modulation*: a person may easily or resistantly change his construct;

i) *fragmentation*: a person may consecutively construe events in different and incompatible ways;

j) *commonality*: people may construe events and take actions in similar ways; and

k) *sociality*: people construe one another as a way to build relationships, understanding and communication.

Measurement of the component of a PCT is focussed on two aspects. These are:

a) *elements*, which are people, objects, events and activities (Stewart & Stewart, 1981, cited in Jangu, 1997) and used as the focus of analyzing constructs; and

b) *constructs*, which are bipolar statements, or discriminations (Fransella, Bell, & Bannister, 2004), used for examining similarities or differences among elements. Besides bipolar in nature, Kelly (1955) also asserts that the constructs should be (i) *permeable* (can be applied to an individual or a population); (ii) *pre-existing* (permanent); (iii) *communicable* (descriptive); (iv) *understanding of other people* (appreciative); and (v) *non-dissociation*. Types of constructs may include (i) *pre-emptive constructs*; (ii) *constellatory constructs*; (iii) *proportional constructs ("as if" type)*; and (iv) c*orresponding, consensus, conflicting and contrasting constructs*.

The procedures usually start with the selection of elements. The criteria for selecting elements are that they must be (i) unambiguous, (ii) uniform, (iii) independent, (iv) representative and (v) detailed (Kelly, 1955). The selection processes include (i) providing a list of considered elements and the relevant clues on the context to the respondents, (ii) describing the scope and category, and (iii) determining elements from discussions with respondents (reviewed from various sources by Jangu, 1997, pp. 63-69). For example, in the case of agricultural technology adoption, farmers are asked to classify some types of fertilizer (the elements), according to their intention or adoption behaviour. The farmers are also asked to explain the reasons associated with their preferences. This is then followed by the elicitation of constructs.

According to Fransella et al. (2004), the 10 ways to elicit personal constructs are[3]:

a) eliciting from triads of elements;
b) eliciting with dyads of elements;
c) eliciting with single elements;
d) eliciting using the *Full Context Form* (a direct comparison of a full list of elements);
e) eliciting from self-characterizations;
f) eliciting from other written material (e.g. an essay about different elements chosen by the subject);
g) eliciting through an interview;
h) eliciting using non-verbal materials;
i) eliciting using computer; and
j) eliciting using constructs (e.g. laddering, pyramids, ABC model).

[3] See Fransella et al. (2004, pp. 27-46) for a complete review of each procedure

The triad procedure is more common. The procedure starts with asking the subject to discriminate between three elements presented to her/him using bipolar statements (constructs). After the constructs are elicited, one element will be replaced by another element, which is randomly selected. The subject is asked again to compare the new set of three elements. The process is repeated until all constructs are elicited. Fransella et al. (2004) refer to this process as the *Sequential Form* of the triad procedure. This process can be time consuming, as there are many possible triads when many elements are used.

The dyad and interview procedures are commonly used in the case of people who have limited cognitive ability (children or disabled persons) (Barton, Walton, & Rowe, 1976, cited in Fransella et al., 2004). Non-verbal materials may also be used for the same reason; however, the subject often finds it difficult to relate the picture or drawing with a matched verbal expression (Baillie-Grohman, 1975, cited in Fransella et al., 2004).

To elicit constructs in more detail, Epting, Probert, and Pittman (1993, cited in Fransella et al., 2004) used an essay format which permits the subjects to fully express her/his idea about an event. In a more informal way, this procedure may be akin to Ross's (1996) qualitative conversational approaches which are based on participant observation such as through "*listening to and joining in conversations… and observing everyday incidents and behaviour*" (p. 185). This method is believed to enable the elicitation of constructs in groups of people with different cultural backgrounds (Ross, 1996).

A more detailed personal construct system can also be defined using a self-characterization technique (Epting et al., 1993, cited in Fransella et al., 2004). In farm management, Salmon (1980) discovered that this technique can provide insights for understanding farmers' cognitive systems. The self-characterization procedure can be followed by hierarchically classifying the constructs, e.g. through laddering or pyramiding (Ravenette, 1999a, cited in Fransella et al., 2004).

Compared to other methods, the computer-based construct elicitation is more commonly used (Dunnett, 1988, cited in Jangu, 1997), and a software package called RepGrid is already available. The reason is that the RepGrid software allows a time-saving procedure. This software also includes the triad procedures, as well as laddering or pyramiding procedures (i.e. using the FOCUS function). In addition, the RepGrid software can reveal the pattern of constructs, using its PrinCom function, and shared constructs, using the Socio sub-program. Nevertheless, this method is quite challenging for some respondents. For example, most respondents in a study conducted by Sjah (1998) found it difficult to discriminate between elements during a computer-based interview. He construed the reason may relate to the "*marginal differences*" between elements that were randomly presented in the triad form. However, the problem in this study could stem from the selection of elements that may not be independent, or clear enough for the respondents.

All the above techniques basically follow the same procedures. All of them involve two-way interactions with the subject. Some interview techniques and factor analyses can replace the functions in the RepGrid software. To describe how this works, a triad procedure using the previous example of fertilizer adoption is presented. In an interview, the farmers are asked to determine the similarities between two out of three types of fertilizers (elements) that are presented. The responses may reveal the constructs, for example profitability, price, etc., which represent the farmers' decision motives. Then, the farmers are asked to explain the relationships among the constructs (e.g. profitability and prices) and among the elements (different types of fertilizer). Next, a hierarchical cluster analysis is performed to test the relationships. The farmers are also asked to decide on the effect of using the fertilizers on their farming practices. The responses are analyzed using a principal component analysis, or a factor analysis, to elicit the correlation between constructs and elements, as well as their variances. The results provide the pattern of constructs used by each farmer and may suggest shared constructs among farmers or, in other words, the social constructs.

PCT is commonly applied within the areas of clinical psychology, psychotherapy, marketing, education, tourism and agriculture (Salmon, 1980; Walker, 1996). Salmon (1980), Murray-Prior (1994, cited in McGregor et al., 2001), and Jangu (1997) are among the analysts who have successfully applied PCT using a farm case study. The advantages of PCT mainly relate to (i) its applicability in various behavioural and motivational analyses, and (ii) its bottom-up nature enabling a more accurate description of an individual's learning process and reducing outsiders' influence during the eliciting process (Jangu, 1997).

Combining PCT with other methods is also plausible. For example, Jangu (1997) and Murray-Prior's study (1994, cited in McGregor et al., 2001) combined PCT with the Ethnographic Decision Tree Model. Jangu, in particular, applied PCT in the case of technology adoption and analyzed different constructs among different groups of farmers (adopters and several groups of non-adopters). The results showed that the combination was able to simplify an individual's decision making structure, reveal the decision rationales, as well as supply information for prediction. The combined procedures were also perceived to be able to overcome some procedural and analytical limitations when applying only one of the methods.

4.6. A Proposed Model

This section outlines the basis and components of a proposed analytical model for use in this study. As mentioned earlier, it is proposed that the model of an agricultural decision making process should include a bargaining process. Intra-household negotiation can represent the farm household's continuous learning, while a social bargaining process can improve the concept of the "*responsibility bearing*" sub-stage introduced by Ohlmer et al. (1998). This clarifies the farmers' effort to find social justification through negotiating their interests against their family and social values. The question left is how the above-proposed concept is measured. Ohlmer et al. (1998) did not test their matrix concept of agricultural decision making using a real case and, therefore, did not provide a guideline.

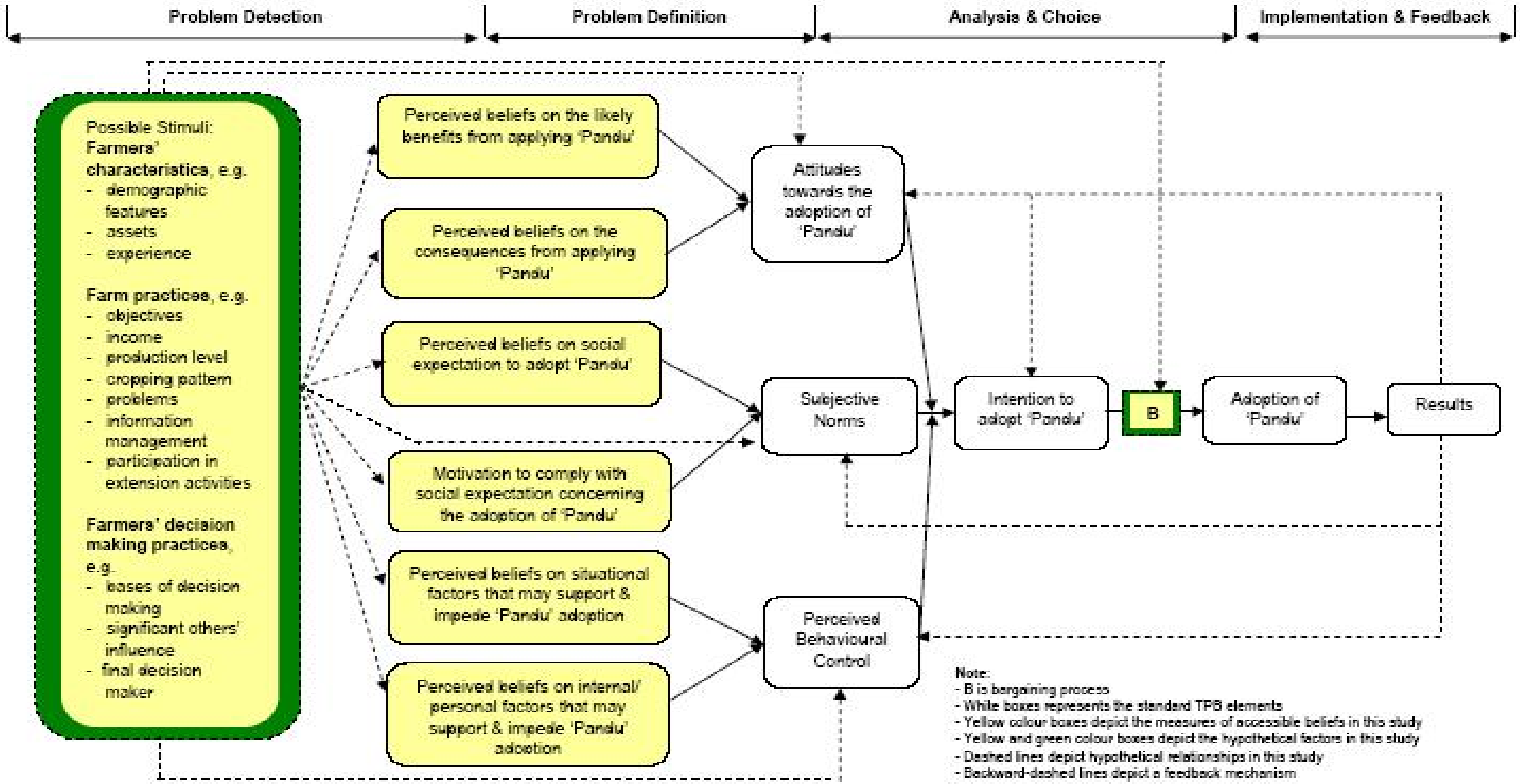
The discussion in earlier sections also shows that farmers rely on rules of thumb, or heuristics, for making decisions. Since the knowledge of how farmers formulate and apply their decision heuristics is still limited, a more detailed study of farmers' decision heuristics is proposed. However, it is difficult to recognize the general pattern of decision heuristics because according to Marsh (2002), the formulation and utilization of heuristics often involves unconscious stages, that is, they only occur in the farmers' mind. The pattern may vary according to the farmers' stock of knowledge, interactions, capacity and problems (Marsh, 2002; Muller, 2001). This means there is a need for a method to analyze farmers' mentally based decision making processes.

Among the decision models reviewed in the previous subsections, EDTM, PCT and a model based on TPB may provide a more proper basis and procedure for analyzing farmers' adoption-decision processes. These models also appear to be complementary and, hence, it may be reasonable to combine them. The integration may overcome the shortcomings involved when using each model separately, and permit a more thorough assessment of an individual farmer's mental process.

A TPB model may be used as a general framework for the analysis. The model represents the interrelationships between (i) farmers' attitudes and confidence; and (ii) the social norms influencing farmers' adoption behaviour. The model is also consistent with theories (see Antonides, 1996; Marsh, 2002; Tversky & Kahnemann, 1982) in which the use of decision heuristics is described as involving a person's beliefs and past experience; social relationships (Marsh, 2002), and the person's confidence in dealing with uncertainties in the decision making context (Muller, 2001).

The TPB model can be based on a TPB model modified by Chetsumon (2005). Chetsumon elaborated on the determinants of attitudes, subjective norms and perceived behavioural control, and traced the concept further back into external factors that were assumed to have direct and indirect impacts on a person's intention.

Figure 4.4. Modified model of Planned Behaviour



Modifications of Chetsumon's model are suggested (see Figure 4.4). First, the stimuli or adoption variables in the model will be determined using the farmers' responses to the background interview that will supplement the TPB questionnaire. Although these variables can be pre-determined, it is more appropriate to choose the variables from the people's constructs (Ajzen, 1991, 2002a). Nevertheless, this does not mean a complete abandonment of variables recommended by previous studies, especially related to the farmers' characteristics, farm assets and performance, and socioeconomic contexts.

Next, the inclusion of behaviour and results is perceived to be relevant in the case of an ex-post research. Two consequences are anticipated. First, the influence of several personality factors, such as self-monitoring, personal orientation and confidence (reviewed from various sources by Antonides, 1996) should be taken into account. Secondly, the analysis may use the farmer's actual behavioural control, instead of its proxy which is the farmer's belief concerning behavioural control. These two sets of factors are related to each other, and will enable the analysis to deal with the doubts (e.g. Antonides, 1996; Burton, 2004) about whether an attitude always leads to behaviour, and whether the same information is used throughout the processes.

The inclusion of results represents the feedback phase and this is expected to help delineate the use of decision heuristics beyond the adoption. This will enable the analysis of farmers' efforts to learn from, and respond to, the changes in their environment (Raaij, 1981, cited in Antonides, 1996; Kelly, 1955; Simon, 1978). The small dotted backward arrows in Figure 4.4 show the feedback mechanisms. Although this may provide a more complete understanding of the farmers' decision making process, this can only be done when there are some attitude changes and when the observation covers a longer period.

The last modification involves synchronizing the TPB model with the improved matrix concept of the decision making process (see Table 4.3 for the matrix). It can be argued that the TPB may represent all four decision stages (Figure 4.4). The problem detection is embodied in the process of how the adoption variables shape behavioural, normative and control beliefs. The problem definition stage is represented by the mechanisms of how behavioural, normative and control beliefs further evolve into attitudes, subjective norm and perceived behavioural control. Meanwhile, the phase of analysis and choice is described by the relationship between the farmer's attitudes, subjective norm, perceived behavioural control, intention and her/his actual behaviour. Although the development of intention is assumed to occur in all decision phases (see Table 4.3 in the sub-stage of bearing responsibility), the intention box in Figure 4.4 may highlight the actual role of the planning sub-stage in the phase of analysis and choice. In the planning sub-stage, the farmer specifies information related to the time, method and location of implementation (see Ajzen, 2002a).

A box representing a bargaining process is also added to the model in order to highlight the role of bargaining processes at each decision stage. The inclusion of this factor in the standard TPB model is plausible, since according to Ajzen (2002c), the TPB only provides a general framework for explaining the structure of one's behaviour. In some cases, other factors may be added in order to improve prediction. For example, Beedell & Rehman (2000) found that farmers in their study had a personal moral norm that influenced their decisions to take care of their farm environment despite any social pressures. This kind of "*self-generated internal obligation*" was not captured by subjective norms and, hence, it was added in the analysis (Beedell & Rehman, 2000, p. 122).

Ajzen (2002c), however, also states that there are some requirements for adding new factors into the TPB model. Firstly, the factor should have a causal relationship with the behaviour in question. Secondly, the factor should be definite and measurable. It should be theoretically standalone but, at the same time, compatible with other elements in the model. Lastly, the factor should have an empirical basis.

The bargaining process introduced in this research may represent the dynamic learning process that acts as the decisive factor directing the farmers' intention and final decision. A farmer may not only receive and seek social justification, but she/he also attempts to express her/his standpoints and use them to influence others. This is confirmed by Case (1992) and Zhang et al. (2002) who concluded that the variation of the neighbour effect in technology adoption reflects the different patterns of how a farmer influences, and is influenced by, others. The extent of the bargaining process may depend on the relative socioeconomic position of the farmer in the community (McGregor et al., 2001; Scoones & Thompson, 1994). Therefore, the concept of a bargaining process is independent of the subjective norm element, but it is still compatible with the existing TPB model. The standard TPB questionnaire may also be modified to measure the effect of bargaining processes (see Appendix B). This has not been recognized in previous studies using a TPB model.

Using a TPB model, however, the analysis may still face challenges because each farmer seeks and construes information in different ways. This may raise a question of how the analysis will measure the processes of heuristic formulation and application, and how the analysis will describe different degrees of adoption and non-adoption behaviour among farmers. There should also be a better way to elicit farmers' heuristics, since the TPB questionnaire cannot reveal the actual behavioural variables (see Figure 4.5) (Nuthall, 2005)[4]. This also includes the measurement of the bargaining process in farmers' adoption-decision system.

To address these questions, the analysis must include methods that can directly measure farmers' personal constructs, such as the Ethnographic Decision Tree Modelling (EDTM) and the Personal Construct Theory (PCT). The EDTM has a similar concept to the TPB model as it explores the structure of farmers' decision making process. The difference is that EDTM involves a sequential elicitation of decision criteria, meaning that it directly shows the hierarchical relationships among the decision criteria as well as between the decision criteria and the decision. The procedures are non-artificial as they use farmers' own terms in defining the decision criteria. The hierarchical relationships in the EDTM may also indicate the path of how farmers strategically take practical clues and predict future outcomes (heuristic

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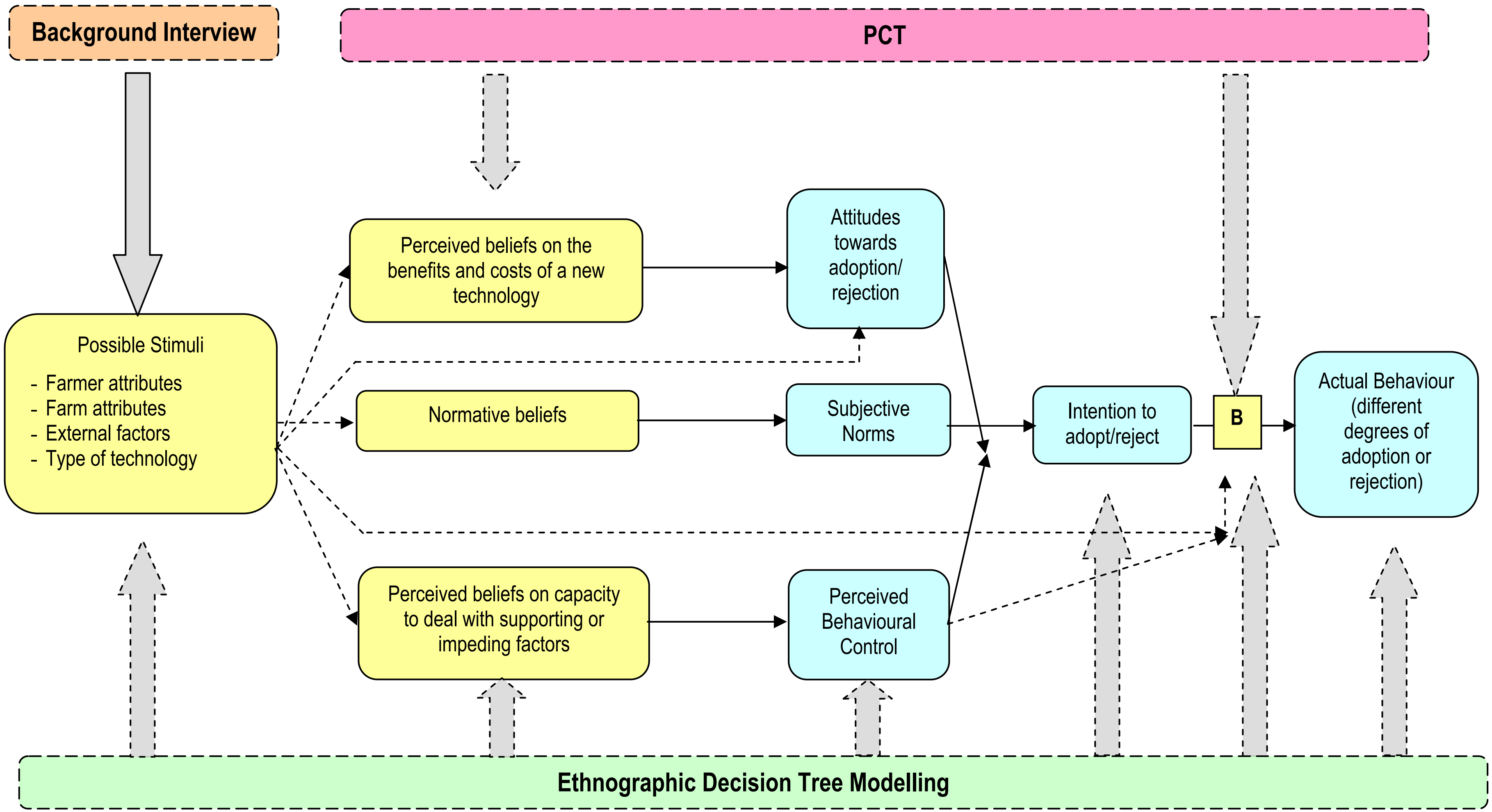
[4] Personal communication, 1 April 2005

Figure 4.5. The link between the background interview, EDTM, PCT and TPB model



Note: B is bargaining process

development) while evaluating a technology. The results reveal different paths that farmers use to make an adoption, or non-adoption, decision, and help explain differences in the adoption and non-adoption behaviour among farmers.

The use of construct elicitation procedures based on PCT may also contribute to a more detailed description of farmers' behavioural, normative and control beliefs in the TPB model (see Figure 4.5). A particular focus may be given to the elicitation of constructs related to the farmers' attitudes toward new technology adoption and their control beliefs. Another focus is the measurement of the role of a bargaining process in the farmers' decision making process. Hence, the use of PCT in this study will be based on the farmers' possible decision criteria as the elements, which may relate to:

a) the possible outcomes (advantages and disadvantages) from adopting the improved paddy-prawn system ("pandu");
b) the possible external and internal factors that may support and impede the respondents to adopt "pandu"; and
c) the possible significant others with whom the respondents discuss and negotiate their intention to adopt "pandu".

Using these elements, PCT may elicit the reason(s), or constructs, why the farmers choose the elements. This will help explain the farmers' information processing capacity in technology adoption, i.e. how a farmer learns from her/his environments and develops heuristics while assessing a new technology. The results may also confirm and/or improve the concept of mental processes in decision making as described in the TPB model and EDTM.

By combining the TPB questionnaire, EDTM and PCT, one may gain a thorough understanding of farmers' personal construct system and adoption behaviour. Since both EDTM and PCT can reveal decision variables that are important for the farmers (Murray-Prior, 1998), the results from these methods can also be used to select the behavioural stimuli (Figure 4.5) and the form of the structural equation models for analyzing the TPB model. One may also use the results to assess the relative efficacy of each method in measuring farmers' personal constructs.

Such analyses are relevant to the case of semi-commercial farmers in developing countries. These farmers usually have limited access to information, while at the same time they still face serious structural problems, such as poor human and institutional capacity. They also value social relationships and, hence, their decision may be, to a large extent, affected by their peers and/or leaders. However, the 'whys' behind their decisions and behaviours (e.g. new technology adoption) are still poorly understood. This analysis would help clarify this issue.

4.7. Summary

This chapter presents an overview of the adoption decision concepts, decision heuristics, and decision models. The discussion starts with the general concept of the mental process in decision making, which according to Antonides (1996, p. 3) may involve "*motivational factors, values and norms, information processing, attitudes, social comparison, rules or heuristics, attributions, emotional factors, bargaining process, learning process and expectation*".

Many of the above factors are covered in Rogers's (1993) "*innovation-decision process*" and the matrix decision making concept introduced by Ohlmer et al. (1998). This emphasizes the importance of these factors in a farmer's adoption decision. Clearly there is a need to improve the concept of agricultural decision making to include these factors. For example, one might need to clarify the role of information in determining farmers' adoption-decisions. This can be achieved through examining farmers' adherence to rules of thumb (heuristics) in decision making, and their efforts to negotiate their interest, intention and objectives against family and social values. A particular focus may also be given to the method(s) farmers use when creating and applying decision heuristics. This enables an evaluation of the efficacy of information utilization by farmers. All these possibilities are represented by the following questions:

a) Do farmers use rules of thumb (heuristics) for making adoption-decisions?

b) How do farmers create and apply their decision heuristic? and

c) To what extent are the intra-household and social bargaining processes involved in the farmers' processes of creating heuristics and decision making?

The discussion about decision models suggests the integration of the TPB, EDTM and PCT in order to enable a thorough analysis of farmers' mental process in decision making. No one has attempted to combine these three models and, hence, such an effort is challenging. According to Beedell and Rehman (2000), the TPB alone may explain around 50 and 70 percent of the differences in how people behave. Various studies also show that the EDTM is robust for identifying the decision criteria and the path of decision making. Through its contrasting methods, PCT has also been found to be effective for eliciting the underlying rationale behind one's decision or behaviour. Thus, the combination is expected to be complementary and provide a more effective and thorough procedure for analyzing the agricultural decision making process. This analysis may also provide an improved understanding of Simon's (1987) concept of bounded rationality, particularly in the case of the decision making process of semi-commercial farmers in developing countries. The results may be used to help these farmers improve their decision making capacity.

CHAPTER FIVE: METHODS

5.1. Introduction

Details of the study area and the technology studied are presented in this chapter. Also included are details of the data collection and its processing. The limitations of this study are also discussed and, finally, a summary is presented.

5.2. Case Study and Location

5.2.1. Case Study

The analysis is based on the case study approach which, according to Babbie (2004), is "*the in-depth examination of a single instance of some social phenomena…*" and has a purpose to seek "*idiographic understanding*" of the phenomena (p. 293). In this study, the idiographic understanding refers to the identification and explanation of the decision making structure related to adoption of the improved paddy-prawn intercropping system among semi-commercial farmers in Lamongan Regency, East Java, Indonesia.

5.2.2. Location

The selection of Lamongan Regency (see Figure 5.1) was based on a suggestion from the Assessment Institute for Agricultural Technology (AIAT) of East Java Province (Muhariyanto & Arianto, 2005)[1]. Lamongan Regency is located in the northern part the East Java Province of Indonesia. Its population was 1,365,402 (31 May 2005), with an annual population growth of 0.9 percent (Pemerintah Kabupaten Lamongan, 2005). Around 5 percent of the population were urban (Bangun Praja Online, 2004).

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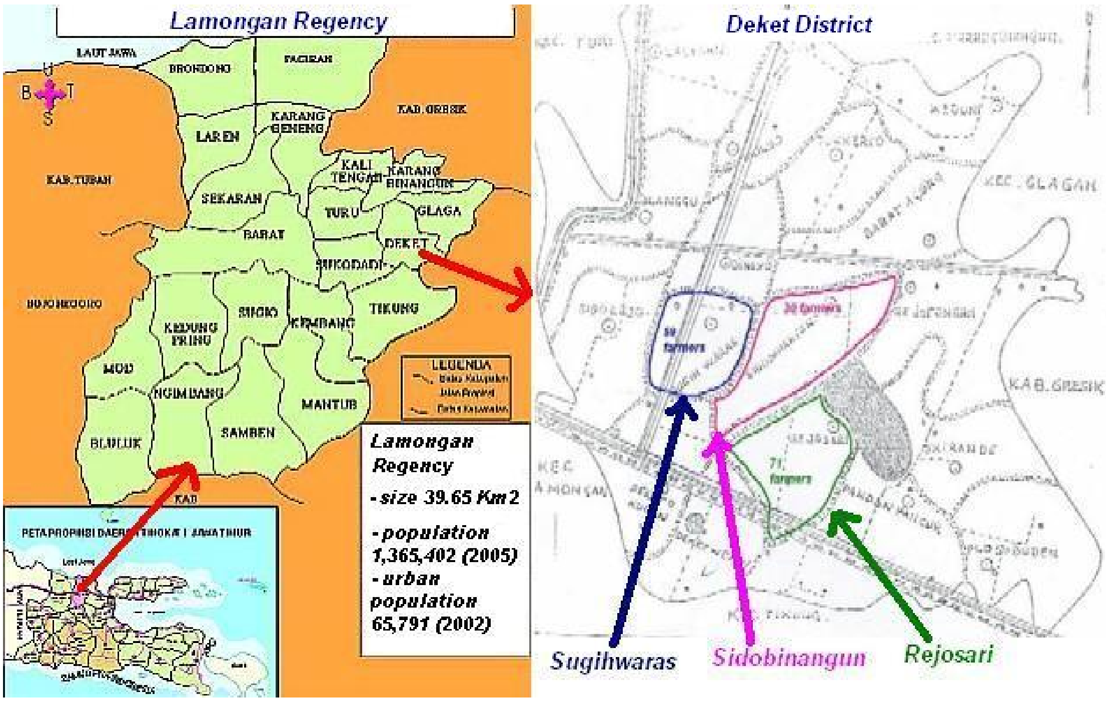
[1] Personal communication with Mr Anang Muharyanto and Mr Hendri Arianto from the Wonocolo Dissemination Laboratory, AIAT of East Java Province, Indonesia

The agriculture sector still contributes the largest share to Lamongan's gross regional domestic products (GRDP) at around 49 and 48 percent of the total GRDP in 2003 and 2004 respectively (BPS & BAPPEDA Kab. Lamongan, 2005). Food crops (mainly rice) and fishery products are the main agricultural products with a share of almost 77 and 20 percent of the agricultural GRDP in 2004, respectively. The agriculture sector also accounts for almost 22 percent of employment, the largest employment share of all sectors in 2004 (Pemerintah Kabupaten Lamongan, 2005).

Figure 5.1 Map of Lamongan Regency, and the case study locations

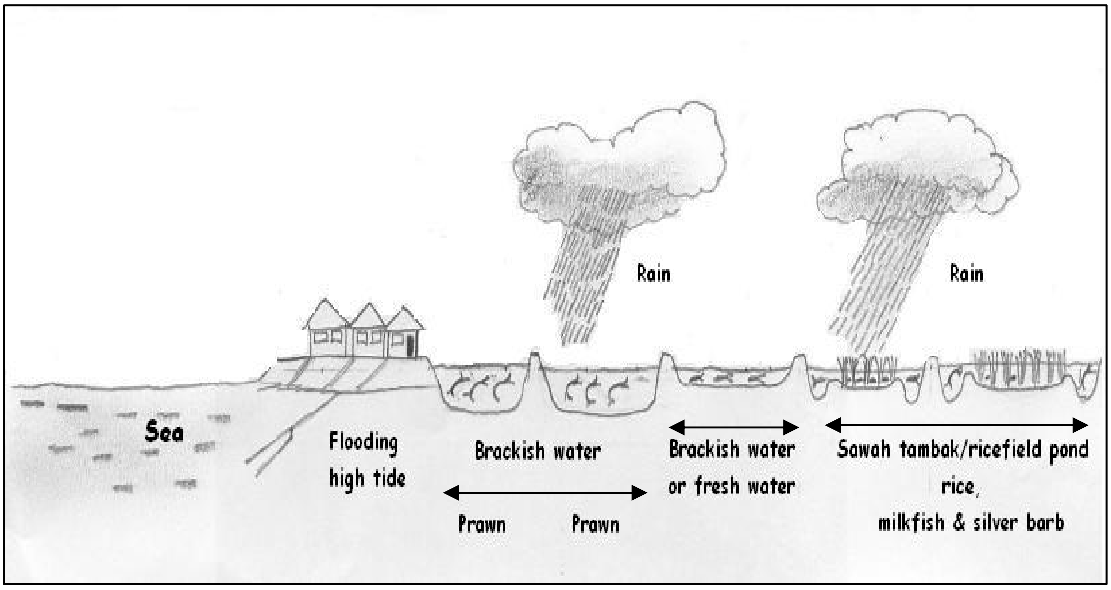


Source: www.eastjava.com ("Peta Potensi Kabupaten Lamongan,") and Deket Agricultural Extension Office (KCD Pertanian dan Kehutanan Kecamatan Deket)

Through a discussion with the AIAT and the Deket Agricultural Extension Office, three neighbouring villages in the Deket District of Lamongan Regency were selected for the case study: Sugihwaras, Rejosari and Sidobinangun (see Figure 5.1). The main criterion for selection was based on AIAT's projects of the improved paddy-prawn system, particularly in Sugihwaras and Rejosari. Sidobinangun was purposely selected to confirm the semi-ethnographic interview conducted in Sugihwaras and Rejosari. The agro-climatic conditions in some parts of Sidobinangun are similar to Sugihwaras, while other parts are similar to Rejosari.

The majority of the population in these villages is engaged in the agriculture sector producing rice, milkfish, silver barb fish, common carp and vegetables. Some farmers have also grown prawn (as a monoculture, or intercropping with milkfish or paddy) for the last 7-8 years. All rice fields in these villages depend on stored rain for water (KCD Pertanian dan Kehutanan Kecamatan Deket, 2005). The rainwater is usually available for 5-6 months through local reservoirs or a canal/branch of Bengawan Solo River, the largest river in Java Island. A discussion of the respondent farmers from the three villages will be presented in a later section following a discussion about paddy-prawn intercropping.

Figure 5.2 The traditional structure of "sawah tambak" in East Java



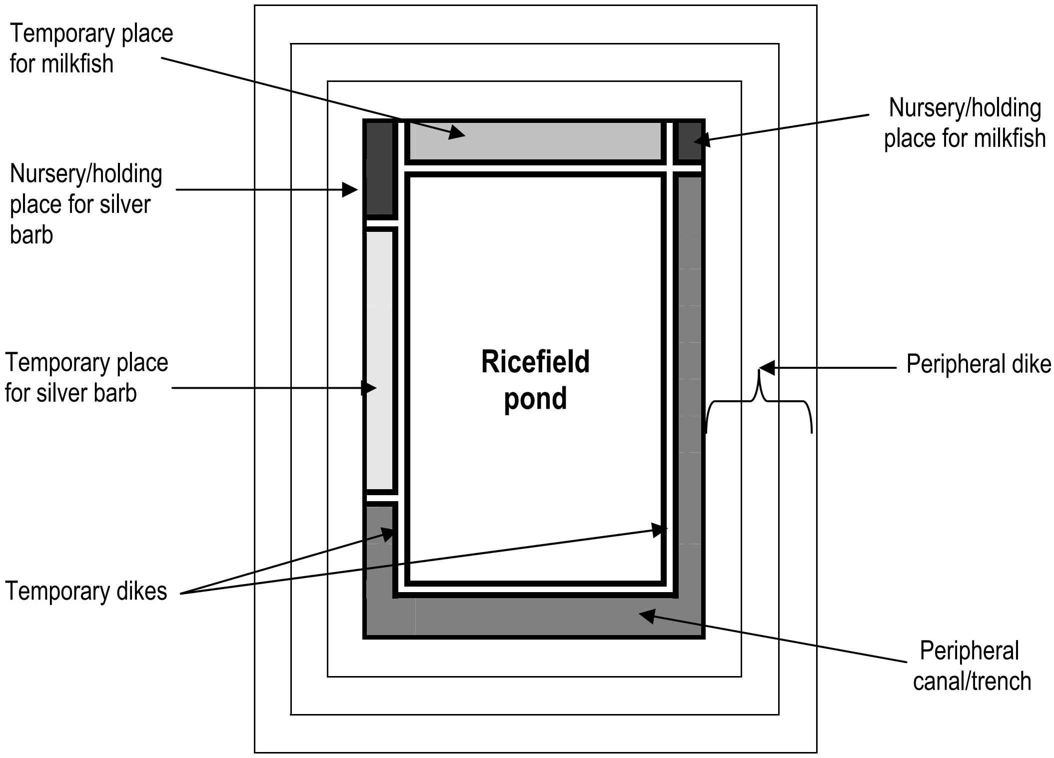
Source: de la Cruz (2001b)

5.2.3. The Improved Paddy-Prawn System

Farmers in some parts of Indonesia have long applied a combination of paddy and fish. The farmers traditionally developed this system. In West Java, the paddy-fish system is called "*minapadi*", which involves an annual rotation of paddy-fish, other crops and fish-maize ("*fish-palawija*"). "*Minapadi*" is usually applied in irrigated rice fields (de la Cruz, 2001a). In East Java, the system is known as "*sawah tambak*" or "*brackishwater*", or "*ricefield pond*" system (de la Cruz, 2001b, see Figure 5.2 & 5.3;

Muhariyanto & Arianto, 2005). In this system, farmers rely on rainwater to grow an annual rotation of fish-fish-paddy for the cycle of the wet season, the first and the second periods of the dry season respectively (Pratomo, Kasijadi, Muhariyanto, Krisunari, & Saraswati, 2004).

Figure 5.3 The components of "sawah tambak" in East Java



Source: de la Cruz (2001b)

The ricefield-pond system is used by around 15,000 farm households (de la Cruz, 2001b) in coastal areas (de la Cruz, 2001a), or areas near a river or sea canal (Muhariyanto & Arianto, 2005) of East Java Province. The area of ricefield-pond in East Java Province is 31,982 hectares (Pratomo et al., 2004), and the largest area is located in Lamongan Residency at around 16,000 hectares (Muhariyanto & Arianto, 2005). The types of fish cultured (monoculture or polyculture) include milkfish (*Chanos chanos*), silver barb (*Barbades gonionotus*), common carp (*Cyprinus carpio* L), and tilapia (*Tilapia mosambica*/African tilapia and *Oreochromis niloticus* Niloticus/Nile tilapia); while for prawn, the variety is tiger prawn (*Penaeus monodon* Fabricius) (Pratomo et al., 2004).

Farmers in Lamongan Regency were among the pioneers intercropping paddy and prawn; this system has since been used in other coastal regencies such as Gresik, Sidoarjo, Bangkalan and Tuban (Pratomo et al., 2004). The basic principles of paddy-prawn intercropping are the same as the "minapadi" system. Paddy is first planted in the field, and seven days later, prawn post-larva is transferred into the canal surrounding the paddy field (Muhariyanto, Pangarso, Supriyono, Astuti, & Krissunari, 2001). Although the prawns are kept in the canal, they can move around the paddy field to find food or shelter at midday. Prawns rely on microorganisms in the paddy field, particularly if the farmers apply manure or other organic fertilizers. Paddy may also benefit from the intercropping as the water height required for maintaining the prawn growth can suppress the growth of weeds. The prawn remains (dung and old skin) may also improve soil conditions in the paddy field.

The prawns are harvested after 60 days in the canal; while the rice is usually harvested after 90 days (Wonocolo Dissemination Laboratory of East Java AIAT, 2004a). The canal is drained so that the prawns can be collected. The prawn harvest may indicate the time for gradually reducing the water height in the paddy field. However, some farmers may also build a small ridge surrounding the paddy field during the prawn harvest to maintain water height for the paddy reproductive stage (flowering and grain development). A similar system has also been developed in other countries such as Bangladesh (Ahmed & Shamsuddula, 2002; Chapman & Abedin, 1998) and Vietnam (Commonwealth Scientific and Industrial Research Organization (CSIRO), 2003; Hung, 2001; Phuong, Son, Toan, Hien, & Duc, 2001), involving tiger prawn, or freshwater prawn (*Macrobrachium rosenbergii*).

In 2000, the AIAT conducted a pilot project of an improved paddy-prawn system ("pandu") in Rejosari with the aim to increase farmers' income. The system consists of four main recommendations: (1) land preparation and the canal dimension ("caren"), (2) paddy sowing and prawn post-larva distribution techniques, (3) balanced fertilizer application, and (4) the application of plant-based pesticides and water height management (Santoso et al., 2003). The AIAT then used the evaluation of the pilot project to enhance the system further, and the results were disseminated to farmers in Sugihwaras in 2004. The latter improvement has standardized practices with recommendations on (Muhariyanto et al., 2001; Wonocolo Dissemination Laboratory of East Java AIAT, 2004a):

a) high yielding paddy varieties and the quality of prawn post-larva;
b) paddy seed requirement and seedling techniques;
c) land preparation techniques, including the dimension of the canal ("caren");
d) a planting distance technique ("jajar legowo"), and procedures of transferring prawn post-larva into the canal;
e) fertilizer dosages and application;
f) water management practices; and
g) monitoring and controlling, including the application of plant-based pesticides.

The AIAT disseminated "pandu" (the improved paddy-prawn system) to farmers in the two villages through farmer group meetings, printed material (manuals) and demonstration plots. The AIAT also provided technical assistance, paddy seeds and prawn post-larva. An evaluation of the program conducted in 2003 indicated that about 31 percent of participating farmers had applied at least one component of "pandu"; while the proportion of non-cooperating farmers was around 14 percent (Santoso et al., 2003). In total, 332 farmers on 301 hectares of ricefield pond had applied "pandu" in the season when the evaluation was conducted, with a total production of 150.9 tons of un-milled rice and 12 tons of prawn (Santoso et al., 2003).

From the financial perspective, "pandu" performance appeared to vary. Based on the farm analysis in the technical guidelines of the improved paddy-prawn system ("pandu", see Muhariyanto et al., 2001), the application of "pandu" was claimed to increase costs by 5.09 percent. However, this was compensated by a 38.55 percent increase in the revenue (sales) mainly due to the dual commodities. These figures were obtained through comparison with the farmers' traditional system. The analysis, however, did not include fixed costs (land and depreciation), and the price of prawn appeared to be lower (IDR 30,000/kg) compared to the normal price between IDR 45,000 to IDR 55,000. This price level might indicate smaller sized prawn produced by the farmers, or the minimum price of prawn that the farmers could get. The analysis also showed an B/C (benefit-cost) ratio of 3.45, although a closer check on each component revealed a lower B/C ratio of 2.73 (both ratios excluded fixed costs). This analysis seemed to be based on the trial in Rejosari. In Sugihwaras, one “pandu” trial plot showed a B/C (benefit-cost) ratio of 1.069 with 55 percent of the profit coming from prawn (Wonocolo Dissemination Laboratory of East Java AIAT, 2004b); there were no records for the second trial plot. Such a ratio was mediocre considering that the objective of introducing “pandu” was to increase the farmers’ income.

The latter aspects may raise a question on whether “pandu” is an ideal case to study. Such doubt, however, can be adequately tackled using the complexities surrounding “pandu” application. These include the potential of “pandu” as a more productive income-generating activity since prawn has a higher market price than milkfish and other secondary products in the ricefield-pond. “Pandu” also contains different components that are more standardized and advanced than the traditional system. These aspects provide opportunities for learning how the farmers respond to a technology package that is only slightly improved relative to their common practices and experiences; and how relevant changes and modifications in the farmers’ decision making process occur. The latter was suggested by the different degrees of adoption as identified in the evaluation of ”pandu” in 2003. Different processes of technology transfer might also occur, and this included a farmer-to-farmer technology transfer as some non-cooperating farmers also applied “pandu”. However, even if the farmers had applied all the “pandu” components, they might revise their decisions. Assumptions about the reasons may be made, but no one has tried to explain the evidence from the farmers’ point of view.

All seem to confirm the need for further research in delineating the motives behind the farmers’ adoption behaviour. The farmers’ perceptions and decision rules should be focused on as they may well provide a better understanding of the farmers’ behaviour and suggest ways to improve the farmers’ adoption-decision making capacity.

5.3. Data Collection

The analysis combined four types of interview for collecting data. These were:

a) a structured background interview for collecting information about the conditions of the farm households;

b) a structured interview, based on the Theory of Planned Behaviour (TPB), for eliciting the structure of the farmers' mental process in decision making;

c) an unstructured semi-ethnographic interview for eliciting and confirming the farmers' decision criteria and paths related to new technology; and

d) a semi-structured repertory grid interview, based on the Personal Construct Theory (PCT), for eliciting and confirming the farmers' personal construct system related to their adoption or non adoption decisions.

The interviews were conducted from June 2005 until September 2005. All questionnaires were prepared in English, and then translated into Indonesian. A village meeting was held prior to the interview process in each village to explain the design of the research, including the purpose, implications, the sample selection approaches and the interview procedures. The meeting resulted in an agreed respondent selection process, a tentative timetable (including an agreement to have all types of interview at once), and a modification of the questionnaires.

All interviews ran without any significant problems. Most participating farmers were attentive to the questionnaires, and were willing to sacrifice half a day to be interviewed at their home. They were keen to get new information, and many of them asked the interviewer to give an analysis immediately after they completed the interview. In many interviews, the wife and/or other household members were also present, and they had a discussion before deciding on the answers. This enabled a better analysis of the intra-household bargaining process.

A few farmers, however, showed a reluctance to provide detailed answers because they were concerned about the impact of the interview on their income tax. This was inevitable, although the purpose of the interview had been explained during the village meetings and at the beginning of each interview. There were also difficulties in getting sufficient information, especially when the farmer's age limited the recollection process. Further discussion about the sample and the interview procedures are provided in the next sections.

5.3.1. Sample

The samples for this research were farmers who are engaged in paddy cultivation and aquaculture. Around 160 farmers were involved as respondents with the composition:

a) 59 farmers from Sugihwaras and 71 farmers from Rejosari were selected for the background, semi-ethnographic, TPB and repertory grid interviews; and

b) 30 farmers from Sidobinangun village were selected for an ethnographic test interview aimed at confirming the semi-ethnographic interview conducted in Sugihwaras and Rejosari villages.

As the same groups of farmers from Sugihwaras and Rejosari were involved in the four interviews (see point a), the results from each interview were expected to either confirm, or supplement, each other in identifying farmers' personal construct systems.

The sample size is perceived to be sufficient for conducting different types of interview that involve respondents from different villages. The sample size also meets the requirement for the semi-ethnographic, and its test, interviews since most respondent farmers have the same socio-cultural background. Where the respondents are not homogeneous, Gladwin (1989a, p. 27) suggests using 90-120 respondents for both the ethnographic interview and testing. However, she also assumes that such a requirement would vary across different cases.

Based on the village meeting, the selection process was based on individual farmer's consent. This was obtained through the help of the head of the farmer group and of the sub-village head, who made a door-to-door visit to invite his fellow farmers to participate in the interview. Some farmers who withdrew their consent were replaced.

For example, some farmers cancelled their participation because they had to go for a job or other commitments outside their village, or after hearing that some interviewees thought the interview was difficult. These farmers were replaced. The final number of 59 respondents from Sugihwaras and 71 respondents from Rejosari represent around, respectively, 36 percent and 66 percent of the total farmers in each of the two villages.

The sample selection process resembles a purposive random sampling. This is based on the "*knowledge of a population, its elements (unit of analysis), and the purpose of the study*" (Babbie, 2004, p. 183). Purposive random sampling may enable the identification of a different range of responses from a certain portion of a population. In this study, the selection process included both farmers who have, and have not, applied the improved system. Therefore, the analysis may explain different levels of adoption behaviour among farmers.

The unit of analysis is the head of the farm household. Respondents' names and addresses were undisclosed. Codes were used to identify each respondent, farmer group and location. The codes were applied for all interview processes.

5.3.2. Background Interview

A background survey was necessary to provide a general perspective about the conditions of the respondents. The survey supplied data related to the personal and contextual precursors for constructing a model based on the Theory of Planned Behaviour (TPB). The survey results were also expected to provide clues about the 'stimuli' (in Figure 4.4, p. 95) that may be important for decision making.

The questionnaire combined both quantitative and qualitative questions (Appendix B). Some questions were designed to avoid the possibility that the respondents will give a simple answer, particularly "yes" or "no", without any explanation. The data collected are presented and listed in Appendix C, and includes:

a) farmers' characteristics, such as demographic characteristics, assets, activities and farming experience;
b) farm practices, such as farming objectives, cropping pattern, the structure of a farm household's income, farming problems, and marketing practices;
c) farmers' information management and extension activities, such as farmers' methods of keeping farm records, type of data recorded, sources of information commonly used by the farmers, participation in a farmer group, extension programs and other organizations; and
d) farmers' decision making practices related to new technology adoption, such as their bases for decision making, farmers' responses to information about new technology, whether the farmers involve family members in making decisions, and the farmers' perception on who should determine the final decision.

5.3.3. TPB Interview

To construct a model of planned behaviour, Ajzen (2002a) suggests conducting a pilot survey. This is because the respondents may have various beliefs that may influence their decision making process, but only some beliefs are in their mind and contribute to their attitudes and behaviour. Thus, the pilot survey is targeted at collecting the respondents' common and retrievable perceptions. The results can provide clues to the respondents' latent constructs or factors that, according to the respondents, are important. The results, hence, can improve the accuracy of the TPB questionnaires.

Due to the limited time available, a pilot interview was not carried out. However, the suggestions from the village meetings were considered, and used, to modify the questionnaires. In addition, some TPB questions were redesigned to confirm each other so that the internal consistency (reliability) requirement among the TPB questions was still in place. For example, sixteen open-ended questions were included in the TPB interview in order to retrieve the respondents' illustrative impression about the improved paddy-prawn system (see Appendix B, Section 7, questions 1-16). The results not only provide important information about the respondents' feedback about the improved system, but also confirm the subsequent TPB questions (91 questions with 1-5 scale).

The TPB questionnaire is targeted at exploring a "*snapshot of the behaviour's cognitive foundation*" (Ajzen, 2002a, p. 2) across farmers during the application of an improved paddy-prawn system ("pandu"). The questions elicit the indicators of:

a) adoption behaviour;
b) intention to adopt "pandu";
c) attitudes towards the adoption of "pandu";
d) perceived beliefs on the likely benefits from "pandu";
e) perceived beliefs on the consequences from using "pandu";
f) subjective norms;
g) perceived beliefs about social expectations to adopt "pandu";
h) motivation to comply with the expectation of significant others;
i) perceived behavioural control;
j) beliefs about external supporting or impeding factors for applying "pandu";
k) beliefs about internal supporting or impeding factors for applying "pandu"; and
l) intra-household and social bargaining processes related to "pandu" application.

The first 12 questions in the TPB questionnaire (see Appendix B, section 7) represent a direct measure of behaviour and intention. Farmers' adoption behaviour is defined as the application of all recommendations of "pandu"; while partial application, and/or modification of "pandu", may indicate different degrees of adoption behaviour. An intention to adopt is defined as an intention to apply "pandu" right after receiving the relevant information.

The 12 questions use a qualitative scaling, for example, the respondents were asked to respond to the following statement:

The price of rice will be high:

unlikely _________:_________:_________:_________:____x____ likely

very quite neither quite very

The response was recorded by writing a mark (x) on the space provided.

The other 67 questions are designed to elicit the farmers' "*accessible behavioural, normative, and control beliefs*" (Ajzen, 2002a, p. 2) (points d, e, g, h, j and k), except for questions related to attitudes, subjective norms and perceived behavioural control which are included as direct measurements. Using these questions, each respondent was asked to assess their perception based on a five-point semantic scale representing five views, e.g. ranging from strongly disagree to strongly agree (see Appendix B, section 7). The farmer then specified her/his evaluation by selecting a number that corresponded to their level of agreement. For example, farmers were asked to respond to the following statement:

Applying all components of the improved paddy-prawn system helps me achieve higher production

1	2	3	4	5
Strongly disagree	disagree	undecided	agree	strongly agree

The response was recorded by circling one number from the scale provided. Concerning the possible supporting and impeding factors (points j and k); the relevant information is construed from the author's experience and personal communications between the author and two officers from the East Java AIAT. The questionnaire also uses modified questions from Chetsumon (2005).

The last 24 questions in the TPB questionnaires are aimed at measuring the respondents' attitudes about the importance of discussing matters with their significant others and identifying the extent they rely on negotiation in making decisions. The results of this survey become the input for constructing structural equation models for the farmers' adoption behaviours. The results of the TPB questionnaires are presented in Appendix D.

5.3.4. Interview Based on the Personal Construct Theory (PCT)

As mentioned in Chapter Four, this interview was expected to explain farmers' underlying motives, constructs, or heuristics in more detail (the shaded boxes in Figure 4.4, p. 95). The procedure includes two steps. The first step was to select the elements. This was done prior to the interview. Three groups of elements were selected (see Table 5.1):

a) a list of elements related to attitudes toward adoption behaviour which are represented by possible outcomes (advantages and disadvantages) from adopting the improved paddy-prawn system ("pandu");

b) a list of elements related to perceived behavioural control which cover external and internal factors that may support and impede the respondents to adopt "pandu"; and

c) a list of elements related to possible significant others with whom the respondents discuss and negotiate their intention to adopt "pandu".

Table 5.1 Possible lists of elements for the PCT interview

	Elements related to:	
Attitudes	**Perceived behavioural control**	**Significant others involved in bargaining process**
Income	Capital	Spouse
Paddy yield	Size of ricefield-pond	Children
Prawn yield	Off-farm work	Parents
Fish yield	Market price	Extended family
Harvest failure	Production costs	Neighbouring farmers
Input costs	Access to information	Farmer group
Input availability	Number of buyers	Village leaders
Working hours in the field	Transportation cost	Religious leaders
hired farm labourer	Levies	Extension officers
Off-farm work	Water conditions	Researchers
Time for family	Pest & disease	Middlemen
Knowledge of paddy-prawn intercropping	Knowledge of paddy-prawn intercropping	Buyers
Farming skills	Working hours in the field	Retailers
Length of time to learn new technology	Experience in cultivating paddy & prawn	Banks
Soil & water conditions	Extension services	Cooperatives
	Input availability	Government
	Household daily expenses	
	Farming skills	
	Debt	

The selected elements were believed to meet Kelly's (1955) requirements of being (i) unambiguous, (ii) uniform, (iii) independent, (iv) representative and (v) detailed. The respondents were also asked to confirm, add and/or remove pre-selected elements, thus ensuring that only the elements relevant to the respondents were considered.

The second procedure is construct elicitation using a paper-based semi-structured interview. The paper-based interview was preferred since the computer-based interview, although it is more common, has limitations such as language barriers and farmers' computer unfamiliarity. The interview used a triad procedure which started with a "practice" interview (see Appendix B, Section 6) so that each respondent was able to grasp the procedures and gain confidence in responding to the interview. This was followed by the real construct elicitation, where each respondent was asked to decide the similarities between two out of three elements that were presented, using contrasting terms. The bipolar terms/statements mentioned by the respondent showed her/his constructs. The farmer was also asked to explain the relationships between the constructs and the elements. Next, a new triad was selected randomly from the list, and the respondent was again asked to compare the new triad. The process was repeated until the respondent did not have any more constructs to be elicited.

Appendix E presents the constructs elicited by 130 farmers from Sugihwaras and Rejosari. Many of them elicited, on average, three constructs for each set of elements. Three farmers, however, could not participate in the interview due to personal limitations in following the procedures. Many farmers also could only elicit one construct for one of the three element sets, and/or completely deselected the elements (variables). Thus, these farmers may have incomplete personal construct analyses since each analysis requires the minimum of two constructs for each element.

5.3.5. Ethnographic Decision Tree Modelling (EDTM)

The EDTM procedure comprises three steps (the complete procedures are presented in Appendix F). First, questions were presented to measure the level of the farmers' knowledge on the improved paddy-prawn system ("pandu"). Then there were questions on the source of knowledge about “pandu” and the associated components. The results are quantified and presented in Appendix G (variable 1 to 5).

A semi-ethnographic interview was then conducted to elicit farmers’ decision criteria and paths with regard to “pandu”. The interview was unstructured and tape-recorded and involved 130 farmers from Sugihwaras and Rejosari villages. Some examples of semi-ethnographic questions are presented in Appendix B, Section 5. The results were arranged in the form of the key terms expressed by the farmers. They are used for constructing individual farmer’s decision trees and some decision models representing different degrees of adoption behaviour.

The last step was a test interview aimed at confirming the interviews in Sugihwaras and Rejosari. A new questionnaire was constructed containing 183 questions with "yes" and "no" answers (see Appendix H). The procedures followed Gladwin's (1989a) book of ethnographic decision tree modelling. The questions were formulated based on more than 200 decision terms/reasons that the respondents expressed during the semi-ethnographic interviews. In addition to the questionnaire, the respondents were asked to provide a brief explanation if they answered "it depends", which was not included as an option.

The test interview involved 30 farmers from Sidobinangun village. Some of these farmers have traditionally intercropped paddy and prawn, but have not been introduced to “pandu”. The procedures included, first, members of a farmer group being invited to attend a video presentation of “pandu”. This was followed by a discussion where the farmers might ask for confirmation or further explanation. This process was expected to resemble the dissemination process of “pandu”. After the discussion, the farmers were interviewed using the ethnographic test questionnaire. The results from the test interview were used to validate the decision criteria that were expressed by 130 farmers from Sugihwaras and Rejosari.

5.3.6. Other Procedures for Data Collection

Some other strategies were also devised in order to further explore the extent of social interaction. For example, each respondent was asked to recommend other farmers who could be interviewed (see question no. 9 (for adopters) and 16 (for non-adopters) in the first part of Section 7 in Appendix B). The person suggested by the respondent might or might not be different from the one who, according to the respondent's belief, approved or disproved the respondent's decision relating to the improved paddy-prawn intercropping system. This person might be another farmer, or a close friend, who shares a mutual preference.

Table 5.2 Psychological commonalities in social comparisons (taken from Neimeyer et al., 1996, p. 139)

Level	Definition	Representative study
Attitude similarity	Personal likes and dislikes in food, entertainment, etc.	Baron & Byrne (1981)
Construct similarity	Content of personal constructs used to interpret others	Duck (1977)
Functional similarity	Application of constructs to mutually known others	Neimeyer & Neimeyer (1981)
Personality similarity	Basic traits or qualities of a person; temperament	Blankenship et al. (1984)
Value similarity	Personal standards that guide social behaviour	Newcomb (1961)
Structural similarity	Differentiation or complexity of construct system	Neimeyer & Neimeyer (1983)

This procedure is important because it can help identify commonality in the use of heuristics. According to Neimeyer, Brooks, & Baker (1996), friends usually share some similarities in the way they construe events. Such commonality can be used for identifying wider social relationships (Kelly, 1955). Furthermore, the similarities between friends may not only relate to their preferences and opinion about other people, but also relate to the values and the use of similar constructs (see Table 5.2). The latter suggests that friends may use similar patterns of heuristics and, thus, the generalization of the farmers' heuristic pattern is reasonable. In addition, since a respondent may suggest a farmer from a different farmer group, the result may enrich the description of the farmers' learning process to include a spatial effect. The presence of shared or communal constructs among the respondents will also be confirmed through the SocioGrids analysis in the RepGrid software.

Finally, this study also collected data from the Deket Agricultural Extension Office and Lamongan statistics office, such as the size of the farmer group, district map, population, employment and gross regional domestic products, to supplement the description of the case under study.

5.4. Data Processing and Analysis

Quantitative responses (including ranks, scores and indexes) from the background and TPB interviews were transferred to the spreadsheet program EXCEL. Qualitative responses from the background, TPB and semi-ethnographic interviews were transcribed into Word documents, and some of them were quantified and transferred to EXCEL. Farmers' responses to the paper-based repertory grid interview were transferred into the RepGrid software. These responses were also standardized in order to allow a group (macro) level analysis of the farmers' constructs related to their decision whether or not to apply "pandu". Quantitative data were analyzed using SPSS to obtain descriptive statistics. T-tests were used to compare the means, and Pearson's correlation coefficient was used to determine the correlation between the variables. Appendix I summarizes the results. Further data processing procedures for the results from each of the four interviews are presented in the next few sections.

5.4.1. Data Processing for Background and TPB Interview Results

SEM is a multivariate statistical modelling technique that may combine methods such as factor analysis, path (causal) analysis and regression analysis (Austin et al., 1998; Rigdon). The aim of SEM is to identify the pattern of latent interrelationships among variables (Austin et al., 1998; Babbie, 2004; Hair, Black, Babin, Anderson, & Tatham, 2006; Rauniyar & Goode, 1992).

In this study, a structural equation model (SEM) was used for constructing the TPB model, linking farmers' attitudes, subjective norms, perceptions of behavioural control, intentions and behaviour. The inputs for the SEM come from either the variance-covariance, or the correlation matrix (Hair et al., 2006). Co-variances usually provide a more precise analysis of causal relationships (Hair et al., 2006); however, some studies (e.g. Chetsumon, 2005) use correlations for practical reasons. Hair et al. (2006) also assert that correlation matrices can avoid upward bias, for example, due to data with a non-normal distribution.

Table 5.3 Cronbach's alpha for the TPB survey results

Variable*	Definition[2]	Cronbach's alpha**
AB	Direct measure of adoption behaviour; Average of questions Part 1: 7-12	0.877
INT	Direct measure of intention to adopt "pandu"; Average of questions Part 1: 1-6	0.917
adv	Indirect measure of the farmers' beliefs on the benefits from adopting "pandu" Average of questions Part 2: A1-A7	0.915
disadv	Indirect measure of the farmers' beliefs on the consequences from adopting "pandu"; Average of questions Part 2: A12r, A13r, A14r, A15r, A16r, A17r, A18r, A19r, C57r,	0.719
norm	Indirect measure of the farmers' beliefs on social expectation; Average of questions Part 2: B21, B20, B22, B23, B24, B25, B26	0.805
motive	Indirect measure of the farmers' motivation to comply with social expectation Average of questions Part 2: B28, B29, B30, B31, B32, B33, B34	0.669
extern	Indirect measure of the farmers' perceptions on external factors affecting "pandu" adoption; Average of questions Part 2: C35, c36, C40, C45, C46, C49, C50, C51, C54, C55, C58r, C65r, C66r, C67r	0.307
intern	Indirect measure of the farmers' perceptions on internal factors affecting "pandu" adoption; Average of questions Part 2: C37, C38, C41r, C42, C43, C44, C47, C48, C60r, C61r, C63r	0.412
DF	Hypothetical measure of the role of family discussion in influencing the farmers' adoption decision; Average of questions Part 2: D68, D69, D70, D71, D72, D73, D79	0.780
NF	Hypothetical measure of the role of negotiation with family members in influencing the farmers' adoption decision; Average of questions Part 2: D74, D75, D76, D77, D78	0.901
DNF	Hypothetical measure of the role of discussions with non-family significant others in influencing the farmers' adoption decision; Average of questions Part 2: D80, D81, D82, D83, D84, D85, D91	0.857
NNF	Hypothetical measure of the role of negotiation with non-family significant others in influencing the farmers' adoption decision; Average of questions Part 2: D86, D87, D88, D89, D90	0.869

* Three variables representing attitudes (**AT**), subjective norms (**SN**) and perceived behavioural control (**PBC**) are each represented by a single question and, hence, reliability analysis is not applicable.

** The mean inter-item correlation for **extern** is 0.261 and for **intern** is 0.344.

According to Ajzen (2002b), the results from the TPB survey should be tested for internal consistency prior to model development. This is a prerequisite for confirming that different questions in the TPB survey measure the same construct. This

[2] The 'r' following the question number indicates that they have been transformed to allow the scale from negative to positive responses (see Francis et al., 2004; Statistical Support, 2001).

particularly applies for direct measures, such as behaviour, intention, attitudes, social norms and perceived behavioural control. High internal consistency among questions relevant to each measure is preferred. The common benchmark is Cronbach's alpha (Ajzen, 2002b; Hair et al., 2006; Pallant, 2005), in which the acceptable scale for high consistency is 0.7 or above, or 0.6 or above for exploratory analyses (Hair et al., 2006). However, if the number of questions for one internal consistency measure is less than ten, the Cronbach's alpha is usually quite low and, hence, it is important to also present the mean inter-item correlation, with the acceptable range between 0.2 and 0.4 (Briggs & Cheek, 1986, cited in Pallant, 2005, pp. 6 & 90).

Table 5.3 presents the Cronbach's alpha for the TPB variables and most of the variables show a high internal consistency. The exception is that the direct measures of attitudes (**AT**), subjective norms (**SN**) and perceived behaviour control (**PBC**[3]) do not require an internal consistency test because each is represented by a single question. Two variables, **extern** and **intern**, also have Cronbach's alpha below 0.6. This may indicate the lack of internal consistency, but the mean inter-item correlation of **extern** and **intern** fall within the acceptable level, which is 0.261 and 0.344 respectively. Both variables are indirect measures of the farmers' perceptions of situational factors and their own capability to apply "pandu".

Ajzen (2002b), however, asserts that internal consistency may not be relevant for indirect measures, such as behavioural beliefs, normative beliefs and control beliefs (see Figure 4.3 in Chapter Four, p. 82). This is because people, in general, often do not think of their behaviour simply in a black and white fashion and, hence, they often have inconsistent behaviour (Antonides, 1996; Jangu, 1997; Muller, 2001; Ohlmer, Olson, & Brehmer, 1998). For example, Ajzen (2002b) asserts that people often consider that their behaviour will bring both positive and negative consequences. This makes the measurement values vary and be uncorrelated, although to ignore these important measures only from the basis of internal consistency is also not reasonable (Francis et al., 2004).

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[3] The question for PBC contains negatively worded statements and, hence, it has been transformed to allow the scale from negative to positive responses (see Francis et al., 2004; Statistical Support, 2001).

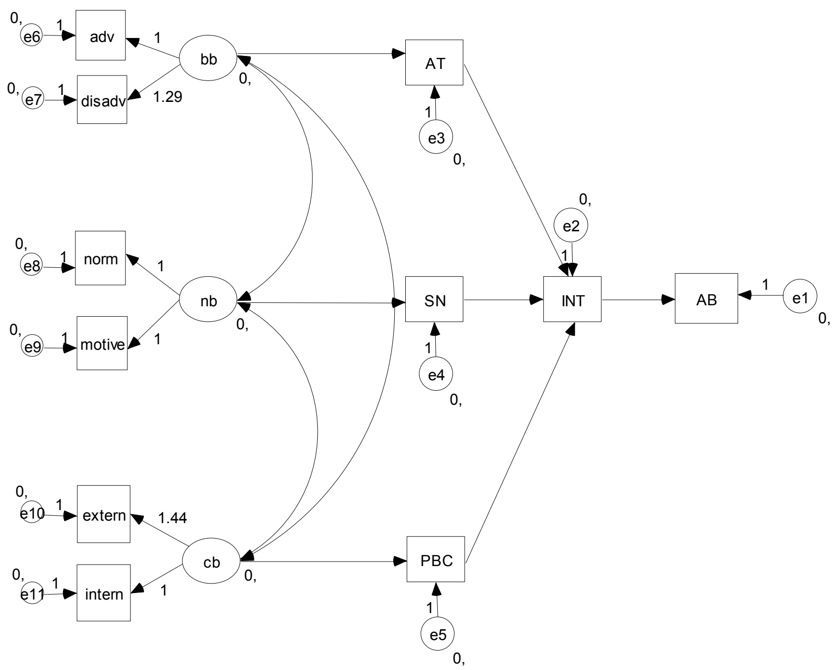
The alternative for this case is to assess 'temporal stability' or test-retest reliability (Ajzen, 2002b). This can be conducted by asking the survey respondents the same questions, but at two different times (Pallant, 2005; Trochim, 2002). The results may detect whether ambiguous responses exist. If low stability exists, the survey results may be of little use for measuring future behaviour (Ajzen, 2002b).

In this study, however, there was not sufficient time and resources to conduct test-retest reliability for the farmers' behavioural, normative and control beliefs. Another strategy, instead, was applied. Some TPB questions were designed to confirm others and to ensure internal consistency. For example, questions #35 and #54 (see Appendix B) both cover the same topic (water supply in the village). Another example is questions #51 and #66r that ask about the farmers' perception of the price conditions for their products in the market. The responses to these questions were quite consistent. Thus, in general, it can be assumed that all the TPB variables have an adequate level of internal consistency.

The TPB variables were then incorporated in a structural equation model (SEM) using a software package called AMOS (Analysis of Moment Structure). According to Hair et al. (2006), AMOS is more user-friendly relative to other programs. Detailed AMOS procedures for SEM can be found in Arbuckle (2005) and Byrne (2001) and the Statistical Support (2001), Univ. of Texas at Austin (http://www.utexas.edu/its/rc/tutorials/stat/amos/). Figure 5.4 shows the basic TPB model using AMOS (next page).

The rectangles in Figure 5.4 represent measured variables, while the circles or ovals represent variables that cannot be measured directly or are latent variables. Thus, there are 11 measured variables and 14 latent variables (including 11 circles representing the error terms of each measured variables). Although Ajzen (2002b) asserts that all variables in the TPB diagram portray "*hypothetical or latent variables*" (p. 2), the belief-based variables (behavioural beliefs—**bb**, normative beliefs—**nb**, and control beliefs—**cb**) may be the true latent variables since they can only be implied from measured variables such as **adv**, **disadv**, **norm**, **motive**, **extern** and **intern** (see Table 5.3).

Figure 5.4 Basic TPB model using AMOS



Note: adv = beliefs about "pandu" benefits, disadv = beliefs about the consequences of "pandu", norm = beliefs about social expectations, motive = motivation to comply with social expectations, extern = beliefs about external factors affecting "pandu", intern = beliefs about internal factors affecting "pandu", bb= behavioural beliefs, nb = normative beliefs, cb = control beliefs, AT = attitudes toward "pandu" adoption, SN = subjective norms, PBC = perceived behavioural control, INT = intention, AB = adoption behaviour, and e1-e11 = error terms

Single-headed arrows depict a causal relationship between the relevant pair of variables, while double-headed arrows represent correlations or non-causal relationships. The numbers attached to arrows originated from the latent factors (**bb**, **nb**, **cb**, and error terms) indicate the weight or relative size of each measure variable connected to a latent variable. For example, **adv** has the regression weight = 1 because it contains 7 questions, while **disadv** has weight = 1.29 due to its content of 9 questions. The relationships between variables in the TPB model in Figure 5.4, hence, can be explained as follows:

a) **adv** and **disadv** represent the effect of **bb** on **AT**;

b) **norm** and **motive** represent the effect of **nb** on **SN**;

c) **extern** and **intern** represent the effect of **cb** on **PBC**;

d) **AT**, **SN** and **PBC** together influence **INT**, which further leads to **AB;**

e) **bb**, **nb** and **cb** are interconnected each other and, hence, they have a certain degree of intercorrelation (see Figure 4.3, p. 82).

Only **INT** (intention) has a direct relationship with **AB** (adoption behaviour), while other variables indirectly influence the adoption behaviour.

Table 5.4 The standardized estimates from AMOS for the TPB model (see Figure 5.4)

Model path	**Standardized estimates**	
	Basic model	**Basic model with actual behaviour & BP**
adv – bb	0.453	0.453
disadv – bb	0.615	0.615
norm – nb	0.263	0.263
motive – nb	0.564	0.564
extern – cb	0.651	0.651
intern – cb	0.312	0.312
bb – AT	0.391	0.391
nb – SN	0.566	0.566
cb – PBC	0.133	0.133
AT – INT	0.366	0.366
SN – INT	0.266	0.266
PBC – INT	-0.037	-0.037
INT – AB	0.467	
INT – BP		0.734
BP – DF		0.235
BP – NF		0.038
BP – DNF		0.534
BP – NNF		0.577
BP – Actual		0.650
Actual – Intr		0.668
Actual – a0405		0.538
Actual - Act		0.725
Model fit		
Overall R^2 (AB or Actual)	0.218	0.422
R^2 for INT	0.239	0.239
chi-square / df	4.403	2.815
RMSEA	0.162	0.119
TLI	0.955	0.963

AMOS provides the standardized estimates of the model paths and the model fit in Table 5.4. The model goodness-of-fit is assessed using the "*relative chi-square*" or "*normal chi-square*" (Garson, 1998b), root mean square error of approximation (RMSEA), and Tucker-Lewis Index (TLI). They are used because they are less sensitive to sample size and, hence, avoid overestimating the model fit (complete reviews of model fit measure, see Garson, 1998b; Hu & Bentler, 1995). Hair et al. (2006) also suggest the use of different indexes in order to make sure the model goodness-of-fit, or at least "*one incremental index and one absolute index, in addition to the chi-square and the associated degrees of freedom*" (p. 752). TLI is one type of the incremental indexes and the RMSEA is one type of the absolute indexes. The relative chi-square is obtained by dividing the chi-square value with the degree of freedom. In AMOS, this is presented as CMIN/DF, and a better model fit usually has CMIN/DF less than 2 (Garson, 1998b) or less than 3 (Kline, 2005). RMSEA assesses "*the discrepancy per degree of freedom*", which is equal to $0.5*((\chi^2/((n-1)df))-(df/((n-1)df)))$; where χ^2 is the chi-square index, df is the degrees of freedom, and n is sample size (Garson, 1998b). The consensus is that a RMSEA value of ≤ 0.05 indicates a good model fit, although an RMSEA index of ≤ 0.08 is also considered adequate (Garson, 1998b). The acceptable value for the TLI is ≥ 0.95 (Statistical Support, 2001).

From Table 5.4, it appears that the basic TPB model has not provided an adequate representation of the farmers' perceptions and behaviour. Its model fit indexes, except the TLI, are still outside the acceptable range, and some of its path estimates are too small, e.g. between **PBC** and **INT**. In addition, the variables only explain 22.5 percent of the adoption behaviour, or almost 24 percent of the intention to adopt "pandu". Nevertheless, the model is feasible as no negative error variance estimates exist, which according to Garson (1998b) can lead to "arbitrary" solutions or a "*Heywood case*". This problem arises when only one or two factors are used to measure a latent parameter, e.g. **bb**, **nb**, and **cb** in the model.

Some modifications representing the focus of this study were then applied to the basic TPB model. First, the farmers' actual behaviour related to "pandu" (**Actual**) replaced **AB**. The variable **Actual**, however, is assumed latent since the information was collected beyond the introduction process, and it can only be inferred from the farmers' responses to the open-ended part of the TPB interview and the semi-ethnographic interview (see Appendix B). **Actual**, hence, is indirectly measured through the farmers' responses related to (i) the extent of "pandu" application in the year of introduction (**Intr**); (ii) the extent of "pandu" application in 2004-2005 (**a0405**); and (iii) the farmers' plan in the future regarding "pandu" (**Act**).

Secondly, the concept of a bargaining process was also introduced to the TPB model. **BP** is expected to tackle a concern over whether an attitude always leads to behaviour, and whether an individual consistently uses the same information throughout her/his decision making processes (Antonides, 1996; Burton, 2004). The bargaining process (**BP**) is considered latent since, in reality, it is difficult to measure how it is involved in helping the farmers make decisions. Here, **BP** is represented by four variables; they are: **DF**, **NF**, **DNF**, and **NNF** (see Table 5.3 and Appendix D for variable descriptions). These variables are expected to explain the role of a bargaining in mediating the transformation of the respondents' intention into actual behaviour.

The inclusion of **Actual** and **BP** has improved the total variance explained and the model fit measures (see Table 5.4). **Actual** may provide better estimations compared to **AB**; and **BP** seems to provide a clearer link between the farmers' intention and behaviour. Nevertheless, the addition resulted in no changes to the path estimates.

Next, some background variables were added to represent the stimuli of the farmers' perceptions. There are about 58 types of responses obtained from the background and semi-ethnographic interviews that can be used for measuring the stimuli. However, considering the sample size of this study, only some of them were selected based on several approaches. First, the selection used the responses to question #18 of the Background Questionnaire (see Section 4 in Appendix B), which covers the farmers' main considerations when evaluating the feasibility of a new technology. The responses include (i) observable results, (ii) significant others' opinion, (iii) financial conditions, (iv) specific features of the technology, (v) agro-climatic conditions, (vi) the availability of relevant extension services, (vii) their current farming practices, (viii) their skills and motivation, and (ix) incentives (see Table I.2 in Appendix I).

Secondly, from the semi-ethnographic interview, it was found that the farmers also used the following guidelines in making decisions about "pandu":

a) whether they have previous experience in intercropping paddy and prawn and whether "pandu" procedures are similar to their current practices;

b) the potential (overall) benefits from applying "pandu", such as objective realization, higher yield, higher income, profitability and business expansion;

c) the effects, or special features, of "pandu" components, particularly related to the growth/survival of the commodity, yield and work load;

d) whether observable results exist;

e) the availability of relevant extension services;

f) whether the farmers have received sufficient knowledge about "pandu" including how to deal with problems;

g) the availability of incentives, especially finance and farm inputs;

h) whether the farmers were experiencing an emergency, or a fluctuating income possibility when faced with a choice to adopt "pandu";

i) whether the farmers' assets are sufficient;

j) the production costs and labour requirement;

k) the influence of neighbouring farms, especially in terms of cropping pattern and pesticide application;

l) commodity preferences;

m) the extent of off-farm activities;

n) agro-climatic conditions, especially water supply and quality;

o) the farmers' skills, motivation and work ethic;

p) the farmers' capacity and the influence of significant others in decision making; and

q) the process of "pandu" dissemination.

The third approach was to consider using adoption decision variables from previous studies as outlined in Chapter Two of this thesis (see also Appendix A). Next, since it is possible to include more than one variable to represent one decision criterion, only variables that resulted in a better estimation were retained. For example, **Crop** (different farmers' cropping pattern), **Veg** (whether or not farmers grow vegetables) and **Pro1** (problems related to pest and diseases) may represent the neighbouring farm effects, or the farmers' concerns about the effect of pesticide applied by their neighbours on the mortality of prawns. Since the inclusion of **Crop** resulted in a better estimation and model goodness-of-fit, **Crop** was selected.

Based on the selection criteria and the available measures, the farmers' perceptions, intention and behaviour are assumed to be influenced by:

a) the farmers' significant others' opinions, as culturally the farmers may seek assurance from important people (e.g. spouse—**SO1**, children—**SO2**, extension officers—**SO5**), or the opinion in the community besides relying on their own decision (**DM**);

b) the participation in the dissemination process of "pandu" (**Diss**), which may represent the farmers' (i) knowledge of "pandu" and (ii) extent of participation in extension activities;

c) the farmers' current problems (e.g. pests and diseases—**Pro1**, water—**Pro2**, market price of prawn—**Pro3**), which may represent the situational factors that affect the farmers' behavioural and control beliefs;

d) a variable called "**Vil**" that represents the agro-climatic, socioeconomic and socio-cultural differences and different "pandu" dissemination periods between the two villages (**Vil** = 1 = Sugihwaras, **Vil** 2 = Rejosari);

e) the farmers' objectives (**Obj**);

f) the farmers' assets, whether they are financial (**OC**), physical (**Ten**) or human capital (**HH**); and

g) commodity preferences (**Crop**), as many farmers indicated paddy and milkfish as the main commodities and, hence, the farmers may use the yield/income from these commodities (e.g. milkfish yield—**Y3**) as a basis for evaluating new commodities/practices. Crop was also used to represent the neighbouring farm effects.

In addition, since **Actual** is used for representing the farmers' adoption behaviour, some direct associations between the measures of **Actual** and **Vil**, as well as between **Intr** ("pandu" application in the year of introduction) and **Diss** are assumed to exist. These links may represent differences in the timing of "pandu" dissemination and the level of "pandu" application among farmers in the two villages. A link between **PBC** and **BP** is also added to represent the respondents' consideration of the practicality of applying "pandu" when they negotiate their intention to apply "pandu" with their significant others. Overall, the variable selection approaches and the assumptions listed above fulfil the requirements of adding new factors into the TPB model as outlined by Ajzen (2002c). That is: (i) the factors have a causal relationship with the behaviour; (ii) the factor should be definite and measurable; (iii) they are theoretically justified and compatible with the model; and (iv) they have an empirical basis.

The modifications resulted in the model in Figure 5.5 (next page), which also show the estimation results. This model contains 32 observed variables (Table 5.5, in page 132), represented by rectangles (Figure 5.5). Fourteen observed variables were obtained from the TPB interview, i.e. the respondents' attitude (**AT**), perceived behavioural control (**PBC**), belief-based measures (**adv**, **disadv**, **norm**, **motive**, **extern** and **intern**), intention (**INT**), subjective norms (**SN**), and four measures of intra-household and external bargaining processes (**DF**, **NF**, **DNF**, and **NNF**)[4]. The application of "pandu" in the year of introduction (**Intr**), and between the period of November 2004 and mid 2005 (a**0405**), and the respondents' future action regarding "pandu" application (**Act**) were also used to represent the actual adoption behaviour. These variables were obtained from the background, semi-ethnographic and TPB interviews. In addition, the model comprise 15 background variables (**Obj**, **OC**, **Ten**, **HH**, **Y3**, **Crop**, **Pro1**, **Pro2**, **Pro3**, **Diss**, **SO1**, **SO2**, **SO5**, **DM** and **Vil**)[5] that may directly and indirectly affect the respondents' perceptions, bargaining practices, intention and behaviour.

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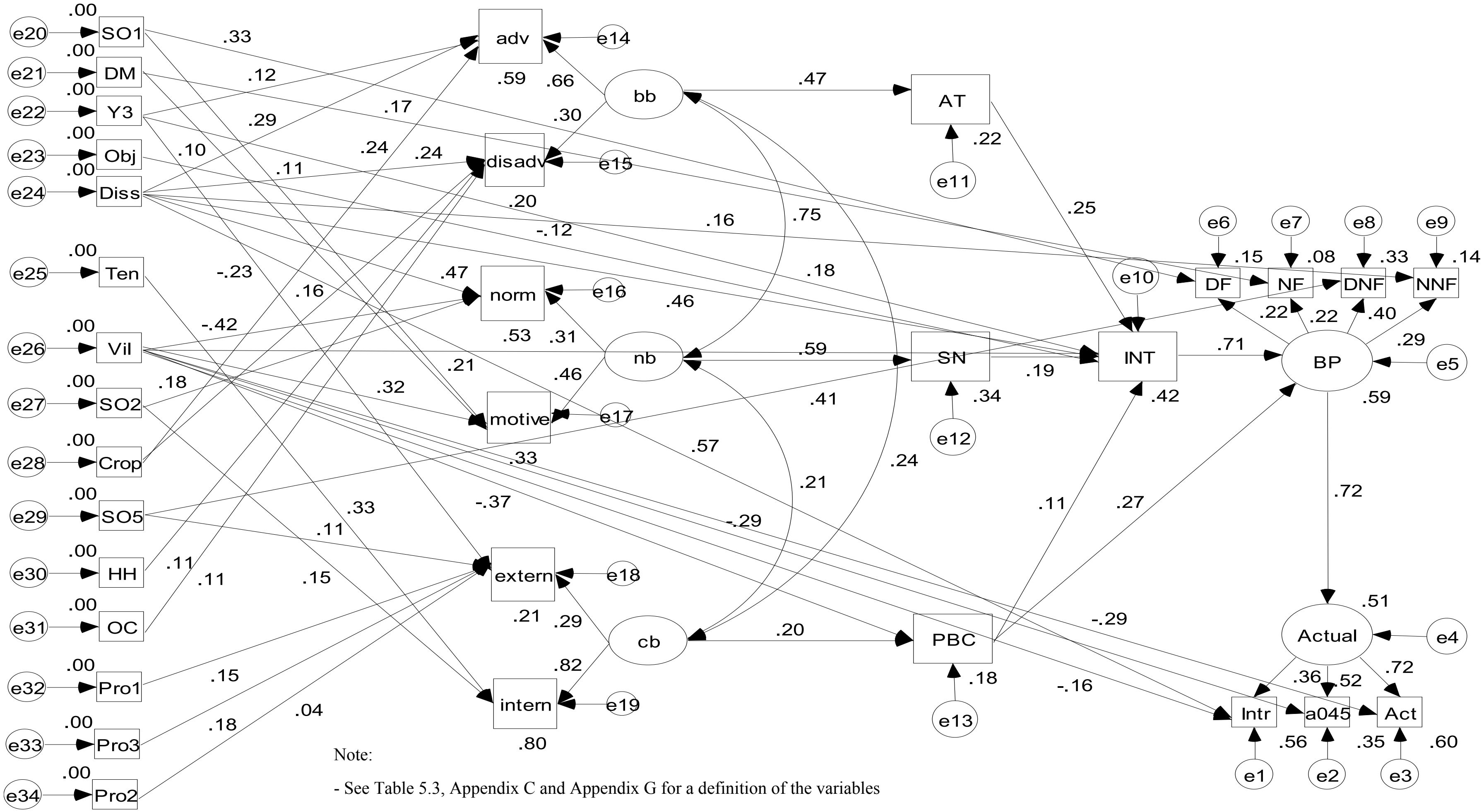
[4] See Table 5.3 in page 121 for the definitions.

[5] See Appendix C and G for the definitions.

Figure 5.5 A TPB model of the farmers' adoption of "pandu" and the estimation results



Note:

- See Table 5.3, Appendix C and Appendix G for a definition of the variables

- The figure beside each box is the R^2, and the figure on each directional arrow is the standardized regression coefficient.

Table 5.5 Summary of the TPB model

Summary	
Number of variables (total)	71
Number of observed variables	32
Number of unobserved variables	39
Number of exogenous variables	37
Number of endogenous variables	34
Number of distinct sample moments	560
Number of distinct parameters to be estimated	121
Chi-square	714.221
Degrees of freedom (df)	439
Probability level	0.000
Discrepancy / df (Chi-square/df)	1.627
Tucker-Lewis Index (TLI)	0.971
Root Mean Square Error of Approximation (RMSEA)	0.070
RMSEA lower bound	0.060
RMSEA upper bound	0.079

Note: Sample size is 130 farmers. The estimations focused on the observed variables.
Observed variables are measured variables obtained from the interviews (represented by rectangles in Figure 5.5).
Unobserved or latent variables can only be inferred from measured variables (represented by circles in Figure 5.5)
Exogenous variables are the ones with the sole role of influencing endogenous variables (represented by variables without the R^2 attached to them in Figure 5.5)
Endogenous variables are the ones explained by the exogenous variables (represented by variables with the R^2 attached to them in Figure 5.5)

The model also contains 39 latent or unobserved variables represented by circles in the model (Figure 5.5). Among these variables, there are 34 exogenous variables representing the error terms or residuals, three exogenous variables representing the respondents accessible beliefs (**bb** = behavioural beliefs, **nb** = normative beliefs, and **cb** = control beliefs), and two endogenous variables (**BP** = bargaining process, and **Actual** = actual behaviour). The error terms or residuals are attached to every endogenous variable (32 observed variables, **BP** and **Actual**). Three variables of accessible beliefs (**bb**, **nb** and **cb**) may represent the "*shared variance*" among the measured variables (Statistical Support, 2001); for example, **bb** may denote a latent variable that sums up the shared variance among **adv**, **disadv** and **AT**.

Direct arrows represent the relationships between the variables in the model. The arrows were determined based on the presumed causal relationships among the relevant variables, the relative compatibility with the overall model specification, as well as theoretical and empirical rationales. Two-headed arrows also connect latent variables (**bb**, **nb** and **cb**) to represent the possible interrelationships among these variables. These interrelations are suggested by Ajzen (2001; 2002b; 2006) in the formulation of the TPB.

The model estimations are provided in two forms. First, a value attached to the path or arrow connecting an exogenous variable with an endogenous variable is the standardized regression coefficient of the exogenous variables (see Figure 5.5). This value indicates the size of change in the value of an endogenous variable when the value of the exogenous variable changes by one unit standard deviation (Statistical Support, 2001), assuming all of other variables are held constant. Secondly, each endogenous variable has a value attached to it representing the R^2 or the total variance explained by its relevant exogenous variables (see Figure 5.5).

The model can explain around 42 percent and 51 percent of the variation in the respondents' intention and adoption behaviour, respectively (see Figure 5.5). The measures of model goodness-fit also show an acceptable level. Its ratio between discrepancy and degrees of freedom (Chi-square/df) is 1.627, which shows a good model fit (less than 2, Garson, 1998b). Two other measures of model goodness-fit are also within the acceptable level. The Tucker-Lewis Index (TLI) is 0.971, while the requirement is $\geq$ 0.95 (Statistical Support, 2001). The value of the Root Mean Square Error of Approximation (RMSEA) is 0.070 with a mean interval between 0.060 and 0.079, all of which fall within the acceptable level ($\leq$ 0.08 as adequate according to Garson, 1998b). A narrow interval may also indicate higher model accuracy (MacCallum, Browne, & Sugawara, 1996).

The analysis also involved the identification of alternative models besides the one described. Two alternative models appeared to show an acceptable level of model goodness-fit measures. The existence of these alternative models may be considered normal as a case may be analyzed from different approaches involving a different set of variables and links (Hair et al., 2006; MacCallum, 1995). For example, in the first alternative model, fewer questions were used for measuring the external and internal factors related to the respondents' behavioural control compared to the current model. This aimed at improving the reliability of the measurements, as **extern** and **intern** in the current model have a low Cronbach's Alpha (see Table 5.3). The result showed the Cronbach's alpha values for **extern** and **intern** were close to the acceptable level. The second alternative model also used fewer questions to measure **extern** and **intern**, and introduced **Pro8** (problems related to human capital) and **Pro7** (problems related to household financial conditions) to replace, respectively, **HH** (family size) and **OC** (percentage of own capital) in the current model. The replacements were based on an assumption that the farmers' current problems may have a great impact on their perceptions of control. This alternative model also introduced **Pro4** (problems related to soil conditions), as empirically this problem is relevant for this case study. The results showed an improvement in explaining the links between the respondents' objective, intention and behavioural beliefs. Nevertheless, the comparison between the three models showed that the current model in Figure 5.5 appears to have the best model fit measures, and structure to meet the assumptions made for this case study.

The SEM model in Figure 5.5 was also examined in terms of its compliance to the structural equation modelling (SEM) assumptions in order to confirm its robustness. According to Hu and Bentler (1995), violations to the SEM assumptions, such as inadequate sample sizes and the lack of normal data distribution, may reduce the reliability of the model goodness-of-fit index.

In general, the SEM model has met the SEM assumptions, especially related to independent observations, the random process of sample selection, and the linearity of interrelationships among the variables. The model may also contain a valid specification as theoretically it uses the TPB framework, and as empirically the background variables were selected based on responses from different interview methods. Nevertheless, this model may violate the normality assumption since its multivariate normality test showed a Mardia's coefficient value (West, Finch, & Curran, 1995) of 69.875, indicating a deviation from the normal distribution (significant non-normality has a test result value of $> \pm 1.96$). Hair et al. (2006), Kline (2005), and West et al. (1995) assert that an acute non-normal data distribution may overly reject the true model and exaggerate the chi-square goodness-of-fit test.

A univariate normality test was also run for individual background variables using SPSS. The test produced skewness and kurtosis values, as well as Kolmogorov-Smirnov statistics (Table 5.6). The results showed that all of the background variables have some degree of non-normal data distribution (all Kolmogorov-Smirnov statistics have a significant level lower than 0.000). The skewness measures of **a0405** has gone beyond the tolerance level (skewness = 2, kurtosis = 7, cited from West et al., 1995), while **Y3** and **Pro3** have an acute non-normality problem (skewness >3, kurtosis >21, West et al., 1995).

Table 5.6 Univariate normality test results

Variables	Skewness	Kurtosis	Kolmogorov-Smirnov		
			Statistic	df	Sig.*
Intr	0.130	-0.776	0.279	130	0.000
a0405	2.451	5.447	0.498	130	0.000
Act	0.192	-1.074	0.237	130	0.000
Crop	-0.343	0.572	0.334	130	0.000
Obj	1.707	2.045	0.447	130	0.000
DM	0.227	-1.043	0.282	130	0.000
HH	0.831	1.032	0.186	130	0.000
OC	-1.817	1.783	0.459	130	0.000
Y3	3.209	14.737	0.197	130	0.000
Diss	0.380	-1.885	0.388	130	0.000
Pro1	-0.540	-1.121	0.259	130	0.000
Pro2	-0.219	-1.710	0.300	130	0.000
Pro3	-4.486	19.155	0.535	130	0.000
Ten	0.251	-1.934	0.361	130	0.000
SO1	-1.592	1.263	0.355	130	0.000
SO2	1.072	-0.601	0.417	130	0.000
SO5	-1.864	4.380	0.388	130	0.000

*Lilliefors Significance Correction

Non-normal data distribution, however, is inevitable in the case of behavioural studies as the responses are often varied or inconsistent. The procedures for behavioural measurement also involve ordinal or dichotomous scales, which according to Garson (1998b) may cause the absence of multivariate normality. This occurs in the case of the TPB variables and some background variables. Non-normal data distribution may also stem from the presence of outliers, which may result from the respondents' failure to answer the questions properly, or the respondents' characteristics or practices that are far different from the average respondents (West et al., 1995). A visual check on the histograms of **a0405**, **Y3** and **Pro3** indicates extreme outliers.

One solution to this problem is to eliminate the outliers. However, the troubled variables contain scaled responses—except **Y3**—and, hence, skewed data distribution is again inevitable. For example, when most respondents answered that they will not apply "pandu" in the future (**act** = 0), some answered "conditional" (**act** = 1), and only less than five respondents are planning to continue applying "pandu" (**act** = 2). This resulted in skewed responses. Deleting the sources of the outliers (e.g. removing some respondents), in this case, will bring a risk of losing important responses. This may also have an impact on the non/less-skewed variables, and the overall solutions.

Another possible solution is to increase the sample size, use different estimation methods, or use different model fit measures (see Garson, 1998b; and West et al., 1995). Some experts have set out rules of thumb concerning the adequate sample size for SEM (see Garson, 1998b; Hair et al., 2006; West et al., 1995); although, many others also argue that the sample size requirement is likely to be determined based on the case studied and the estimation method. For example, Hair et al. (2006) assert that if a SEM is based on the maximum likelihood estimation (MLE), a sample size between 100 and 150 can be considered appropriate. However, if non-normality exists, the ratio between the sample size and the number of measured variables should be increased at least to 15:1. Hair et al. (2006) add that a more complex model usually requires a larger sample size.

The ratio between the sample size and the number of measured variables in the SEM model in this study is around 4:1; hence, the model may need simplification or a greater sample size. However, increasing the sample size in this study was not practical due to resource and time limitations. The same reason also applies to the alternative solution of using estimation methods other than MLE (AMOS is based on MLE). The recommended methods, such as "*asymptotically distribution free*" (ADF) and "SCALED χ^2 *Static and Robust Standard Errors*", usually require a certain range of sample size in order to be effective in dealing with multivariate non-normality (see West et al., 1995, pp. 64-70). This requirement cannot be fulfilled in this study.

The absence of multivariate non-normality, however, may not prevent the model producing accurate estimates (Kline, 2005), and the model may still be "*unbiased and efficient*" (Garson, 1998b). However, Garson (1998b) asserts that the trade-off of such model remains in the form of inflated chi-square or a bias due to "*Type I error (rejecting a model which should not be rejected)*". The acceptance of the model also depends on whether the model had normally distributed residuals that are independent, as well as have zero means and constant variance (Garson, 1998b). From the AMOS results, it was confirmed that the model had zero mean residual. Since most of the variance is explained in the model (R^2 for **Actual** of 0.51), it can be assumed that the model also has a constant variance. Nevertheless, the residual covariance matrix from AMOS shows that **OC** has interdependent residuals.

From the discussions above, a strategy to mitigate the impact of non-normal data distribution in this study may involve the reduction in the number of measured variables. **Y3** and **OC**, for example, may be considered for deletion/modification based on the univariate normality test and the residual matrix respectively. However, the deletion/modification may have an impact not only on statistical measures, but also on the theoretical and empirical aspects, which in this case are quite important. The final solutions, thus, include keeping **Y3** and **OC** as they are relevant for the respondents' situation and using different measures of model goodness-of-fit, such as chi-square/df, RMSEA and TLI, which can be applied for any multivariate analyses using different sample sizes. The complete interpretation of the SEM results will be presented in Chapter Six.

5.4.2. Data Processing for RepGrid Interview Results

The results of the repertory grid interview seem to disprove the concern that the repertory grid interview may be too complex for farmers in developing countries (see Sjah, 1998). The choice of having a paper-based repertory grid interview, a careful screening process of the elements and the use of a "practice" interview may have been the key to the success in conducting the repertory grid interview in this research.

Each repertory grid interview explored an individual farmer's reasoning when making a decision whether to adopt the improved paddy-prawn intercropping system ("pandu"). Farmers' responses were transferred into, and analyzed using, the RepGrid part of the Rep IV software that was developed by Mildred Shaw (Gaines & Shaw, 2004) based on George Kelly's Personal Construct Psychology (1955). Shaw (1980, p. 15) asserted that a grid "*can map out not only an individual's personal space to assist him in looking at his own perceptual and conceptual styles, but it can also help map out shared space and enable him to relate to his individual perceptions to the styles of communication of others*".

The data processing involved the following steps:

a) all elements confirmed by a respondent were manually entered to the 'elements pane' in the 'Grid' part of the RepGrid window (Figure 5.6, next page);
b) all constructs mentioned by a respondent and the associated values/ratings were manually entered to 'the constructs pane' in the 'Grid' part of the RepGrid window (Figure 5.7, next page); and
c) these responses then were analyzed using FOCUS, PrinCom and SocioGrids functions.

The minimum requirement for conducting FOCUS and PrinCom analyses is that the respondent should at least elicit two constructs. Based on this criterion, there are 124 respondents eligible for construct and element analyses related to their attitudes toward "pandu" application. Fewer respondents, however, are eligible for construct and element analyses related to their perceived behavioural control and bargaining process, which are respectively 77 and 104 respondents (Table 5.7, page 140).

These different responses might relate to the respondents' preference for evaluating the possible outcomes of "pandu" from different aspects, although they seemed to be very specific in identifying their supporting and impeding factors and their partners in decision making. The lower eligible responses for the PBC might also indicate the roles of incentives and technical assistance in the "pandu" program in improving the

Figure 5.6 Element pane in the grid part of the Rep IV software

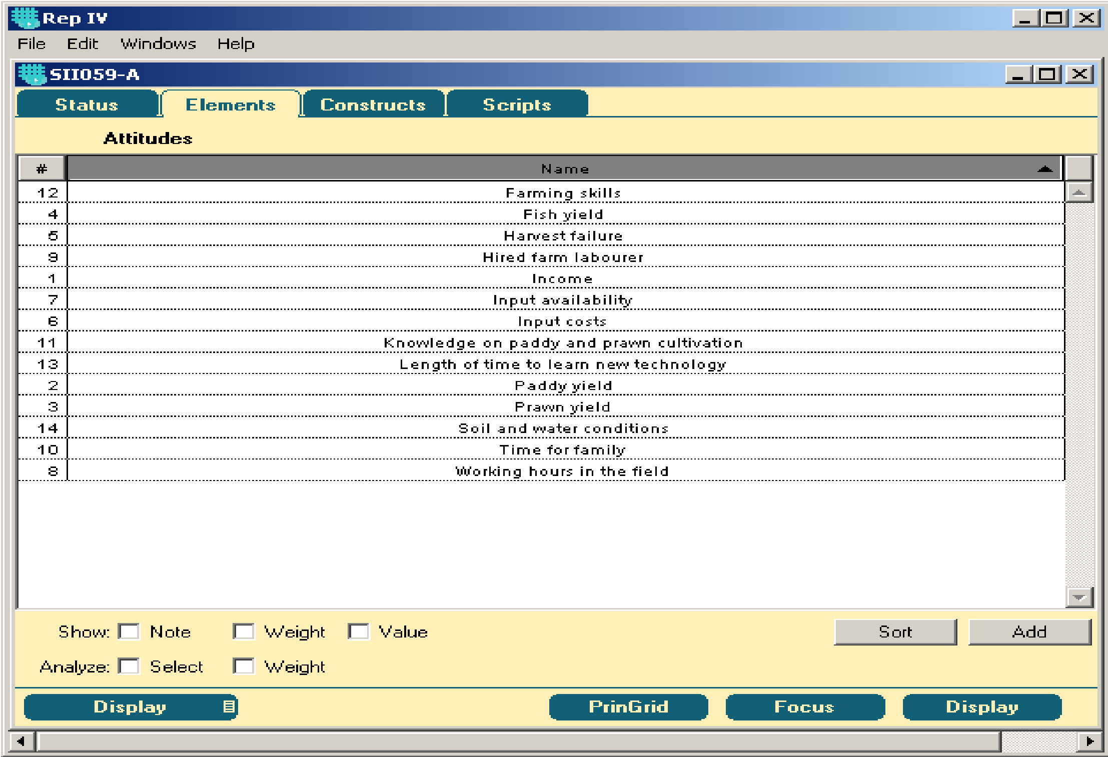


Figure 5.7 Constructs pane in the grid part of the Rep IV software

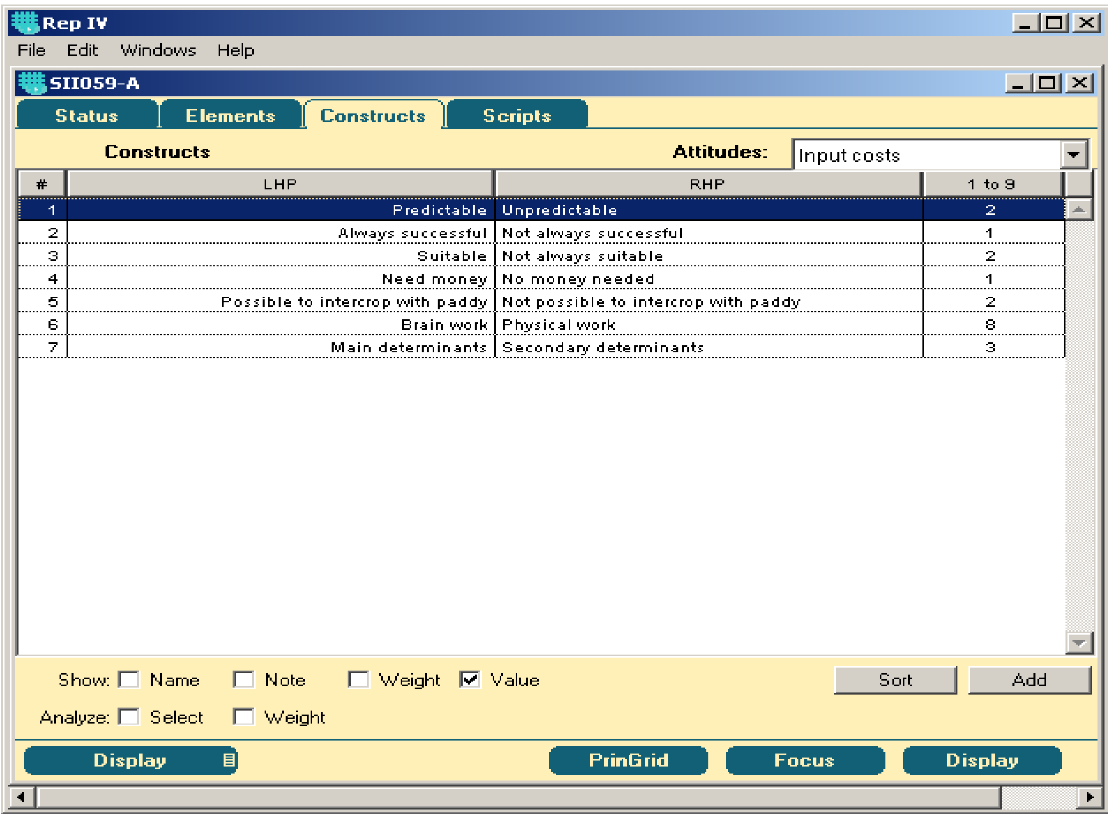


Table 5.7 Farmers' responses to the repertory grid interview

	Sugihwaras village			Rejosari village		
	Attitudes	PBC	Bargaining process	Attitudes	PBC	Bargaining process
Number of respondents	59	59	59	71	71	71
Number of eligible responses	54	39	43	70	38	61
Percentage of eligible responses (%)	91.5	54.9	72.9	98.6	64.4	85.9
Average number of elements confirmed	12	5	6	13	7	6
Average number of constructs elicited	3	2	2	3	2	2

respondents' perceptions of control over supporting and impeding factors. This led the respondents to deselect the relevant PBC related elements, and reduced the number of eligible responses.

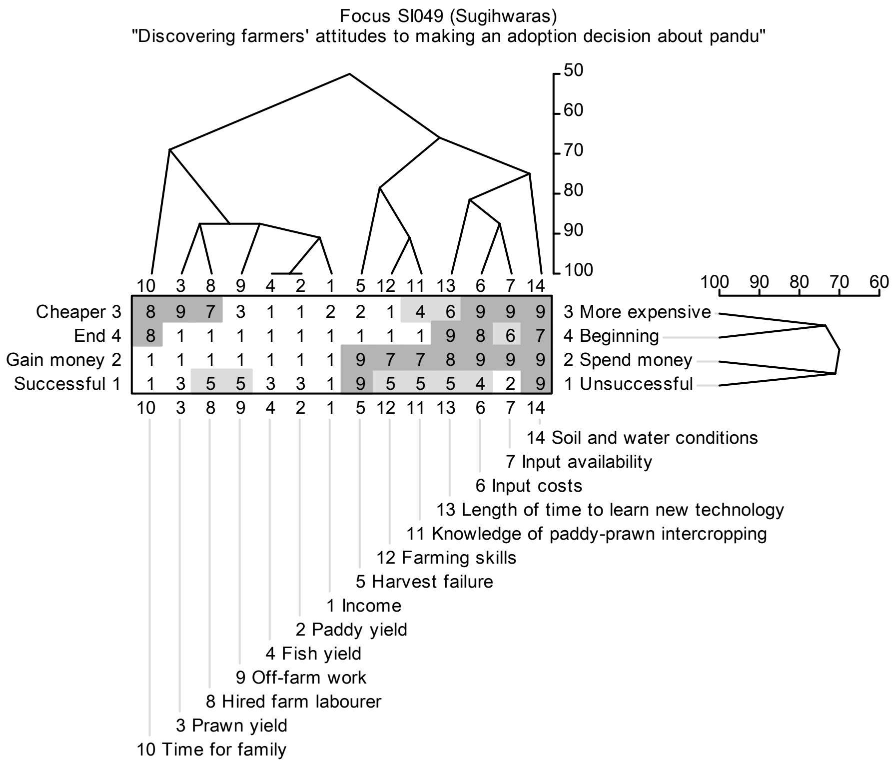
Some responses also appeared to be ineligible because the respondents elicited too few constructs for a set of elements, or completely deselected one set of elements. This meant the FOCUS and PrinCom analyses failed. The low number of constructs elicited, however, might also indicate the respondents' application of simple approaches when considering their decision criteria. The list of all constructs elicited for the available elements can be viewed in Appendix E.

5.4.2.1 FOCUS

The FOCUS function analyzes a grid based on "*a two-way cluster analytic technique*" (Shaw, 1980, p. 26) that hierarchically sorts the elements (decision variables) and the constructs (reasoning) and defines the relationships between the elements and the associated constructs. The result is a two-dimensional plot, in which all of the confirmed elements are presented in a vertical direction and the constructs are displayed in a horizontal direction, with all the ratings (Figure 5.8). The clustering of the elements appears as an element tree at the top of the graph, while a construct tree on the right hand side shows the construct clustering. The contrasting terms of the constructs are presented on the left and right hand sides of the plot, while the element terms are displayed at the bottom of the plot.

The example in Figure 5.8 shows a FOCUS analysis result from respondent SI049 who confirmed 14 elements and elicited four pairs of terms or constructs. The interpretation of the graphic plot follows the procedures in Shaw (1980). It starts by explaining the element and construct trees to determine hierarchical relationships among the elements and constructs respectively. For example, respondent SI049 appeared to have two clusters of elements; each was formed through a combination of smaller clusters (Figure 5.8). The first element cluster may be termed "*yield and income*", and it contains two smaller clusters: "*main source of income*" and "*secondary source of income*", and an independent element (time for family). Between 87.5-100 percent of the "*main source of income*" are related to the elements of "fish yield", "paddy yield", "income" and "off-farm work", while 87.5 percent of "*secondary source of income*" comes from "prawn yield" and "hired farm labourer" (see Table 5.8). These are relevant to respondent SI049's explanations in that besides growing paddy and fish, he also operated a motorcycle taxi service. He had also been working as a farm labourer during the harvest period, and tried "pandu" once.

Figure 5.8 FOCUS (cluster) analysis result



The second main cluster may be named "*farming requirements*" and it is composed of two smaller clusters: "*knowledge and skills*" and "*expenses for obtaining inputs and dealing with soil and water requirements*". The element of "skills" is 90.6 percent matched with "knowledge about paddy-prawn intercropping" and, together with "harvest failure" (matched 78.1%), they form the "*knowledge and skills*" cluster (Table 5.8). The last element may suggest the link between the lack of knowledge and skills and the respondent's discontinuation of "pandu". Another cluster called "*expenses for obtaining inputs and dealing with soil and water requirements*" is related to the elements of "input costs", "input availability", "length of time to learn new technology" and "soil and water conditions" (75-87.5 percent matched). Overall, when evaluating the feasibility of "pandu", respondent SI049 seemed to be concerned about the aspects of income, knowledge, and expenses.

Table 5.8 Element and construct matches of respondent SI049

Element links			Element number & names		Construct number & names	
Element		%				
			1	Income	1	Unsuccessful-Successful
2	4	100.0	2	Paddy yield	2	Gain money-Spend money
1	2	90.6	3	Prawn yield	3	Cheaper-More expensive
11	12	87.5	4	Fish yield	4	End-Beginning
3	8	87.5	5	Harvest failure		
4	9	87.5	6	Input costs		
6	7	87.5	7	Input availability		
8	9	87.5	8	Hired farm labourer		
6	13	81.2	9	Off-farm work		
5	12	78.1	10	Time for family		
7	14	75.0	11	Knowledge of paddy-prawn intercropping		
3	10	68.8	12	Farming skills		
11	13	65.6	13	Length of time to learn new technology		
			14	Soil and water conditions		

Construct links		
Construct		%
3	4	73.2
2	1R	70.5
2	4	69.6

Figure 5.8 also shows that respondent SI049 has two groups of constructs. The first construct cluster consists of "*cheap-expensive*" and "*end-beginning*", which may indicate the respondent's "*perception of prices*". The two pairs of constructs are 73.2 percent matched. The second construct cluster consists of "*gain money-spend money*" and "*successful-unsuccessful*" with 70.5 percent matched. The two pairs of constructs may represent the respondent's "*perception on outcomes*". The pole names and the ratings for construct #1 (unsuccessful-successful) are reversed automatically by FOCUS in order to achieve the highest match with another construct (see Table 5.8).

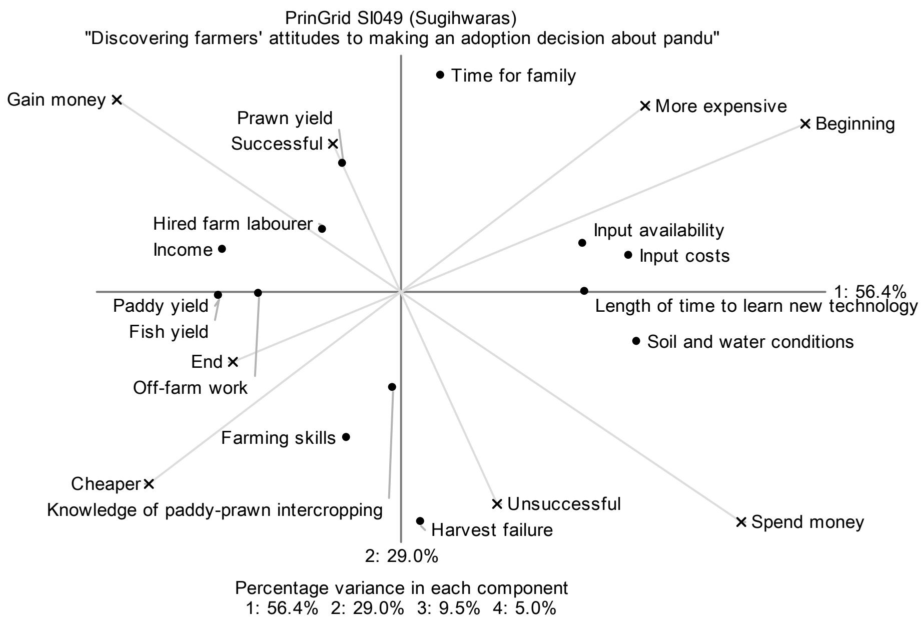
The names of the construct clusters become clearer when the interpretation combines the elements and constructs. This is shown by different shades inside the box that indicate the top and bottom three ratings for a particular construct, and determine which elements are commonly used for a particular construct. Thus, although some elements are related, they may not be grouped together for some constructs. For example, elements #11 and #12 (knowledge of paddy-prawn intercropping, and farming skills) are grouped together, but their ratings differ (shown by different shades) in construct #3 (cheaper-more expensive). Thus, construct #3 is only used when the respondent is thinking about an element group called "*farm resources*", containing elements #3, 6, 7, 8, 10, 14, and possibly 11 and 13, but not element #12.

The shades may also suggest a general term for the combination of elements and constructs. For example, based on the shades, respondent SI049 seemed to have two major construct clusters related to "*high expenses and low revenue*" and "*effects of soil and water conditions on outcomes*". These clusters might exhibit the farmer's most practical and frequently used set of considerations (heuristics or rules of thumb) when making a decision about "pandu". Shaw (1980) refers to this as a representation of "*organization*" and "*range*" corollaries of the Personal Construct Theory, where it is explained how a person adapts her/himself prior to making a decision or taking an action by considering the most reasonable set of constructs. Thus, FOCUS may provide a deeper insight to the respondent's important and frequently used constructs.

5.4.2.2 PrinCom

According to Gaines and Shaw (2004), PrinCom treats the grid "*as if the elements were points plotted in an n-dimensional space defined by the constructs as axes centered on the means of the elements*" (pp. 7-6). The procedure involves a principal component analysis technique to plot the elements and constructs in a two-dimensional graph (see Figure 5.9, next page). Elements that are located close to each other may share the same construct(s), all indicating a possible decision criterion. Constructs that go in the same direction are positively correlated, and the longer their length the higher is their contribution to the corresponding component (Stevens, 2005; Young, 1999). The plot also shows what constructs are involved in the first principal component (horizontal axis) and in the second principal component (vertical axis). The percentage of variance for each component is displayed in the bottom part of the graph, with two variances for the first two components shown at the right end of the horizontal axis and at the bottom end of the vertical axis. The results may simply display the differences in the constructs and elements in two contrasting poles, but they also represent the general pattern of decision criteria (the most important combination of elements and constructs) used by an individual farmer.

Figure 5.9 PrinCom analysis result



Note: • = element, x = construct

The interpretation also follows Shaw's (1980) procedures, and it focuses on the elements and constructs with high loadings, or located close to each other in the graph (see Figure 5.9 and Table 5.9). Figure 5.9 shows that, for respondent SI049, the first component explained 56.4 percent of the variance, which seemed to be attributable to his perceptions of *the revenues and expenses*. The combination of elements and constructs in the first component may suggest that the respondent perceived the *inputs for "pandu" were expensive*, *particularly in early planting seasons*. He also seemed to spend a lot of money *learning how to deal with the soil and water requirements for* *"pandu"*, maybe through trial and error. He also perceived that the *paddy and fish production had not brought a higher income*.

Table 5.9 Factor loadings from PrinCom analysis, respondent SI049

Element loadings for each component				Element
1	2	3	4	
-1.43	0.35	0.47	0.23	1. Income
-1.47	-0.04	0.35	-0.16	2. Paddy yield
-0.47	1.02	-0.92	0.35	3. Prawn yield
-1.47	-0.04	0.35	-0.16	4. Fish yield
0.16	-1.85	-0.25	-0.12	5. Harvest failure
1.83	0.30	0.21	0.17	6. Input costs
1.46	0.39	0.23	0.77	7. Input availability
-0.64	0.51	-0.88	-0.10	8. Hired farm labourer
-1.14	-0.02	-0.24	-0.35	9. Off-farm work
0.32	1.73	0.40	-0.35	10.Time for family
-0.07	-0.78	-0.12	0.42	11. Knowledge of paddy-prawn intercropping
-0.45	-1.18	0.36	0.22	12. Farming skills
1.48	0.01	0.63	-0.44	13. Length of time to learn new technology
1.89	-0.42	-0.60	-0.50	14. Soil and water conditions

Construct loadings on each component				Construct
1	2	3	4	
-0.75	1.62	1.01	0.86	Unsuccessful-Successful
2.80	-1.89	0.34	0.62	Gain money-Spend money
2.23	1.70	-1.17	0.34	Cheaper-More expensive
2.55	1.07	0.93	-0.73	End-Beginning

The second component for respondent SI049 suggests *prawn yield and skills as the success factors for "pandu"*. Nevertheless, this component is less important than the first one as it represents only 29 percent of the variation among the elements and constructs. Both components account for 85.4 percent of total variance explained by the combination of elements and constructs.

5.4.2.3 <u>SocioGrids</u>

According to Gaines and Shaw (2004), SocioGrids contain various functions that include identifying shared constructs within a group of people (through Composite Grid and SocioNet), comparing the structure of constructs between two people (through Compare function), and identifying the most frequently used constructs (through ModeGrid). The analyses are based on a factor analysis. The detailed procedures of SocioGrid functions can be found in Gaines and Shaw (2004). In this study, the SocioGrids analyses focus only on the ModeGrid function and SocioNet. Other applications, such as Composite Grid and Compare, were not used because they became too complicated for a large sample size such as the one in this study.

One mandatory requirement for SocioGrids is that the names of elements and constructs for all respondents should be exactly standardized, using exactly the same names. This may unfortunately conceal the uniqueness of the respondents' constructs as even slightly different names may prevent the analysis from recognizing the similarities among the elements and the constructs. Thus, the construct names were standardized to add to the already standardized element names (see Appendix B). For example, a construct name of "fertilizer requirement" and "seed quality requirement" may be termed "input requirement". The standardization, however, was still expected to enable the identification of different groups among the respondents.

Table 5.10 Adopter and non-adopter groups

Respondent groups based on their responses towards "pandu"	Sugihwaras		Rejosari	
	#	%	#	%
Continued full adoption	3	5.08	0	0.00
Continued partial adoption	11	18.64	2	2.82
Incremental adoption (increasing trend of adoption)	0	0.00	1	1.41
Reduced practice from full to partial adoption	1	1.69	3	4.23
Discontinued from partial adoption	32	54.24	24	33.80
Discontinued from full adoption	1	1.69	15	21.13
Would never adopt	11	18.64	26	36.62

This study also focuses on identifying the shared constructs within a group of adopters/non-adopters. The identification of adopter and non-adopter groups is based on the background, TPB and semi-ethnographic interviews. The latter identified the level of "pandu" application in the year of introduction, which was classified as "not adopt", "partial/modified adoption" and "full adoption" (see Table 5.10). The "partial/modified adoption" category might represent the application of only some "pandu" components being influenced by impeding factors, or simply by the respondents' intuitive preference. For the respondents' recent farming system, it was identified through the background interview, supplemented by the TPB and semi-ethnographic interviews. In addition, the open-ended part in the TPB interview collected information about the respondents' current level of practice and their plan regarding "pandu" in the future.

The groups were determined by simply combining the adoption scores for the introduction year and recent years. For example, if a respondent applied only some of "pandu" components in the year of introduction (level of adoption = 1) and did not continue the application in recent years (level of adoption = 0), he was classified as among the adopters who discontinued partial adoption. Based on the combination of the scores (0 = not adopt, 1 = partial/modified adoption, and 2 = full adoption), there were 9 possible classification of adopters and non-adopters. However, no one among the respondents from both villages belonged to two groups: new adopters (partial) and new adopters (full).

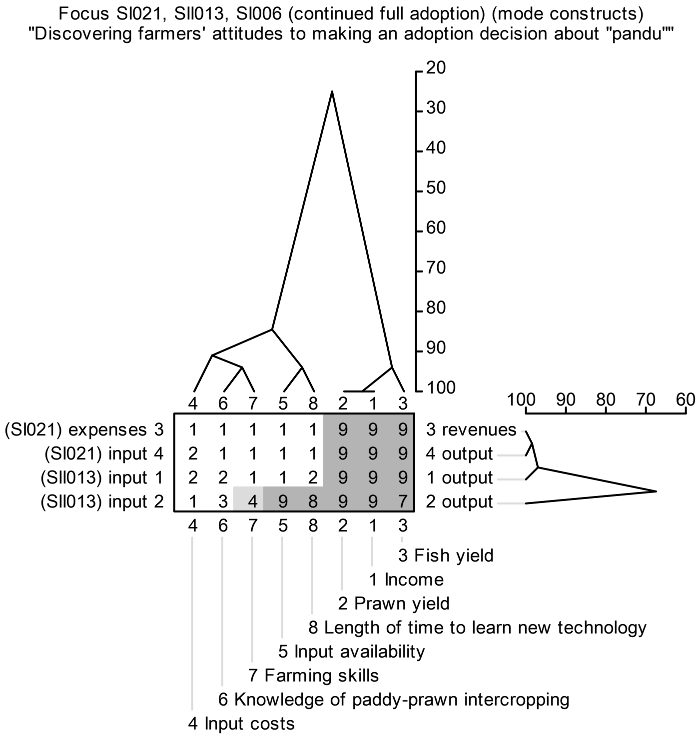
Using these grouping, the SocioGrids function combined all the information from a group of respondents based on the similarities in the elements, or constructs. The result was a composite/single representation that was further analyzed using FOCUS, PrinCom and SocioNets. Respondents who elicited less than two constructs were excluded from the analysis. These respondents could become the outliers that reduced the numbers of shared constructs or elements being identified, although the SocioGrids function does not require a minimum number of constructs to be elicited, as in the FOCUS and PrinCom functions. Supplementary information from the SocioNets function was also provided in order to show the link among the respondents based on their construct similarities.

Figure 5.10 (next page) presents an example of the results, showing the elements and constructs shared by the *continued full adoption* group in Sugihwaras. In the FOCUS and PrinCom, only two out of three respondents in the group were considered. The exclusion of respondent SI006 might indicate that this respondent shared the least commonality with the other two respondents in the group. There were also two identical constructs from respondent SII013 included in the analysis. Originally, these constructs were different as shown by different scoring/responses/shades (see Figure

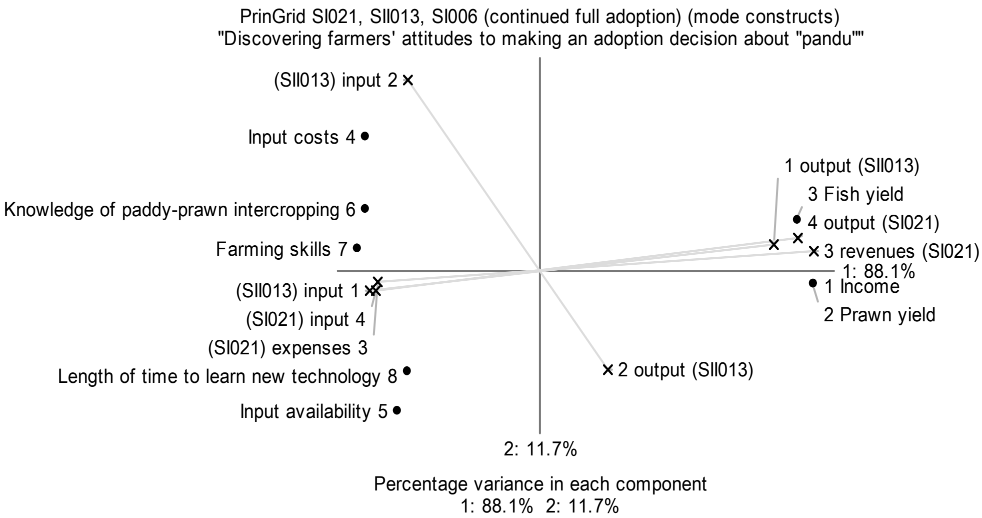
5.10 (a)). However, due to the construct standardization required by the SocioGrids analyses, these constructs were re-termed according to their shared characteristics.

Figure 5.10 An Example of FOCUS and PrinCom results for ModeGrid

(a) FOCUS results



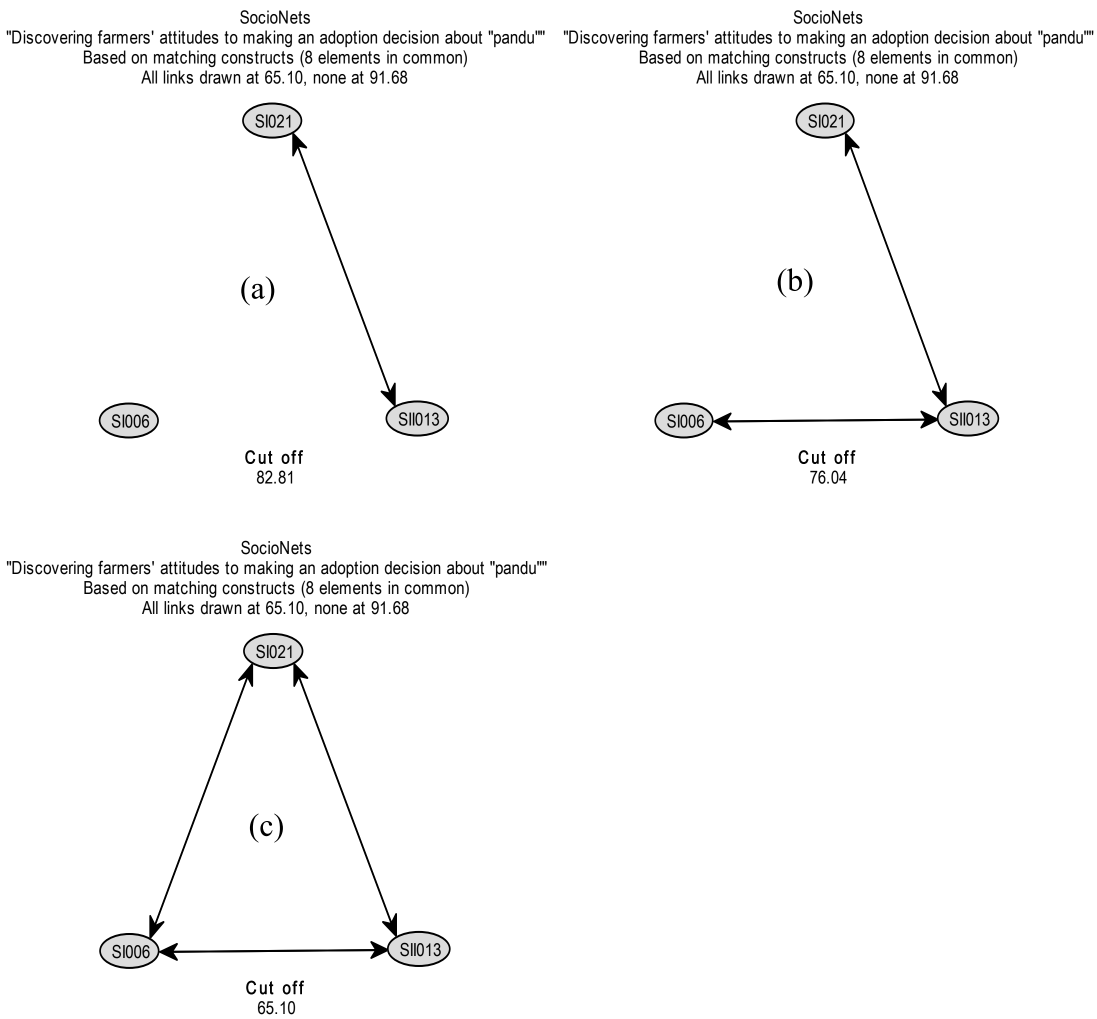
(b) PrinCom results



Note: • = element, x = construct

The FOCUS and PrinCom results in Figure 5.10 suggested that the three Sugihwaras respondents continued the full adoption of “pandu” because they shared the same perception that profit from prawn was higher than from fish. To some extent, they also considered the skills and knowledge required for applying “pandu”.

Figure 5.11 SocioNets for the *continued full adoption* group from Sugihwaras



The results from the example above were also supplemented by the SocioNets analysis which confirmed how respondent SI006 was different from the other two members of the group (Figure 5.11 (a)). All of them were involved in the dissemination of “pandu”, but respondent SI006 had only around 76 and 65 percent similarities in perceptions, respectively, with respondent SII013 (Figure 5.11 (b)) and with both SII013 and SI021 (Figure 5.11 (c)). This might be due to the shared construct (*expenses-revenues*), while the two other constructs were different (*stable-fluctuating* and *depend on money-not depend on money*). The last two constructs indicated that respondent SI006 seemed to be concerned about the uncertainties of costs. This issue, however, might not be important for respondent SII013 and SI021 because they were among the richest farmers in Sugihwaras. Overall, the SocioNets clarified that although these three respondents shared similar decisions regarding "pandu", the decisions appeared to be influenced by slightly different reasons.

Overall, the results of the SocioGrids analysis may provide explanations about the factors/constructs that have driven a group of people to behave/make decisions differently from other groups. Nevertheless, Shaw (1980) asserts that differences among a group's members may persist, as the mental process of each person may not completely add up to the group's action/decision. Thus, the results may only indicate the most frequent constructs used by a group of people that differentiate this group from other groups. The results may also confirm the structure of the decision making process for each of the adopter and non-adopter groups, which is identified through the semi-ethnographic analysis.

5.4.3. Data Processing for the Semi-Ethnographic Interview Results

Unlike the interviews based on the Theory of Planned Behaviour (TPB) and the Personal Construct Theory (PCT), the semi-ethnographic interviews did not have minimum requirements that should be met by the respondents in answering the questions. The semi-ethnographic interviews allowed the respondents to use their own terms in explaining their decisions regarding the improved paddy-prawn system ("pandu"). A list of leading questions, however, was still used in order to help extract the respondents' main decision criteria (see Section 5 of Appendix B). Hence, all responses from the semi-ethnographic interviews were eligible for the analysis.

LeCompte (1999, pp. 82-83) summarized several approaches that might be applicable for analyzing the results from an ethnographic interview. The consensus appears to include the following steps:

a) code and classify the responses into several key terms;

b) outline the association among a group of key terms in the form of patterns or paths;

c) justify the links between the key terms and the paths through some assumptions relevant to the case studied; and

d) explain the outcomes and the implications to the case studied and general application.

With some modifications, the above steps were applied in this study. The analysis began with summarizing and coding the responses to form a database of key terms that may represent the respondents' decision criteria concerning "pandu". Some of the responses were also quantified; and the results were used in the TPB analysis (see Section 5.4.1 of this chapter).

Since each respondent appeared to elicit many terms, indicating a complex set of decision criteria, it was necessary to re-classify the key terms to produce the most relevant decision criteria for each respondent (Gladwin, 1989a, pp. 28-33). This was done by identifying the general themes of a group of decision criteria, and by choosing some key terms based on their specific reference in the respondents' explanations, indicating a particular decision option and/or a new direction of decision making path. For example, one participating farmer in Sugihwaras mentioned:

> *"I asked the farmer group, and re-thought again before deciding to apply pandu"*

Another participating farmer in the same village also explained:

> *"I was interested in Pandu because the development of prawn and paddy was better and tidy, and because of the financial incentives…"*

The first farmer suggested a decision criterion related to his effort in seeking more information (and assurance) despite being involved in the dissemination process. The second farmer indicated a financial motive underlying his interest on "pandu". Both terms might apply for the decision option of "try, or not try, pandu".

Other examples are:

> *Farmer 1: "I only allocated pandu for the smaller ricefield-pond because I did not have enough money."*
> *Farmer 2: "I tried (pandu) in a smaller plot because I was worried the trial would be unsuccessful…"*

These farmers participated in the dissemination process, and did not directly mention why they tried "pandu". Instead, they indicated that they directly applied "pandu", but faced constraints, i.e. lack of capital and observable result. These constraints could be classified as decision criteria which persisted despite the provision of financial incentives and demonstration plots.

The above examples are only partial and may indicate only one decision option. A more complete explanation usually indicates several key but different phases of decision making. This is shown by the explanation from one farmer in Rejosari:

> *"I was interested in applying pandu after hearing from the explanation (dissemination) that the results would be doubled. I could easily learn about, and apply, pandu because technical assistance was provided."*
> *"I did not use jajar legowo (the recommended paddy planting distance) because the farm labourers did not want to… although using planting distance, pests and diseases could be controlled easier; paddy clumps and yield increase…."*
> *"I do not apply pandu again because water supply is limited, and I did not know that water is plenty this year."*

From this particular farmer, at least four decision factors for three decision options could be identified. The yield from "pandu" and the technical assistance were the first two factors determining the farmer's intention to try "pandu" (first decision option). However, this farmer appeared to be a partial adopter, as the unfamiliarity of "jajar legowo" among local farm labourers had limited applying all the "pandu" recommendations (second decision option). The farmer also added that the limited water availability was the reason for quitting "pandu" (third decision option).

All decision criteria and the relevant decision options were then classified and summarized. This process resulted in nine groups of decision criteria and three possible decision options. The nine groups of decision criteria represented:

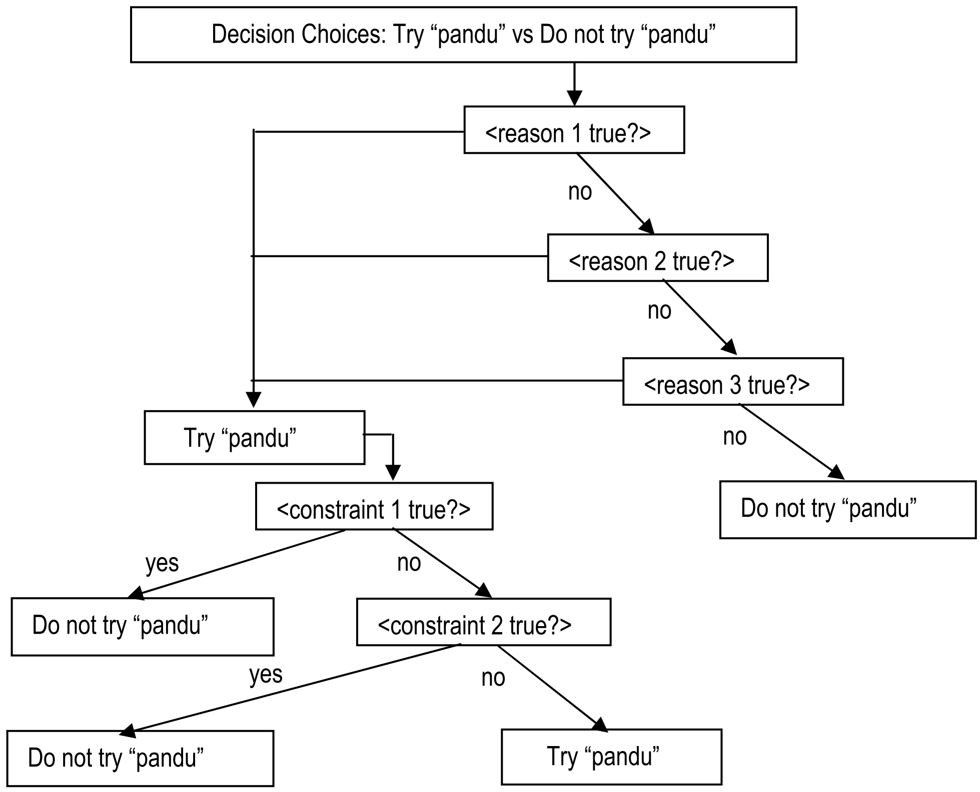
a) the respondents' belief in the potential of "pandu";
b) the respondents' efforts to seek information, either actively or passively;
c) the respondents' level of experience and reliance on their own practices;
d) the financial aspects related to "pandu", which included capital, land possession, costs, incentives, yield (including prawn survival rate), prices/marketing aspects, and "pandu's" contribution to the fulfilment of household needs;
e) the technical aspects related to "pandu"; this included the level of difficulty, workload, time availability to work on the farm, the provision of technical assistance, knowledge and skills, age/strength, and the local farm labour system;
f) suitability of "pandu" with the local agro-ecosystem; this included the suitability of paddy being intercropped with prawn, water quality and availability, soil conditions, level of pest and disease infestation, the effects of different cropping patterns among farmers, the feasibility of ricefields for "pandu", and commodity preference;
g) the level of "pandu" application: partial or full adoption;
h) the involvement and contribution of others in the respondents' decision making process; and
i) the respondents' general evaluation on "pandu".

These nine groups were then used for developing several decision trees. The construction of the decision trees followed the procedures set out by Gladwin (1989a, pp. 21-45), with some modifications. They are summarized as follows:

a) define the decision, and set the relevant assumptions;
b) apply the decision criteria (key terms) for each domain branch leading to different decision choices, followed by the next (underneath) branch(es). Each decision criterion serves as a decision constraint. Figure 5.12 provides an example of a decision tree development, although the structure may be different for different decisions and groups of farmers;
c) check the branches and the decision criteria involved for a logical decision making flow, and whether more branches (more constraints) are required before the final decision; and

d) test the aggregate decision tree to confirm the generalizability by involving a different group of respondents.

Figure 5.12 A direct approach to building an aggregate decision tree (modified from Figure 2.9 & 2.10, pp. 43-44, in Gladwin, 1989a)



In this study, no individual decision tree was developed. Instead, a group decision tree model was formulated directly using the decision criteria mentioned by each respondent. This was deemed to be time saving considering the large sample size and differences in the respondents' adoption process.

In each village, the respondents were divided into two groups: participating farmers and non-participating farmers. The grouping was important as these groups might have a different level of understanding about "pandu". The participating farmers were involved in the "pandu" dissemination process; while the non-participating farmers might only rely on indirect observation and information passed from their colleagues. The participating farmers also received financial incentives and technical assistance.

A few of the non-participating farmers who tried “pandu” during the introduction period might also receive technical assistance, but not the financial incentives.

The two groups might also experience a different adoption process. The participating farmers might have to make three consecutive decision options: (i) whether to try “pandu”, (ii) whether to apply all recommendations, and (iii) whether to continue adoption. The second decision might indicate that although the participating farmers had committed to apply “pandu”, they might face constraints causing them to have different degrees of adoption. These three decision options did not necessarily apply only for the introduction year, as they might also apply in the subsequent years depending upon the farmers’ situations.

For the non-participating farmers, their first decision choice included try, or not try, “pandu”. If they decided to try “pandu”, they had to decide whether to continue. Since most of the non-participating farmers did not receive complete information about “pandu”, they were assumed to rely on observations of others’ application of “pandu”. This increased the possibility of partial/modified application among these farmers if they had decided to try “pandu”. Hence, the “full/partial” decision option was excluded.

The recognition of consecutive decision options enables the analysis to look deeper into the respondents’ adoption process, which covers not only the adoption decision, but also the modification and continuation choices. This is believed to portray the respondents’ real decision making process better. In addition, the decision grouping has simplified the procedures for developing the aggregate decision tree models, which Gladwin (1989a) and Murray-Prior (1998) referred to as time consuming and complicated.

Using the two farmer groups, nine groups of decision criteria and some decision choices, 12 decision trees were developed. Each decision tree contained decision criteria that served as constraints in the decision path. Most decision criteria used were the ones leading to a decision. Hence, each respondent had to go through every decision path and pass each criterion (constraint). Some respondents had to stop when facing a particular constraint. This indicated the factor that led the respondents to their final decisions. Other respondents continued passing through several constraints and then stopped. This showed that more decision criteria were involved in the decision making process. Some decision criteria might also be applicable for more than one decision tree, but these criteria were carefully selected in order to assure their relevancy.

After all decisions were identified, they were compared to the respondents' answers to the open-ended part of the TPB questionnaires (see Section 7, Appendix B), which contained questions directly asking the respondents about their "pandu" application. All matched responses were counted giving a percentage showing the level of correct representation of the respondents' actual behaviour in the decision tree model. These procedures represented the internal validation for the decision tree.

Some decision trees were also validated using a different group of samples to determine the generalizability of the decision tree models. The test involved 30 farmers from Sidobinangun village, the neighbouring village of both Sugihwaras and Rejosari. The test did not use the decision trees; instead, it employed an interview with 183 questions based on the key terms mentioned by the respondents from Sugihwaras and Rejosari (see Appendix H). From the 183 questions, only responses similar to the nine groups of decision criteria (see page 152) were used. The test procedures required the relevant responses from the test group to go through each path in the decision tree. Some respondents stopped when facing a particular constraint, while others continued until they passed through all decision criteria and came to the end-point of a decision branch. The number of respondents in every decision end-point was calculated, and this was checked against their answer related to their interest in applying "pandu". Every matched decision increased the decision tree's predictability power. The rule of thumb for a good decision tree model is if it can predict around 80-90 percent of individual choices (from various applications, see Fairweather, 1996; Gladwin, 1989a; Jangu, 1993; Murray-Prior, 1998). The validated decision tree models then can be used for explaining or predicting similar behaviour in different case studies.

The test, however, only involved decision trees that were related to the decision option of "*try or not try pandu*" because farmers from Sidobinangun had not been introduced to "pandu". The other decision options ("*partial or modify pandu*", and "*continue or discontinue pandu*"), thus, were not tested. Nevertheless, these decision trees could still enrich the description of the farmers' decision making processes. All decision trees for the two farmer groups in Sugihwaras and Rejosari are presented in Chapter Eight.

5.5. Limitations

One critical challenge for this study relates to the effect of "*ex-post facto hypothesizing*", which Babbie (2004, p. 436) defines as "*a hypothesis linking two variables after their relationship is already known*". Ohlmer et al. (1998) assert that "*ex-post rationalization*" is inevitable unless the study uses long-term observations. They are also uncertain whether providing the farmers, for example, with an introductory explanation before interviewing will reduce the effect. To address this issue, this study used different approaches to identify the structure of the farmers' decision making process. When the background interview revealed that most farmers considered the low sale price of prawn as the main reason for them not to apply "pandu", the results from the semi-ethnographic interview might suggest different reasons, because the latter method extracted all possible reasons behind the farmers' decision. The results may provide supplementary material for the analysis as well as confirm, or counter, findings from other approaches. Thus, different analytical approaches used in this study may annul or change the "*ex-post rationalization*".

Another issue is related to the sample size. Although the sample size is perceived adequate, better results may be achieved from a larger sample size. To increase the sample size, however, was not practical due to time and resource limitations. Lastly, the models resulted from the TPB analysis are quite complex, and may not be applicable for other cases. However, the models may be a realistic representation of the decision making structure of farmers in Sugihwaras and Rejosari concerning "pandu". The models may also be applicable for other groups of farmers in other parts of Indonesia.

Table 5.11 Methods and procedures of analysis

Procedures	Type of data	Contribution
Data collection		
Background interview	Demographic, agro-climatic, socioeconomic, institutional data	Provide a complete description of the farmers' background and their decision making context
TPB interview	Adoption-decision variables, the role of socio-cultural values	Collect information related to the farmers' attitudes toward new technology adoption, their perceptions of control, and the effect of socio-cultural norms
EDTM	Decision criteria and path used by adopters and non- adopters	Elicit farmers' decision criteria and decision paths; identify different adoption and non-adoption behaviours; and provide inputs for the TPB model
An interview based on PCT	Farmers' constructs	Reveal farmers' constructs or heuristics in adoption-decision making; and identify the most frequent constructs used by a group of adopters and non-adopters
Secondary data collection		Provide supporting information about the case studied
Data processing & analysis		
Descriptive statistics analysis	Demographic, agro-climatic and socioeconomic data	Provide descriptive statistics related to the farmers and location
Reliability test	Sum of indexes from the TPB interview	Measure the consistency of the total score of the indexes
Structural Equation Modelling	Covariance and correlation matrixes	Assess the extent of how attitudes, subjective norms and perceptions of control can influence intention and behaviour
Decision tree construction & testing	Farmers' qualitative responses to the ethnographic interview	Construct models from different decision criteria and different decision paths used by different farmers
Repertory Grid analysis	Indexes of the elements and constructs	Provide the basis for interpreting personal and social constructs, and the interrelationships between constructs and elements

5.6. Summary

This chapter has presented the location, the case technology to be considered, and the procedures for data collection and analysis. The analysis was based on a case study of the adoption-decision of an improved paddy-prawn system among farmers in Lamongan Regency, East Java Province of Indonesia. The data collection procedures include a background interview, a TPB interview, a semi-ethnographic interview, and an interview based on PCT. The questionnaires are presented in Appendix B. The results were examined using statistical analyses, structural equation models (SEMs) and repertory grid analyses. The interconnection between the analytical procedures was also outlined so that the results of each analysis might supplement or be used in other analyses. Strategies to deal with the limitations were also described and used. The summary of methods and procedures in this study is presented in Table 5.11.

CHAPTER SIX: FARMERS' CHARACTERISTICS AND PLANNED BEHAVIOUR

6.1. Introduction

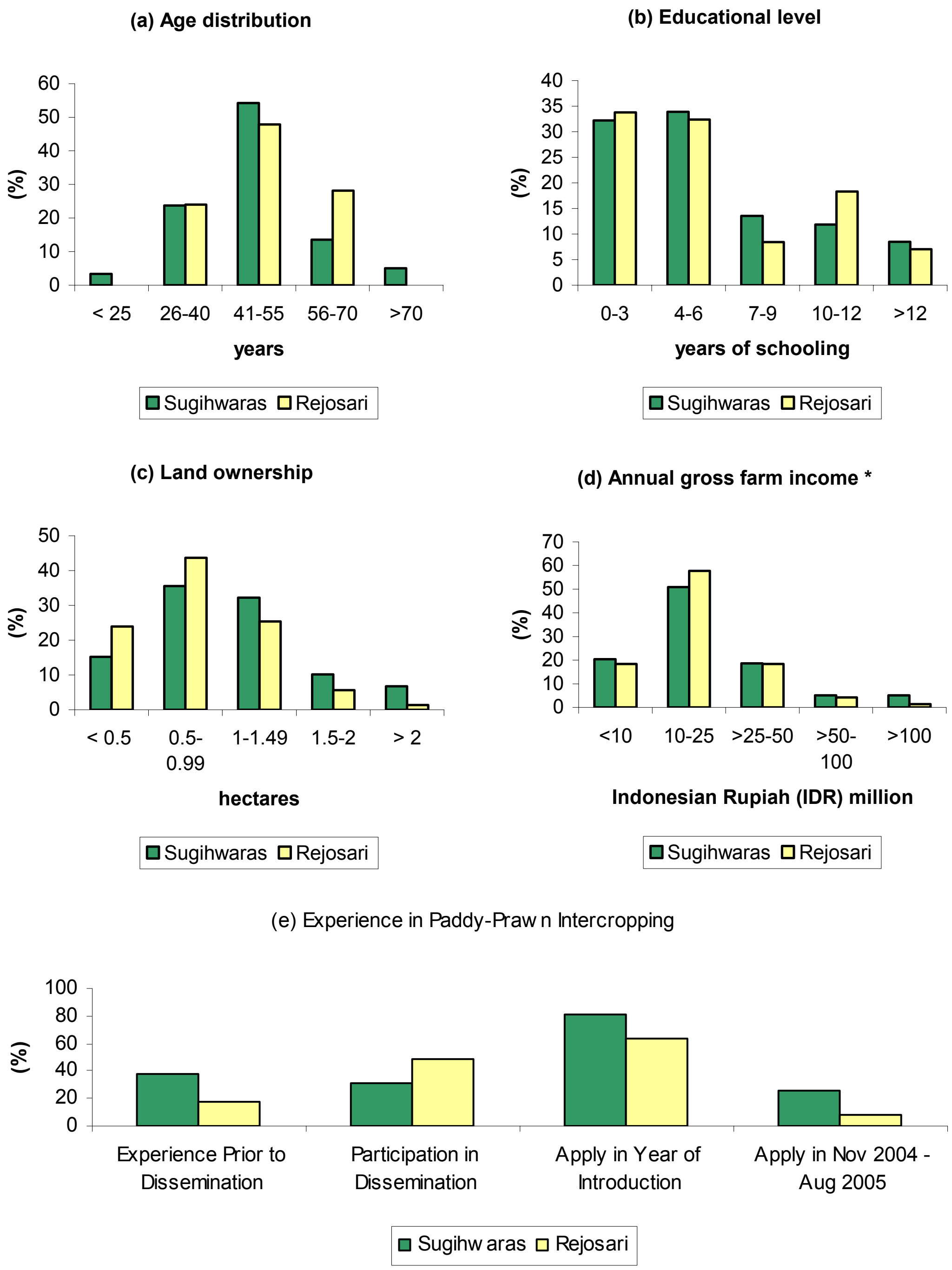
The results from the background and TPB interviews are presented and discussed in this chapter. The discussion starts with a section outlining the characteristics of the farmer respondents, with the respondents' socioeconomic conditions being highlighted. This will provide a general explanation about the farmers' personal and contextual aspects useful for assisting understanding their mental process described through the TPB model. Next, the results from the structural equation modelling are presented. This contains the discussion of a TPB model representing the structure of the farmers' perception, intention and adoption behaviour related to the case of an improved paddy-prawn intercropping system ("pandu"). Some possible modifications to the model are also discussed, together with the relevant statistical, theoretical and empirical justifications. Finally, the implications for the farmers, extension services and relevant parties are presented.

6.2. Characteristics of the Respondents

6.2.1. Socioeconomic Characteristics

The characteristics of the respondents are presented in Figure 6.1 and Appendix I. The majority of the respondents were between 41 and 55 years old, with an average of 48 years (Figure 6.1 (a)). The youngest respondent was 22 years old, while the oldest was 79 years old; both from Sugihwaras village. In terms of education, the average respondent had only 6 years of formal education; while only around 20 and 25 percent of the respondents, from Sugihwaras and Rejosari respectively, had at least a high school level of education. The level of education was not much different between the farmers and their spouse (see Table I.1 and I.3 in Appendix I). The average years of schooling of the farmers' children were between 10 to 12 years (high school level; see Table I.2 and I.4 in Appendix I).

Figure 6.1 Characteristics of the respondents



* The income figure did not include off-farm income.

While the average household size was around five persons, the number of family members working in the field was very limited, being restricted to just the head of the household. These farmers preferred not to borrow land, although most of them (around 51 and 68 percent of the respondents from Sugihwaras and Rejosari respectively) had only less than one hectare of ricefield-pond (Figure 6.1 (c)). Only one farmer from Rejosari produced paddy and milkfish in a rented ricefield-pond. The average land possession in Sugihwaras was larger (1.32 ha) than that of Rejosari (0.83 ha). A larger land area may create a need to borrow additional capital, and this may support why respondents from Sugihwaras (34 percent of total respondents) were more willing to borrow money compared to respondents from Rejosari (13 percent of total respondents).

Table 6.1 Annual cropping pattern in the studied locations

Season (months)	Sugihwaras	Rejosari
1st (November-January)	Milkfish-prawn, or milkfish-silver barb-carp	Milkfish-silver barb-carp
2nd (February-April)	Milkfish-prawn, or milkfish-silver barb-carp	Milkfish-silver barb-carp
3rd (May-August)	Paddy-prawn, paddy monoculture, or paddy-fish	Paddy-fish, or paddy monoculture
4th (September-October)	Fallow	Fallow

Based on the cropping pattern in 2004-2005, farmers from both villages were mostly engaged in multicropping (Table 6.1). The multicropping practice in Sugihwaras, however, was more diverse, mainly due to prawn cultivation.

There were also differences across farmers in the two villages concerning crop selection, productivity and marketing approaches. Rice, prawn and milkfish appeared to be the main products in Sugihwaras, whilst farmers in Rejosari mainly produced rice, milkfish and a large number of side commodities such as silver barb fish, common carp and vegetables (see Table I.1 and I.3 in Appendix I). For rice production in 2004-2005, the productivity in Rejosari was higher than in Sugihwaras (6.835 ton/ha compared to 5.698 ton/ha, respectively). The productivity in both villages, however, was higher than the average productivity in the East Java Province and the national level in 2005, which was 5.318 ton/ha and 4.574 ton/ha respectively (Statistics Indonesia, 2005a). In aquaculture, the annual production of prawn in Sugihwaras was around nine times higher than in Rejosari, whereas the annual production of milkfish in Rejosari was almost three times higher than in Sugihwaras (see Table I.1 and I.3 in Appendix I).

While most of the aquaculture products were sold through intermediaries, farmers kept most of the rice harvest for their own consumption and gradually sold the surplus to a local warehouse, intermediaries or local markets (see Table I.2 and I.4 in Appendix I). Respondents from Rejosari generally received a higher price for rice (14.7 percent higher) than respondents from Sugihwaras. This may suggest that farmers in Rejosari better timed their rice selling. Nevertheless, respondents in Sugihwaras could sell prawn, milkfish and other fish at higher prices (24.6 percent, 5.1 percent and 21.5 percent higher, respectively) than those of Rejosari. This may suggest that the quality of aquaculture products from Sugihwaras was better than that of Rejosari, perhaps because Sugihwaras is located closer to the source of water, which is the branch of the Bengawan Solo River.

Figure 6.1 (d) also shows that a large percentage of the respondents from both villages had an annual gross farm income less than IDR 25 million (USD 2,362[1]). The average was IDR 27.014 million and IDR 22.457 million (USD 2,844 and USD 2,364) for respondents from Sugihwaras and Rejosari, respectively. The income figure assumed that all paddy harvested was sold to the market. Nevertheless, the figure did not include income from off-farm and other on-farm productive activities, as well as the value of products (fish, vegetable, poultry, etc) consumed by the farm household. Around 51 and 38 percent of the respondents from Sugihwaras and Rejosari, respectively, had off-farm businesses such as a small shop at home (Sugihwaras) or a food stall/restaurant outside the village (Rejosari). In addition, around 24 and 89 percent of the respondents from Sugihwaras and Rejosari respectively grew vegetables to obtain cash for daily expenses and to provide vitamins for the family (see Table I.2 and I.4 in Appendix I).

With regard to farming experience, most respondents had more than 20 years of experience in paddy and milkfish cultivation. Regarding prawn culture, respondents from Sugihwaras appeared to be more experienced compared to their colleagues from Rejosari (see Appendix I). This is also evident in the case of paddy and prawn

[1] Exchange rate assumption: USD 1 = IDR 9,500 (IDR = Indonesian Rupiah)

intercropping experience. Around 37 percent of the respondents from Sugihwaras had intercropped paddy-prawn prior to the dissemination of “pandu”, while only 17 percent of the respondents from Rejosari had similar experience (Figure 6.1 (e)).

The spread of knowledge about “pandu” among farmers in Sugihwaras was more extensive than in Rejosari. Although the “pandu” dissemination process had involved only 17 of the 59 respondents in Sugihwaras (in mid 2004), 48 respondents (81 percent of the respondents) applied it in the subsequent seasons. In contrast, only 63 percent of the respondents in Rejosari (around 45 farmers) adopted “pandu” after the dissemination; an addition of 10 farmers to the original 35 farmers participated in the dissemination process in 2000. This difference might be because not all participating farmers in Rejosari had ricefield ponds suitable for prawn. They received milkfish fingerlings, instead of prawn post larva, as one of the incentives provided through the program. In addition, the introduction of “pandu” in Sugihwaras was more recent than in Rejosari and, hence, the respondents in Sugihwaras might still be motivated to try or continue “pandu”. Nevertheless, the number of adopters in both villages has been decreasing in recent years (Figure 6.1 (e)).

The respondents’ productivity and gross income in these two villages may not be related to the respondents’ experience. Table 6.2 shows that the Pearson correlation between the farmers’ experience in rice and milkfish cultivation and their income and production level is quite low. On the other hand, having some experience in prawn culture, and possibly in paddy-prawn intercropping, may contribute to the increase in productivity and income. This may confirm that paddy and milkfish are the traditional commodities in these two villages, while prawn has shown potential for bringing improvement. The Pearson correlation may also suggest the importance of having sufficient experience in prawn cultivation in order to be successful in applying “pandu”. This, however, may not be the sole justification, as experience may closely relate to the farmers’ capacity in seeking and processing information. This will be discussed next, but first, the farmers’ objectives and their farming prospects and problems will be highlighted.

Table 6.2 Pearson correlation between farmers' experience, income and production

Years of experience in growing	INC	Y1	Y2	Y3	Y4	S1	S2	S3	S4
Paddy	-0.09	-0.09	-0.02	-0.10	-0.10	-0.10	-0.02	-0.11	-0.10
Prawn	0.33**	0.20*	0.54**	-0.04	-0.24**	0.17	0.52**	-0.03	-0.19*
Milkfish	0.00	-0.05	0.01	0.01	0.01	-0.05	0.02	0.00	0.00
Paddy-prawn	0.18*	0.11	0.24**	0.06	-0.02	0.10	0.21*	0.11	-0.02

Note: INC = monthly gross income, Y1 = paddy yield, Y2 = prawn yield, Y3 = milkfish yield, Y4 = other fish yield, S1 = cash received from paddy, S2 = cash received from prawn, S3 = cash received from milkfish, S4 = cash received from other fish; ** Significant at the 0.01 level (2-tailed); * significant at the 0.05 level (2-tailed)

6.2.2. Farmers' Objectives and Perceptions of Problems and Future Prospects

Around 62.7 percent of the respondents in Sugihwaras and 78.9 percent of the respondents in Rejosari mentioned better earnings as their main objective in farming (see Table I.2 and I.4 in Appendix I). However, 21 farmers from Sugihwaras (35.6 percent) and 7 farmers (9.9 percent) from Rejosari indicated multiple farming objectives. For example, some respondents from Sugihwaras also perceived that better income could help them afford their children's education (16.9 percent), as well as meet their daily household needs (10.2 percent). Other objectives included increasing experience, contributing to the local economy, increasing production, as a hobby, and as an asset for worship. Few respondents from Rejosari, on the other hand, mentioned achieving higher yields (8.5 percent), gaining more income for supporting household expenses (4.2 percent), and sending their children to school (2.8 percent) as their main objectives in farming. Some farmers also mentioned the goals of contributing to the local economy, going for a pilgrimage, increasing experience, saving money, and renovating the house.

Overall, the economic objectives seem to be the main reasons for the respondents to stay on the farm. This, to some extent, supports an economic point of view, which often assumes farmers pursue economic benefits in which they treat their farm as an enterprise with the sole goal of maximizing profits, either through achieving higher productivity and/or returns. Such economic assumptions, however, are not always be factual as some respondents in this study had multiple goals involving non-economic goals. Previous studies, e.g. Aromolaran and Olayemi (2000) and Solano, Leon, Perez, and Herrero (2001a), also showed that despite the major role of economic motivation, farmers in general have multiple objectives, with the economic ones as a means to pursue other (economic and non-economic) goals, or vice versa. Multiple objectives may also indicate the respondents' different approaches in dealing with their situations (Aromolaran & Olayemi, 2000).

Current problems and past performance, for example, are among farming contexts that may accentuate the farmers' perceptions and objectives. In this study, the most common problems cited by the respondents in Sugihwaras appear to relate to pests and diseases (72.9 percent), water supply and irrigation (49.2 percent), prawn sale price (16.9 percent), soil conditions (15.3 percent), and prawn growth and mortality (15.3 percent). On the other hand, only water supply and irrigation (57.7 percent), as well as pests and diseases (43.7 percent) were among the frequent problems faced by respondents in Rejosari. Among the respondents in Sugihwaras with pest and disease problems, most perceived the problems as "becoming serious"; while the respondents in Rejosari perceived the opposite (trivial, see Table I.2 and I.4 in Appendix I). For the water supply issue, most respondents in Sugihwaras and Rejosari perceived it as "serious" (20.3 percent) and "quite serious" (28.2 percent), respectively. The intensity of other problems, however, was perceived as being minor.

These findings, to some extent, are quite contradictory to the general opinion shared by most respondents in both villages. For example, the respondents in Rejosari believed that a low prawn price was the biggest disincentive for applying, or continuing, "pandu". However, when the respondents were asked to rank the intensity of their problems, only three respondents in Rejosari indicated the prawn price as a "quite serious" problem. Similar perceptions were obtained in the case of the most cited problems by the respondents, which were related to water supply, pests and diseases. These problems were considered less significant.

Regardless of the intensity, the problems faced by the respondents may have had an impact on farm performance. This could be crucial as the respondents are likely to set their expectations and goals based on previous conditions and performance. This may relate to the respondents' perceptions of yields, prices and costs.

In this study, around 45.8 and 79.1 percent of the respondents from Sugihwaras and Rejosari, respectively, perceived that the trend of their paddy production had been increasing year on year (see Table I.2 and I.4 in Appendix I). The respondents also viewed a similar trend for the annual production of milkfish (41.4 and 73.2 percent in Sugihwaras and Rejosari, respectively). However, they perceived that the prawn yield had been either lower, or fluctuating, from year to year (60 and 61.1 percent in Sugihwaras and Rejosari, respectively). Only a few of them had an increasing prawn yield over the past years (30.9 and 22.2 percent in Sugihwaras and Rejosari, respectively).

Concerning prices, respondents from both villages experienced a similar pattern. Most perceived that the fertilizer and pesticide prices had been increasing; while the paddy seed price was either higher or unchanged (see Table I.2 and I.4 in Appendix I). The respondents perceived the impacts from these trends would be small, as long as they could get higher product prices. Nevertheless, this was not the case, especially for respondents who grew prawn.

The prawn price in both villages had been lower, or fluctuating, in the past years (69.1 and 72.2 percent in Sugihwaras and Rejosari, respectively). The respondents in both villages also experienced different trends of paddy and milkfish prices, with Sugihwaras respondents perceiving stable paddy and milkfish prices (61 and 34.5 percent, respectively) year on year. In contrast, Rejosari respondents could sell their paddy and milkfish at a higher price (62.7 and 42.3 percent, respectively).

Higher productivity and sale prices of paddy and milkfish resulted in the higher income, particularly for respondents from Rejosari, while the fluctuating prawn yield and price had led many respondents in Sugihwaras to a lower income. Around 83 percent of the respondents from Rejosari had experienced an increasing trend in annual income compared to only 48 percent of the respondents in Sugihwaras. The minor impact of prawn yield and price in Rejosari was due to fewer farmers in Rejosari who had grown prawn in the last three years. The Sugihwaras farmers described the causes as not only relating to the fluctuation of prawn yield, but also to an insufficient water supply. The latter problem, however, was difficult to understand since Sugihwaras is located close to the branch canal of the Bengawan Solo River. A possible explanation may relate to the low quality of the water as around 29 percent of the respondents in Sugihwaras had indicated a water quality problem. In contrast, only 4 percent of the Rejosari respondents had the same problem.

In summary, most respondents focused on achieving their economic goals. Some of them also had multiple objectives, with their non-economic ones closely attached to the economic ones. These objectives were achieved mainly through the contribution of paddy and milkfish production, while prawn production had been fluctuating with a trend of lower yields and prices. The latter conditions had led the respondents to assume the prawn price was the biggest impediment to growing prawn, although this was not widely confirmed. Instead, the availability of an alternative product (e.g. milkfish or other types of fish), which has a more stable production, might become the underlying factor for the respondents' decision to give up "pandu". This may simply represent the respondents' strategy to find the most practical and realistic way to achieve a higher income, their main motivation for farming. Such a strategy, however, is dependent on the way the respondents define their goals and decisions, which according to Ohlmer, Olson and Brehmer (1998), and Solano, Leon, Perez and Herrero (2003), relate to information seeking and processing. This can help farmers deal with their limited production capacity and resources, as well as their different working environment. The findings related to this topic are outlined next.

6.2.3. Farmers' Practices in Seeking and Processing Information

6.2.3.1 <u>Information seeking practices</u>

The interview revealed that most of the respondents relied only on memory (89 percent, see also Table I.2 and I.4 in Appendix I). The most commonly memorized information relates to yield, income, prices, costs and profit. Only 11 respondents in Sugihwaras (11.9 percent) and three respondents in Rejosari (4.2 percent) have ever kept production information in a farm record book. Not all, however, have continuously used the same system, or recorded the same information.

Although a memory-based recording system is common in developing countries (see IDS Workshop, 1989b), many (e.g. Biggs & Clay, 1980; Swift, 1979 cited in IDS Workshop, 1989b) argue that the system is unreliable and results in variations in decision making. Nevertheless, Ohlmer et al. (1998, p. 286) stated that farmers may not always rely on their memory for making decisions, because "*farmers continually update their problem perceptions, ideas of options, plans and expectations when new information is obtained*". Thus, farmers may have their own methods for keeping up with the changes in their internal and external settings. This may come in the form of farmers' information seeking and processing practices.

According to Errington (1986), farmers may access information from internal or external sources (e.g. family members or neighbouring farmers), verbal or written sources (e.g. discussion with extension officers or newspapers), or through direct observation. The information may come in the form of numbers, suggestions/ opinions, and experience. The importance of each source is mainly dependent on the decision to be made, the decision making phase, the characteristics of the farm/farm family/farmer, and decision making contexts (various studies summarized by Solano, Leon, Perez, & Herrero, 2001b; 2003).

In this study, the sources of information used by the respondents were traced using a list of possible information sources for the respondents to determine the intensity of usage, from 0 (never) to 4 (always). The list includes information sources related to farming techniques, loans, new technologies (new inputs and machinery), and product marketing (particularly market prices).

The results show that most respondents from Sugihwaras (78 percent) and Rejosari (80.3 percent) learned farming techniques from their family (see Table I.2 and I.4 in Appendix I). This may indicate knowledge has been passed through the generations. These respondents also appeared to exchange knowledge with their colleagues more often than with field extension workers (FEWs). Neighbouring farmers were also an important source of information about new inputs and machinery (in both villages). This was particularly evident for respondents from Rejosari (73.2 percent). This shows the importance of farmer-to-farmer technology transfer. In contrast, family members, village leaders, farmer group meetings, input retailers, and extension officers had a minor role in providing information about new inputs.

Similar findings have also been found in other studies. For example, Solano et al. (2003) found that Costa Rican dairy farmers generally obtained information for decision making from their family. Asfaw and Admassie (2004) also showed the importance of information sharing among a farm household's members in the case of chemical fertilizer adoption among smallholder farmers in Ethiopia. Some studies in developed countries (e.g. Blum, 1989; Ford & Babb, 1989; Henderson & Gomes, 1982; and Sutherland et al., 1996; all cited in Solano et al., 2003) also confirmed the importance of family as the source of information for seasonal planning as well as decision making related to financing and innovation. The studies by Ford and Babb, and Sutherland et al., also observed a central role of farmer colleagues as information sources for decision making. Other studies in developing countries also confirmed the influence of neighbours and village colleagues in farmers' decisions related to new technologies (e.g. Case, 1992; Munshi, 2004; Pomp & Burger, 1995; Zhang, Fan, & Cai, 2002). Learning from neighbours, or other farmers, in the village may be the only source of innovation for semi-subsistence farmers in developing countries who usually have limited resources, skills and access to information. This is relevant for the respondents in Sugihwaras and Rejosari who, to some extent, still have semi-subsistence characteristics.

Solano et al. (2003) also indicated the importance of extension services as the source of information for the Costa Rican dairy farmers. This was relevant especially for farmers who sought information about new techniques, and/or who became more business-oriented with an income-maximizing goal (Solano et al., 2006). However, the relative access to extension services seems to determine whether the extension services are an important information source for farmers. For example, Sulaiman (2002) found a significant role of field extension workers (FEWs), government agencies (Assessment Institute for Agricultural Technology, AIAT) and farmer group leaders as innovation sources for small-scale farmers in tidal swamp agro-ecosystem zones in South Sumatra Province of Indonesia. In contrast, the roles of the FEWs, researchers and farmer groups as a source of innovations for the respondents in this study appeared to be limited (12-37 percent).

The availability of extension services in Sugihwaras and Rejosari has been significantly decreasing for the last five years. Currently there are only two field extension workers (FEWs) available in the Deket District, and they have to assist farmers in 17 villages, including Sugihwaras and Rejosari. Both FEWs are specialized in food crops; no FEWs are available for dealing with aquaculture. This explains the infrequent interaction between the respondents and the FEWs. Among the respondents, the ones from Rejosari seemed to interact with extension officers more frequently compared to the respondents from Sugihwaras (see Table I.2 and I.4 in Appendix I). Nevertheless, most of the respondents seemed to be familiar with the extension activities, including field training and demonstration plots, individual meetings, and group meetings. The latter were facilitated by the farmer groups in each village.

In the absence of extension services, farmer groups usually take a leading role. However, the Sugihwaras respondents' farmer group (there are two farmer groups in Sugihwaras) seemed to be inactive as indicated by a high percentage of non-participation rates (57.6 percent). Similar conditions occurred in Rejosari, but the farmers in this village still meet annually, at the beginning of each planting season, to decide water allocation as well as the amount of seed and fertilizer collectively purchased. This has brought many benefits for the farmers in Rejosari especially in terms of farm planning, problem solving, as well as in obtaining new information, knowledge and skills (see Table I.4 in Appendix I). The respondents from Sugihwaras who participate in the farmer group also obtain similar benefits (see Table I.2 in Appendix I). Frequent absence from the village, mostly for off-farm jobs, is the main reason why respondents do not participate in a farmer group.

For farm credit, the respondents in both villages seemed to have limited access to credit information. Very few of them obtained information from banks and cooperative offices (see Table I.2 and I.4 in Appendix I). This may suggest the respondents faced barriers in accessing credit, or the existing financial institutions in both villages were operating less than optimally. Many respondents had obtained credit from a cooperative, but the scheme was abolished in 2000 due to mismanagement. The respondents from Sugihwaras seemed to use more diverse sources of credit information than the Rejosari respondents did.

The respondents' reliance on intermediaries for marketing their products also indicates that intermediaries were the most important source of market information (77 percent of respondents in both villages). Many respondents in Rejosari also obtained information about the price of rice from a local warehouse. Only around 16 percent of Sugihwaras respondents, and 42 percent of Rejosari respondents, also obtained price information from local markets.

Overall, despite the heterogeneity of information sources used, the preferences seem to be dependent on the decision environment. In this study, the preferences of information sources also determined the respondents' information processing practices. This relates to the level of interaction between the respondents and their significant others, and the respondents' perceptions about the quantity and quality of information obtained from their significant others. The respondents' information processing practices, particularly related to technology adoption, are presented next.

6.2.3.2 Information processing practices

When the respondents were asked about their reactions to information about a new technology, many of them stated "directly applied the technology" (37.3 and 35.2 percent of the respondents from Sugihwaras and Rejosari, respectively). At the same time, many of them also seek further information by asking their significant others, and/or observing other farmers who have applied the technology (Table I.2 and I.4 in Appendix I). These respondents will make decisions after they have sufficient information and/or feel more confident from observing their colleagues' results.

Among the respondents' significant others, their spouse appears to be the most frequent person involved in assessing new information for decision making (around 69 and 89 percent of the respondents from Sugihwaras and Rejosari, respectively). The roles of children, parents and extended family in the respondents' decision making process, however, are more limited than the respondents' spouse (Table I.2 and J.4 in Appendix I). This may indicate that the respondents view their spouse as the most trusted and closest person with whom they can share farm decision making.

Outside family, the respondents discuss new information and collaborate in decision making with neighbours and, to some extent, the head of the farmer group (see Table I.2 and I.4 in Appendix I). This confirms the previous findings that neighbours are the main source of information about new inputs and machinery. The roles of extension officers and village leaders are considered less important, which is consistent with previous findings.

When the respondents were asked about their main consideration when appraising a new technology, most of them answered "observable results" (64.9 and 84.3 percent of the respondents from Sugihwaras and Rejosari, respectively). They also indicated the importance of their "significant others' opinion" (43.9 and 54.3 percent of the respondents from Sugihwaras and Rejosari, respectively). Other considerations include costs, profit, prices, specific features of the technology, and agro-climatic conditions (see Table I.2 and I.4 in Appendix I).

Overall, these findings show that the respondents perceive their significant others not only as the source of information, but also as role models who can give support when making decisions. This is also confirmed by the reasons behind the respondents' preferences for their significant others. "Easy to meet" and "prompt responses" are among the most cited reasons by the respondents (47.3 and 59.7 percent of the respondents from Sugihwaras and Rejosari, respectively). The knowledge and experience of the respondents' significant others are also important, especially when the respondents need to deal with farm planning and problem solving (see Table I.2 and I.4 in Appendix I). Nevertheless, only a few respondents perceived that the discussion with their significant others would result in a more reliable decision about new technologies (5.1 and 5.7 percent of the respondents from Sugihwaras and Rejosari, respectively). This raises a question about the final decision maker.

The respondents appeared to have two choices regarding making the final decision of whether to adopt/delay/reject the technology. First, some involved others in making decisions as 54 percent and 89.7 percent of the respondents from Sugihwaras and Rejosari, respectively, preferred to have discussions and debate to find a mutually acceptable solution when they faced differences with their significant others (see Table I.2 and I.4 in Appendix I). Only a few acted passively when faced with a different opinion. Secondly, many respondents also preferred to be the sole decision maker, although they may listen to their significant others' suggestions. Around 40.7 percent of respondents from Sugihwaras were not willing to share decision making with others, while some considered a consensus (23.7 percent). Similar patterns were also found in Rejosari (49.3 percent were not willing to share decision making). The most common people with whom the respondents shared their decisions were colleagues (12 percent in Sugihwaras) and family members (20 percent in Rejosari).

Similar practices were also identified from studies in other countries. These studies (see Solano et al., 2001b, p. 182) found that individualistic decision making appears to be the most common phenomena in farming decision-making, regardless of gender and culture. For example, Solano et al. (2001b) found that dairy farmers in Costa Rica were in favour of making decisions by themselves, although their decisions appeared to be strongly influenced by others' opinion, particularly from family members.

However, the influence of the farmer's spouse and non-family significant others is determined by the nature of decisions to be made (Errington, 1986). This is evident in the case of financial/risky planning and decisions with certain requirements for information, and is influenced by decision period (short-, medium- or long-term) (Solano et al., 2001b). Asfaw and Admassie (2004) also found the role of family characteristics, particularly the level of education, and the decision environment, affected the decision making process. This applies when the family acts as one decision entity.

Overall, the respondents exhibited different strategies for processing information about new technologies. These results, however, have not highlighted any interrelationship between the respondents' characteristics and their decision contexts that influenced their information practices. This could be achieved by applying the Theory of Planned Behaviour (TPB) where the respondents' information processing approach could be explained through interlinking their perceptions with their significant others' opinions as well as their decision making setting. This actual analysis is in fact presented in Section 6.3.

6.2.4. Summary

From the background interview it was found that most of the respondents in Sugihwaras and Rejosari were small-scale farmers. Most of them also had a limited level of education and obtained their farming knowledge and skills from their family as well as an exchange of knowledge with their neighbours. Their main commodities included paddy and milkfish with a yearly production level ranging from stable (Sugihwaras) to increasing (Rejosari). High production of paddy and milkfish in both villages, however, had not brought a higher income.

The introduction of "pandu", which could probably produce higher returns, had not been as successful as might be expected as the respondents appeared to lack interest. One possible reason was that the respondents preferred to have a secure income, although this might not always mean a higher income. Many respondents also viewed prawn as a more risky product than milkfish, despite the higher market price. This perception might stem from (i) the decreasing production trend and prawn price, and (ii) the respondents' lack of experience. The respondents' inclination for a steadier income was also confirmed by their high reliance on marketing through intermediaries. On one side, this attitude was reasonable since most of them were smallholder farmers. On the other side, such attitudes were inconsistent considering that most respondents set a higher income as their main objective. In addition, the problems faced by the respondents were found to be relatively moderate. The respondents who showed a preference toward prawn culture usually had sufficient experience, lived in a village close to a water source, and/or had sufficient resources/knowledge for dealing with the challenges.

The background interview also revealed the respondent's approaches to information seeking. The respondents used different local sources when searching for certain types of information. They learned their farming skills from their family, but sought information about new inputs from their neighbours. Middlemen, local warehouse and local market people were also important sources of market information. Low utilization of external information sources on farm credit, however, reflected the existing barrier to credit in both villages. A similar situation was also identified in the case of obtaining information from extension services, which was mainly due to the limited number of field extension workers available for farmers in both villages.

The respondents were also asked about their information processing approach. Most of them relied on a mind-based farm recording system. When they were asked about their reaction to information about a new technology, two decision making approaches were identified. Firstly, some respondents directly decided to implement the technology once they received relevant information. Alternatively, the respondents would search for further information and, at the same time, wait for an observable progress/result. The second approach seemed to be more common as the respondents indicated that their main consideration when appraising a new technology included "observable results" and "significant others' opinion". Other considerations included financial aspects, the characteristics of the technology and agro-climatic conditions. The respondents who chose the second approach discussed new information mostly with their spouse and, at the same time, learned from their neighbours. The latter might include passive observation of neighbours' practices and/or an evening-informal discussion in a local coffee shop (in local terms, known as a "*cangkruk*").

Despite the interaction with others, most of the respondents preferred making the final decision alone. This may suggest differences in the way the respondents and their significant others construe information about new technology. A bargaining process might also be involved in reaching a compromise, although this could not be proved using the background interview results. A framework that can integrate the interrelationships between the respondents' characteristics, their significant others and the decision making environment, hence, is clearly required. This is explained next.

6.3. Models of Planned Behaviour

6.3.1. Model interpretation

The interpretations of the TPB model were focused on the relationships between the TPB components (behavioural beliefs, normative beliefs, control beliefs, attitudes, subjective norms, perceived behavioural control, intention and behaviour), the bargaining process, and the perception stimuli. These were represented by the standardized regression coefficient of the exogenous variables and the total variance of each endogenous variable explained by its relevant exogenous variable (see Figure 5.5 in page 131). All are expected to delineate the functioning of perceptions and socio-cultural aspects in influencing the farmers' mental process in decision making. Table 6.3 summarizes the R^2 values for the endogenous variables, while the standardized regression coefficients and the relevant P value are presented in Table 6.4 – 6.8.

Table 6.3 Squared multiple correlations (R^2) of the endogenous variables

Endogenous variables	R^2	Endogenous variables	R^2	Endogenous variables	R^2
Actual	0.512	a0405	0.350	Adv	0.590
INT	0.417	Act	0.601	Disadv	0.202
BP	0.587	DF	0.153	Norm	0.528
AT	0.219	NF	0.080	Motive	0.334
SN	0.343	DNF	0.329	Extern	0.206
Intr	0.564	NNF	0.142	Intern	0.805

See Table 5.3 in page 121, Appendix C and Appendix G for the variable definition. See Table 6.4 – 6.8 for the details. The sample size for the TPB analysis is 130 farmers

6.3.1.1 Behavioural beliefs

The estimation showed that the respondents' behavioural beliefs (latent variable **bb**) were positively related to the respondents' perception on the advantages (**adv**) and disadvantages (**disadv**) of "pandu". Table 6.4 (next page) shows that the standardized path estimate for **bb-adv** (0.661) is larger than for **bb-disadv** (0.302), suggesting that the respondents first looked at the potential benefits of "pandu" before considering the possible shortcomings related to the application of "pandu".

Table 6.4 Standardized regression coefficients and P values for behavioural beliefs

Endogenous variables		Exogenous variables	Standardized path estimates*	P value*
adv	←	bb	0.661	
disadv	←	bb	0.302	0.010
adv	←	Diss	0.286	0.000
disadv	←	Diss	0.243	0.003
adv	←	Crop	0.239	0.001
disadv	←	Crop	0.165	0.043
adv	←	Y3	0.117	0.098
disadv	←	OC	**0.113**	**0.157**
disadv	←	HH	**0.108**	**0.180**

* adv-bb path has no P value as its value is fixed (=1.00) in order to allow the SEM estimation. Numbers in bold show insignificant path estimates. See Table 5.3 in page 121, Appendix C and Appendix G for the variable definition.

Concerning the background components in the model, the perception of the advantages of "pandu" (**adv**) appeared to be influenced by the annual cropping pattern (**Crop**, path estimate = 0.239) and production of milkfish (**Y3**, path estimate = 0.117) as well as by whether the respondents participated in the dissemination process (**Diss**, path estimate = 0.286). The three background variables, or behavioural stimuli, and other behavioural belief variables (**bb**) accounted for around 59 percent of the variation represented by **adv**. The positive estimates for these stimuli suggest that the respondents who participated in the dissemination of "pandu", who were engaged in a certain degree of intercropping between November 2004 and mid 2005, and/or who had a high level of milkfish production considered the potential benefits when they were first introduced to "pandu". The farmers might also assess the benefits to determine whether "pandu" can be added to their current intercropping practices, or substitute the existing commodities, e.g. milkfish.

The findings confirm the results from the background interview showing “observable results” as the main criterion for evaluating a new technology. In fact, the respondents might expect a higher income as the price of prawn is 4-7 times higher than that of milkfish and 55 percent of the “pandu” profit comes from prawn (Wonocolo Dissemination Laboratory of East Java AIAT, 2004b). “Pandu” could also further increase the respondents’ income, by around 43 percent compared to the income from intercropping milkfish and other fish (silver barb/carp/tilapia).

Besides the benefits, the respondents also considered the trade-off from “pandu” (**disadv**). This was mainly influenced by whether the respondents participated in the dissemination process (**Diss**, path estimate = 0.243). The positive and significant link between **disadv** and **Crop** (see Table 6.4) suggests that the respondents evaluated the consequences of applying “pandu” compared to their current intercropping system. Nevertheless, the low R^2 of **disadv** (20 percent) might imply that many factors underlying **disadv** were still unidentified. The impacts of **OC** (percentage of own capital) and **HH** (the size of farm household) on **disadv** also appeared to be small (see Table 6.4). Efforts to augment the R^2 by adding new variables or dropping two insignificant variables connected to **disadv**, i.e. **OC** and **HH**, resulted only in lower R^2 and model fit measures. **OC** and **HH** were left in the model because their positive path estimates suggested that farmers with sufficient resources might be less concerned about the possible shortcomings related to “pandu” (**disadv**[2]).

Overall, the relationships between **adv**, **disadv** and some background variables indicated that the respondents who participated in the dissemination of “pandu” were first interested in the potential benefits of “pandu” before considering the shortcomings associated with the application of “pandu”. Their current farming practices and performance, particularly in milkfish production, might also have an impact on how they perceived the benefits from applying “pandu”. In addition, the level of cash asset and the size of household, to a lesser extent, might affect the respondents’ perception on the trade-off associated with “pandu” application.

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[2] Questions that composed **disadv** were reversed due to the negative wording (see Table 5.3, p. 121).

6.3.1.2 Normative beliefs

The estimation also revealed the respondents' beliefs about social pressure (latent variable **nb**). Table 6.5 shows that the **nb** variable appeared to be positively related to their beliefs (i) that their significant others had a certain expectation (or interest) about their decision on "pandu" (**norm**), and (ii) that they had a certain degree of responsibility to fulfil others' expectations about "pandu" (**motive**). A larger path estimate for **nb-motive** (0.457) than for **nb-norm** (0.307) showed the respondents' commitment to applying "pandu", particularly for those who participated in the dissemination process and received the incentives. For non-participating farmers, their motivation to try "pandu" might originate purely from peer observations and a farmer-to-farmer technology transfer mechanism (in local terms this is known as "*getok tular*").

Table 6.5 Standardized regression coefficients and P values for normative beliefs

Endogenous variables		Exogenous variables	Standardized path estimates*	P value*
norm	←	nb	0.307	0.004
motive	←	nb	0.457	
norm	←	Vil	-0.421	0.000
motive	←	Vil	0.318	0.000
norm	←	Diss	0.473	0.000
norm	←	SO2	0.181	0.004
motive	←	SO1	**0.115**	**0.135**
motive	←	DM	**0.101**	**0.189**

* motive-nb path has no P value as its value is fixed (=1.00) in order to allow the SEM estimation. Numbers in bold show insignificant path estimates. See Table 5.3 in page 121, Appendix C and Appendix G for the variable definition.

A significant path estimate of **nb-norm** also indicated some degree of expectation from the AIAT, the farmer groups, and village leaders that the farmers in both villages would apply "pandu". Such social pressures were quite intense for the participating farmers (path estimate of **Diss-norm** = 0.473), mostly in Sugihwaras (path estimate of **Vil-norm** = -0.421). This is reasonable because the funding of the "pandu" program could involve only 17 farmers in Sugihwaras, compared to 35 farmers in Rejosari. The large number of non-participating farmers in Sugihwaras might have increased the pressure as they had an expectation of receiving financial incentives from the program that should have been revolving from farmer to farmer. A moderate level of pressure also came from the family members, particularly for farmers who "always" (the highest degree of interaction) discuss the matter with their children (path estimate **SO2-norm** = 0.181). This might indicate that younger generations tend to be more interested in trying new things. **Diss**, **SO2** and **Vil**, and other normative belief factors (**nb**), attributed 53 percent of the variation depicted by **norm** (Table 6.5).

In contrast to **Vil-norm**, the link of **Vil-motive** was positive, indicating that the respondents in Rejosari (**Vil** = 2) were more socially attached and felt more responsible to comply with the general opinion in their village. **Vil** together with **SO1** (degree of interaction between the respondents and their spouse) and **DM** (final decision maker), and other **nb** factors, attributed around 33 percent of the variance explained by **motive**. The influences of **SO1** and **DM** were positive but insignificant (Table 6.5). This confirmed that the respondents' motivation to comply with others (e.g. spouse—**SO1**) was not aimed at reaching a consensus (the highest value of **DM**); instead, it showed their commitment to comply with others' opinion and/or to participate in the "pandu" program. The latter might also suggest that introducing "pandu" as a technology transfer program had created an embedded pressure for the respondents to apply "pandu".

Table 6.6 Standardized regression coefficients and P values for control beliefs

Endogenous variables		Exogenous variables	Standardized path estimates*	P value*
extern	←	cb	**0.292**	**0.258**
intern	←	cb	0.821	
intern	←	Ten	0.331	0.000
extern	←	Y3	-0.232	0.003
extern	←	Pro3	0.179	0.024
extern	←	Pro1	0.149	0.060
intern	←	SO2	0.147	0.054
extern	←	Pro2	**0.038**	**0.631**
extern	←	SO5	**0.106**	**0.183**

* intern-cb path has no P value as its value is fixed (=1.00) in order to allow the SEM estimation. Numbers in bold show insignificant path estimates. See Table 5.3 in page 121 and Appendix C for the variable definition.

6.3.1.3 Control beliefs

The results from AMOS show that the respondents' control beliefs (**cb**) were affected by some external (**extern**) and internal (**intern**) factors. The effect of **intern** (the respondents' beliefs about their own capacity to deal with the decision making and implementation environment) appeared to be dominant (path estimate = 0.821), while **extern** (the respondents' beliefs in the external supporting and impeding factors in decision making) had an insignificant effect (see Table 6.6). This implies that, when dealing with "pandu", the respondents were more concerned about their own experience, knowledge, skill, and/or assets than about external factors. This confirms the background interview results showing the respondents' lack of experience and knowledge of prawn culture as a key determinant of a poor prawn yield.

Some background stimuli further helped explain the interrelationships between **extern**, **intern** and **cb**. Table 6.6 shows that **extern** was influenced by **Pro1** (pest and disease problems), **Pro2** (problems related to water supply and quality), **Pro3** (problems related to prawn sale price), **Y3** (milkfish yield) and **SO5** (degree of interaction between the respondents and their neighbours). All stimuli showed a positive association with **extern**, except **Y3**. The positive links between the problems and **extern** were expected, and this implied that the respondents had enough experience to deal with these problems (high values of **Pro1**, **Pro2**, and **Pro3** indicate trivial problems). The path estimate of **Pro3-extern**, in particular, might annul the respondents' stated belief (see the background interview results) referring to a low prawn price as the main reason for abandoning "pandu".

The effects of **SO5** and **Pro2**, however, appeared to be less significant (Table 6.6). The link of **SO5-extern** might reflect the concern of some respondents, particularly in Rejosari, who said that their prawn survival rate was affected by their neighbours' pesticide application. However, such neighbouring effects appeared to be minor since the intensity of **Pro1** in general was considered moderate (see also the background interview results in previous sections). For the link of **Pro2-extern**, its triviality might not reflect the situation when "pandu" was introduced; instead, it might represent the respondents' perception on the recent water conditions in their village.

The significant and negative **Y3-extern** path further confirmed milkfish as a competing product for "pandu". Many respondents asserted that prawn was too difficult to grow, because they had to monitor the water conditions night and day. It was also difficult to predict the mortality rate of prawn and, as a result, the yield fluctuated. The respondents also repeatedly compared these problems with milkfish production, which was less demanding and had a higher success rate. Thus, the respondents who were used to growing milkfish might view “pandu” as more susceptible to external risks and, hence, they might decide to remain with milkfish.

The R^2 for **extern** was around 21 percent, suggesting that there might be other underlying—but unidentified—factors involved. The addition of other background variables to explain **extern**, however, did not result in a big improvement. For example, although the addition of the **Vil-extern** link raised the R^2 to 23 percent, it was insignificant.

In the case of **intern**, only two stimuli were identified: **Ten** (status of land ownership) and **SO2** (degree of interaction between the respondents and their children). The positive and significant links between these factors and **intern** indicated their importance in improving the respondents’ self-confidence, i.e. a more positive perception of their own capacity for dealing with “pandu”. The effect of **Ten**, in particular, confirms the links between **disadv** and two stimuli (**OC** and **HH**) presented in the previous section, implying that sufficient resources seemed to reduce the respondents’ concerns about the possible trade-off from “pandu”. **Ten** and **SO2**, and other control belief variables (**cb**), contributed to around 80 percent of the variance explained by **intern** (see Table 6.3).

Overall, the respondents’ control beliefs seemed to be affected by their preference toward milkfish production, land tenure, and interaction with their children. The respondents had also been accustomed to deal with the problems related to pests and diseases, water supply and market prices.

6.3.1.4 Attitude, perception and intention

The path estimates from AMOS confirm that the respondents’ intention (**INT**) was directly affected by their attitudes (**AT**), subjective norms (**SN**) and perceived behavioural control (**PBC**), and indirectly affected by their accessible beliefs (behavioural beliefs—**bb**, normative beliefs—**nb** and control beliefs—**cb**). **AT**, **SN** and **PBC** were positively related to **INT**. Since **bb** mainly related to the respondents' interests in the benefits of "pandu", the positive and significant path estimates of **bb-AT** and **AT-INT** (Table 6.7) implied the importance of a positive attitude toward "pandu" in securing the respondents' intention to adopt "pandu". This was confirmed by the background interview results indicating that the respondents preferred to observe the potential benefits of "pandu" before making an adoption decision.

Similar interpretations also apply for the path estimates of **nb-SN** and **SN-INT** (Table 6.7), which indicate the roles of (i) the respondents' commitment to comply with others' opinion, (ii) the "pandu" program design, and (iii) a farmer-to-farmer technology transfer mechanism in creating a social norm relevant to the intention to adopt "pandu". The social norm might also signal a socio-cultural influence on the respondents' decision making process.

Table 6.7 Standardized regression coefficients and P values for attitudes, perceptions and intention

Endogenous variables		Exogenous variables	Standardized path estimates*	P value*
AT	←	bb	0.468	0.001
SN	←	nb	0.586	0.001
PBC	←	cb	**0.199**	**0.284**
INT	←	AT	0.251	0.000
INT	←	SN	0.194	0.005
INT	←	PBC	**0.106**	**0.144**
PBC	←	Vil	-0.371	0.000
INT	←	Vil	0.205	0.005
INT	←	Diss	0.458	0.000
INT	←	Obj	-0.116	0.085
INT	←	Y3	0.184	0.006

* Numbers in bold show insignificant path estimates. See Table 5.3 in page 121, Appendix C and Appendix G for the variable definition.

The role of **PBC** in influencing **INT**, however, was less significant (see Table 6.7). The link between **cb** and **PBC** was also insignificant. These findings might be specific for this case study considering several possible explanations. First, as a program, "pandu" was equipped with financial incentives (for purchasing prawn post larva and other farm inputs) and technical assistance during the program operation.

Both incentives were provided to attract wider adoption and to help the participating farmers cope with the requirement of additional capital and on-hand knowledge (Muhariyanto & Arianto, 2005). Such incentives could improve the respondents' capability to control "pandu" application, but, at the same time, led to a modest effect of **PBC** on **INT**. Nevertheless, the condition might apply only for respondents who participated in the "pandu" dissemination program. Since the incentives were also limited to the program period, other factors might influence the respondents' **PBC**.

Other explanations refer to the rather moderate problems faced by the respondents, and the difficulty in selecting proper questions to represent what Ajzen (2002d) termed "*self-efficacy*" and "*controllability*". The latter suggests that to measure PBC, and the relevant belief-based variable (cb), seems to require a more comprehensive set of questions covering the circumstances relevant to the behaviour under study. In contrast, the questions for attitude toward behaviour (AT), subjective norms (SN), and the two other belief-based variables (bb and nb) seemed to be more straightforward.

A comprehensive PBC questionnaire, however, may not be formulated entirely from taking inferences, for example from a pilot interview, especially when the behaviour occurred in the past. The respondents in this study might have forgotten about the actual circumstances involved in "pandu" application. Furthermore, the respondents might not have an accurate assessment about their own skills and knowledge, their socio-economic conditions, and/or market conditions. The accessible information mainly related to their memories about the dissemination process, the incentives, agro-ecological problems, and yield. Thus, the responses to the PBC questionnaire might vary greatly and lead to an unsatisfactory result. This was confirmed by (i) the low value of Cronbach's alpha for **extern** and **intern** (less than 0.6), (ii) low correlations between **cb** and **bb**, and between **cb** and **nb** (less than 0.3), and (iii) low and insignificant path estimates of **cb-PBC**, and **PBC-INT** (see Table 6.7).

Several modifications to improve the significance of **PBC**, and control beliefs (**cb**), were pursued but the results were unsatisfactory. This included the use of fewer responses for extern and intern in order to increase the internal consistency. The results were a negative link of **cb-PBC** and an insignificant link of **PBC-INT**. A link between locational influences (**Vil**) and **PBC** was also added to represent a set of effects from different agro-ecological and socio-cultural factors that had not been captured by the variables in the TPB model. The result was a negative, but significant, path estimate of **Vil-PBC** (-0.371, P value = 0.000). This result was consistent with the findings from the background interview indicating that the respondents from Sugihwaras (**Vil** = 1) might be more optimistic in dealing with "pandu" application, because (i) their village is located close to a water source, (ii) they are more experienced in prawn culture, and (iii) they have sufficient resources (larger farm). Further modifications, e.g. by adding a link of **extern-Vil**, **intern-Vil**, or other background variables, had led to redundancy and a lower path estimate and/or R^2.

The unique relationship between perceived behavioural control (**PBC**) and intention (**INT**) found in this study was, in fact, not unusual. For example, Strating, Van Schuur, and Suurmeijer (2006) found that PBC (represented by self-efficacy measures) accounted for a lower and insignificant effect toward the intention than toward actual behaviour of self-management among rheumatoid arthritis patients. Another study by Terry and O'Leary (1995) showed more diverse effects, as self-efficacy was found to affect intention—but not the actual behaviour, while the opposite effects were produced by perceived behavioural control. Bagozzi and Kimmel (1995) also discovered that the PBC appeared to be a weak predictor for a goal-oriented intention or behaviour, particularly when past behaviour was included in the analysis. A study by Notani (1998) also revealed that the effects of PBC appeared to vary for different case studies. This analyst asserted that a more robust link between PBC and the target behaviour, or intention, could be obtained if the questionnaire comprised more macro level questions focusing on the control over underlying inner features of the target samples. A frequently performed behaviour might also secure a more effectual PBC (Notani, 1998), but Ajzen (2001) disagreed and argued that the link between behaviour and PBC was not solely determined by the familiarity of the behaviour. All these findings confirmed the results of this study, where a weak link between **PBC** and past intention (**INT**) was discovered. Only control over internal factors (**intern**) appeared to have a strong link with the respondents' control beliefs (**cb**), and the regularity of "pandu" application might not fully justify the effects of **PBC** on the respondents' intention or behaviour.

Besides the three TPB components, four background variables also appeared to directly influence **INT**, which were **Diss** (whether the respondents participate in "pandu" dissemination), **Vil** (locational factor), **Y3** (milkfish yield) and **Obj** (farmers' objectives). These seven variables together accounted for around 42 percent of the variation represented by **INT**.

Among the background variables, **Diss** and **Vil** appeared to be the major determinants of **INT** (Table 6.7). This suggested that the dissemination of "pandu" was quite successful in attracting the respondents to apply "pandu". This particularly applied to the respondents from Rejosari (positive path value of **Vil-INT**). The combined effects of **Diss**, **AT** (see earlier explanation) and **Vil** on **INT** were in accordance with the interpretations for the path estimates of **motive-nb**, **adv-bb**, and **motive-Vil**; all indicated a strong motivation and positive perceptions toward "pandu" particularly among farmers in Rejosari.

The impact of milkfish production (**Y3**) on **INT** might suggest that the respondents who had a high milkfish yield had an intention to adopt "pandu". However, this was uncertain, because the respondents appeared to have an inclination towards milkfish and a secure income (see interpretation of **Y3-extern** and the background interview results). This was also confirmed by the negative path estimate for **Obj-INT** suggesting that the respondents who had multiple (economic and/or non-economic) objectives were less likely to apply "pandu". If respondents who enjoyed higher income from milkfish production had a tendency to have different objectives, they might become concerned that the application of "pandu" was not suitable for the current conditions, indicating a diminishing prospect of achieving their multiple objectives. Nevertheless, the underlying reason might be largely affected by the respondents' perceived behavioural control.

6.3.1.5 The bargaining process, intention and behaviour

The inclusion of the bargaining process (**BP**) and the respondents' actual behaviour (**Actual**) in the TPB model improves the total variance explained and the model fit measures (see Table 5.4 in page 125, and the discussion in Chapter Five, page 126-127). **BP** was assumed to be a latent variable that mediates the link between the respondents' intention (**INT**) and behaviour. Here, **BP** was measured through four variables: **DF** (discussion with family members), **NF** (negotiation with family members), **DNF** (discussion with non-family significant others), and **NNF** (negotiation with non-family significant others). **Actual** was also assumed to be a latent variable that incorporated past and future behaviour; and, hence, it was represented by three measures: (i) the extent of "pandu" application in the year of introduction (**Intr**); (ii) the extent of "pandu" application during the period between November 2004 and mid 2005 (**a045**); and (iii) the farmers future plan regarding "pandu" (**Act**).

Table 6.8 Standardized regression coefficients and P values for the bargaining process, intention and behaviour

Endogenous variables		Exogenous variables	Standardized path estimates*	P value*
BP	←	INT	0.707	0.001
BP	←	PBC	0.268	0.040
DF	←	BP	0.215	0.061
NF	←	BP	0.224	
DNF	←	BP	0.399	0.006
NNF	←	BP	0.293	
DF	←	SO1	0.327	0.000
NF	←	DM	0.173	0.042
DNF	←	SO5	0.412	0.000
NNF	←	Diss	0.160	0.068
Actual	←	BP	0.716	0.003
Act	←	Actual	0.723	
a0405	←	Actual	0.522	0.000
Intr	←	Actual	0.356	0.000
Act	←	Vil	-0.289	0.000
Intr	←	Vil	-0.162	0.012
Intr	←	Diss	0.565	0.000
a0405	←	Vil	-0.286	0.000

* Some regression paths have no P value as their values are fixed (=1.00) in order to allow the SEM estimation. See Table 5.3 in page 121, Appendix C and Appendix G for the variable definition.

The roles of BP can be explained from the link between the respondents' intention (**INT**) and **BP**, the structure of **BP**, the link between **BP** and **Actual**, and the structure of **Actual**. Table 6.8 shows a positive and significant relationship between **INT** and **BP** (path estimate = 0.707, P value = 0.001). A link between **PBC** and **BP** was also included, and the path estimate was 0.268 (P value = 0.040). Both **INT** and **PBC** contributed to around 59 percent of the variance explained by **BP** (see Table 6.3). These findings probably indicate the respondents' efforts to seek justification for their intention to apply "pandu" (**INT**) by discussing the matter with family members and non-family significant others. In this process, the respondents probably relate their intention with the practicality (**PBC**) of applying "pandu".

The structure of **BP** itself involves different levels of discussion and negotiation as the respondents discuss and negotiate their intention with family members and/or non-family significant others. The results from AMOS revealed that the respondents seemed to prefer measuring up their intention concerning "pandu" with non-family significant others. Table 6.8 shows that the path estimates for **DNF-BP** and **NNF-BP** (discussion and negotiation with non-family significant others, respectively) were higher than those of **DF-BP** and **NF-BP** (discussion and negotiation with family members, respectively).

Nevertheless, the bargaining process with non-family significant others appeared to mainly focus on discussions rather than negotiations. This was shown by a larger path estimate for **DNF** than for **NNF** (Table 6.8). This was of relevance because farmers in Sugihwaras and Rejosari usually gather in the evening in a local coffee shop (known as "*cangkruk*"). The informal settings allowed the respondents to discuss anything, including farming matters, with non-family significant others in an egalitarian way. On the other hand, the informality might mask the negotiation process as the respondents exchanged information and express their own position without making a directly declared comparison or formal argument. The positive, large and significant path estimate for **DNF-SO5** (Table 6.8) further confirmed the importance of "*cangkruk*" in facilitating the discussion, and negotiation, between the respondents and their colleagues.

A similar pattern was also found for the intra-household discussion and negotiation processes. **DF-BP** and **NF-BP** appeared to have almost similar sized path estimates (0.215 and 0.224, respectively), indicating the informal approach of the intra-household bargaining process. The bargaining process might occur informally during dinnertime, when watching television together in the evening, or before going to sleep. The respondents, as the household head, led the discussion, and other family members contributed in the discussion. Among family members, their spouse appeared to contribute most (path estimate for **DF-SO1** = 0.327, P value = 0.000). This was again in congruence with the background interview results.

The dominance and informality of the discussion process on the one hand showed that a negotiation might not always be evident. On the other hand, this might suggest the influence of the respondents' communication behaviour in their decision making process. This was represented by two possible decision making approaches. First, the respondents might not instantly make a decision during/after the conversation with others, as they chose to first digest all information and others' opinions before making any decisions. A time lag between the discussion/negotiation and the actual decision making, hence, existed. The respondents might fill the time gap with further discussions and/or observations. This fits with the background interview results indicating how the respondents learned about farming from family and their colleagues, and how the respondent could act as the final decision maker regardless of others' opinions. This was justified by a lower path estimate of **NNF-BP** than that of **DNF-BP**, and almost similar estimates of **DF-BP** and **NF-BP**.

Nevertheless, in the case where the respondents chose to make the decision directly after discussion with others, the decision might come in the form of a consensus. The respondents, for example, might submit their decision to their leaders, or reach consensus with their non-family significant others. This was shown by the influence of the "pandu" dissemination process (**Diss**) on **NNF** (Table 6.8). An intra-household consensus might also exist as indicated by a positive path estimate between **DM** (the final decision maker) and **NF**. On one side, these might depict the role of the socio-cultural structure in the villages as well as household norms. On the other side, these showed the importance of the new technology dissemination process and intra-household discussions in providing a conducive medium for negotiation towards a consensus. Overall, the respondents seemed to use different communication approaches when making decisions involving their family members and/or non-family significant others.

The results from the bargaining and decision making processes were then realized in the form of behaviour, indicated by a strong link between the bargaining process and the respondents' actual behaviour (path estimate for **BP-Actual** was 0.716, P value = 0.003). With the R^2 for **Actual** of around 51 percent, this finding confirmed the robustness of **BP** as a moderator between **INT** and **Actual**. If **BP** was dropped, the R^2 for **Actual** was only 39 percent, and the path estimate for **INT-Actual** was 0.628 (compared with path estimate of **INT-BP** = 0.707). **BP**, hence, has clarified the link between the respondents' intention (**INT**) and behaviour (**Actual**).

The use of **Actual** was deemed appropriate for an ex-post analysis. If **Actual** was replaced by **AB** (a measure of behaviour obtained from the TPB interview), the results would be worse in terms of path estimates, R^2 and model fit (**INT-BP** = 0.615, **BP-AB** = 0.539, R^2 = 29%, Chi-square/df = 1.729, TLI = 0.970, RMSEA = 0.075). **Actual** was also a more comprehensive measure of behaviour since it included past and future behaviours. The path estimate between **Act** (future intention) and **Actual** was 0.723, indicating the potential of the model to be used for predicting the respondents' future behaviour concerning "pandu". For past behaviours, the model seemed to explain "pandu" adoption in a recent year (November 2004 and mid 2005), compared to the year of introduction. This was shown by a larger path estimate of **a0405-Actual** than of **Intr-Actual** (Table 6.8).

Some stimuli also appeared to influence **Intr**, **a0405** and **Act**. For example, a link between **Diss** and **Intr** (path estimate = 0.565, P value = 0.000) indicated an adoption decision might have been assumed and realized right after the dissemination of "pandu". The respondents' decision to apply "pandu" in the year of introduction, hence, simply represented their commitment to try new ideas. The path estimates of

Vil-Intr (-0.162) and **Vil-a0405** (-0.286) also suggested different levels of adoption between respondents in Sugihwaras and Rejosari. The descriptive statistics presented earlier confirmed a more successful farmer-to-farmer technology transfer in Sugihwaras. Originally, the “pandu” program had involved only around 29 percent of the respondents in Sugihwaras in mid 2004, but the number of respondents who applied “pandu” increased to 81 percent in the subsequent seasons. In contrast, around 49 percent of the respondent in Rejosari were involved in the “pandu” program in year 2000, but the number of adopter respondents increased to only 63 percent. This might be because not all participating farmers in Rejosari had ricefield ponds suitable for prawn. The introduction of “pandu” in Sugihwaras was also more recent than in Rejosari and, hence, the respondents in Sugihwaras might still have a greater motivation to try or continue “pandu”. The latter was confirmed by the negative, but significant, path estimate of **Vil-Act** (-0.289, P value = 0.000).

Overall, the inclusion of **BP** and **Actual** had improved the total variance explained and the model fit measures. **BP** appeared to clarify the link between the farmers' intention and behaviour, and the final stage of the farmers' decision making process, through recognizing the role of communication behaviour. The use of **Actual** also appeared to provide a more thorough explanation of both past and future behaviour.

6.3.2. Summary, Discussion and Relevant Implications

The results from AMOS in this study confirmed the robustness of the TPB in explaining the interrelationships between one's behavioural beliefs, normative beliefs, control beliefs, intention and behaviour. The behavioural and normative beliefs appeared to have a strong link, respectively, with the respondents' attitude toward “pandu” application and with the subjective norms, each of which played a key role in mediating the respondents' beliefs with their interest in “pandu”. However, the effects of the farmers' control beliefs and perceived behaviour control (PBC) on their intention were weak.

The latter finding might be unique for this particular case study, since many studies have shown a strong effect of PBC on intention and behaviour (see Armitage & Conner, 1999; Notani, 1998). This situation might stem from the incentives provided by the "pandu" program, which could reduce the role of PBC. It might also be due to the difficulty in creating a more straightforward, but representative, questionnaire for capturing the effect of control beliefs. This measurement issue was complicated as different studies using the TPB also appeared to employ different measurement bases (see Bergevoet, Ondersteijn, Saatkamp, Van Woerkum, & Huirne, 2004; Coleman, McGregor, Hemsworth, Boyce, & Dowling, 2003; Notani, 1998; Strating et al., 2006; Terry & O'Leary, 1995; Zubair & Garforth, 2006). In this study, external and internal contexts were used for measuring the components of PBC since this was believed to be the best way of dealing with the farmers' less accurate assessment of their decision environment in the past. Several modifications to improve the significance of PBC, and control beliefs, in this study were pursued but the results were unsatisfactory. The best explanation, hence, might rest on Ajzen's assertion (1991) that the effect of PBC may vary according to the type of behaviour and the relevant behavioural settings.

The inclusion of the bargaining process (**BP**) in this study improved the overall model explanation. **BP** contributed around 51 percent of the behavioural variance (R^2) in the TPB model, and this was considered higher than most R^2 found in past behavioural studies using the TPB (see Armitage & Conner, 1999; Sutton, 1998). Recognizing the role of **BP** in the TPB framework also allowed a more comprehensive analysis of the relationship between the farmers' intention and behaviour. For example, the structure of **BP**, represented by the farmers' interaction with their family members and non-family significant others, was able to reveal the role of the farmers' communication behaviour as a decisive factor in their decision making process. The farmers used different communication approaches when making decisions involving their family members and non-family significant others. The farmers might act and make decisions individually, or collectively, depending upon the situations. These findings clarified the interactions between socio-cultural influences as well as the farmers' personality and rational strategy in decision making. This particularly applies in the case of semi-commercial farmers and in situations where the influence of socio-cultural aspects is strong. The farmers' communication behaviour also provides useful insights, particularly when the bargaining process occurs in an informal way.

The addition of **Actual** and background variables in the TPB framework was also relevant. The path estimates of **Actual** indicated a strong potential for using the TPB model to predict future behaviour, while they were also powerful in explaining past behaviour. The inclusion of background variables was proven to allow a more thorough exploration of the underlying sources of the farmers' perceptions and behaviour. This also had alleviated the shortcomings brought by the PBC measurements, especially in explaining the complex interrelationships between the farmers' perceptions and their decision making environment. The results also confirmed the findings from other studies related to agricultural technology adoption.

Overall, the results could be used to improve the effectiveness of agricultural technology policies and extension services. Some key findings that are worth noting are as follows. First, when introducing a new technology, the researchers and extension officers should clearly explain the advantages to the target users, because the farmers in this study preferred to examine the potential benefits before considering the possible downfalls associated with "pandu". The researchers and extension officers should also consider the current farming practices and performance in order to correctly address differences in experience, skills, level of knowledge, and commodity preferences among the farmers. The latter is important for this case study, as the farmers were accustomed to growing milkfish and enjoyed a high return from milkfish production, which may have reduced the likelihood of "pandu" application. The incentives in the "pandu" program could help alleviate the possible income variability, but they were not revolving as originally planned due to the lack of a clear mechanism. Overall, new technology introduction needs to provide clearly demonstrated greater benefits than current practices, and consider the farmers' objectives and their preference towards a more secure income. The latter may be addressed, for example, by improving the farmers' access to formal lending (from banks and other financial institutions) and/or establishing a more reliable revolving fund mechanism. These may provide financial relief for the farmers, including technology adoption support during a bad season.

Secondly, a participatory dissemination process is advisable considering that the design of "pandu" as a program might create a pressure on the target farmers. A participatory process could provide a more conducive environment for negotiation, conflict mitigation and creation of consensus among the parties involved. Such an approach could also strengthen a more positive perception among the farmers.

Next, the approach to introducing a new technology should not be uniform because socio-cultural differences exist, even among neighbouring communities such as in this study. Different approaches for different locations may allow the target farmers to observe, learn and decide the most suitable way of applying the technology. For example, a participatory dissemination process may combine different activities (group discussions, video presentation, demonstration plot, experience sharing, etc.), and adjust the timing and the sequence of the activities according to the interest of each of the target groups. This, however, requires prior knowledge about the target group's preferences. The approaches may also consider differences in communication behaviour used by individual farmers in decision making. For example, the farmers in this study could act independently after discussing the matter with others and observing others' practices, but they could also act collectively and base a decision on a consensus. Anticipating that such differences exist may enable the technology introduction process to cover socio-cultural norms, and to foster a more sustainable adoption practice.

Different communication behaviour may also imply the need to consider the time lag between the time the target farmers receive information and the final decision making process. In this study, the time lag seemed to occur when the farmers decided to act independently, after discussing "pandu" with others. The time lag might represent the farmers' learning process, but it might also suggest problems in accessing information and this could delay the adoption process. A more balanced flow of information to the target farmers, hence, is needed. The information should be distributed during and beyond the introduction period, and it should cover both the intended users and the users' significant others.

The latter is crucial as many farmers in this study preferred to discuss their farming matters with their spouse, children or some neighbours who were not involved in the dissemination process. These people might have a different level of understanding and their opinions, if not in favour of "pandu", might impede the adoption. This may be overcome, for example, by providing a family extension activity, increasing the frequency of home visits by the field extension worker, and using a different timing to allow the extension activities to suit the farmers' free time (e.g. coinciding with timing of "cangkruk"). These approaches will attract wider participation, from other farm household members and the farmers' colleagues in the extension activities, including the technology dissemination process. In summary, it is important to ensure the information about a new technology is accessible to everyone in the target areas.

Another recommendation is related to the interrelationships between the background variables, the behavioural factors, and the bargaining process. The farmers seemed to take decisions and act according to their external and internal circumstances. This makes different adoption practices common and abandonment, or modification, of "pandu" in a particular season might not always mean complete non-adoption. In this regard, the provision of regular extension services becomes very important to assist the farmers to evaluate their situations and, at the same time, sustain new technology application.

Lastly, the use of the TPB framework for analyzing the technology decision making process by semi-commercial farmers, after some additions, has been successful. The model may be used in a predictive analysis for similar behaviour. The inclusion of the bargaining process in the model has helped reveal the decisive factor in the farmers' decision making process and, hence, clarified the final step of decision making. The concept of a bargaining process can also be used for a more general case study, but this requires further exploration. Overall, this study has presented a more realistic description and thorough analysis of farmers' decision-making processes.

CHAPTER SEVEN: FARMERS' PERSONAL CONSTRUCT SYSTEM

7.1. Introduction

The results from the repertory grid are presented and discussed in this chapter. The discussion starts with a brief synopsis of individual farmer's personal construct systems. This is followed by the discussion on the SocioGrids results, which are the focus of the repertory grid analyses in this study. The SocioGrids analyses will involve the identification of common elements and constructs of adopter and non-adopter groups in Sugihwaras and Rejosari. These groups were identified through different interviews in this study (see Chapter Five, Table 5.10, page 146).

Lessons learned from the repertory grid interviews will also be highlighted. This includes the possible contribution of this approach to the improvement of the adoption analysis using the Theory of Planned Behaviour. Finally, implications for the farmers, extension services and relevant parties are presented.

7.2. An Overview of Individual Farmers' Personal Construct System

The analyses of individual farmer's personal construct systems were based on three groups of elements purposely chosen to link the repertory grid analysis with the Theory of Planned Behaviour (TPB). The first group relates to the respondents' perceptions about the impacts (advantages and disadvantages) of "pandu" (attitudes). The second group relates to the respondents' perception of external and internal factors that may support and impede the adoption of "pandu" (perceived behavioural control, PBC). The third group relates to the people with whom the respondents discuss and negotiate their intention to adopt "pandu" (bargaining process).

The results show an individual farmer's unique evaluation of the feasibility of "pandu". This was indicated by the FOCUS and PrinCom analyses, and the results from both analyses can complement each other. The clustering of elements and constructs in FOCUS is rich in showing different approaches used by the respondents for evaluating "pandu". Meanwhile, PrinCom extracts information from the clusters to reveal the most important decision criteria, and the core elements and constructs, used by each respondent. This has helped summarize the complex structure of an individual's mental process.

Nevertheless, the interpretation is challenging due to the uniqueness of each response and a sample size that is larger than is usually used in repertory grid analyses. It was decided to further summarize the clusters of elements and constructs, as well as the main decision criteria before analyzing the results from FOCUS and PrinCom. This may conceal some important details, particularly for the FOCUS analyses; however, it is expected that the benefits are greater than the trade-offs. The detailed results are presented in Appendix J, while this section highlights the main findings of individual farmer's personal construct systems.

7.2.1. Elements and Constructs Related to Attitudes toward "Pandu"

The FOCUS and PrinCom results exhibited that the respondents from Sugihwaras and Rejosari seemed to develop their attitudes towards "pandu" based on the aspects (elements) and conceptions (constructs) related to (i) the income/yield, (ii) managerial aspects (knowledge, skills, experience and workload), and (iii) the relevant risks. The respondents also considered their commodity preferences and the possibility of cooperating with others in obtaining the resources, in working and in making decisions. All these aspects might represent the main decision criteria used by the respondents when evaluating "pandu".

These decision criteria also seemed to be interconnected. For example, the element of "*soil and water requirements*" was frequently clustered with, or located in the same direction as, elements and constructs related to knowledge, expenses and failure. This might indicate the consideration of factors related to failure. The combination of elements and constructs for the decision criteria of commodity preferences also seemed to relate to workload, water requirement, capital and yield.

The decision criteria also showed the spatial aspect of the farmers' learning process. Different villages seemed to have a different priority, as shown by different perceptions among the respondents regarding the most important aspects to look for in "pandu". This also occurred between different groups of farmers in each village, for example between participating farmers and non-participating farmers, and/or between adopters and non-adopters. This topic will be discussed in the later section related to SocioGrids analyses.

7.2.2. Elements and Constructs Related to Perceived Behavioural Control

When considering the external and internal factors affecting "pandu" application, the respondents from both villages seemed to use criteria related to technical, financial and environmental conditions. The technical aspects included the workload, while the financial aspects mainly related to the sources of capital. The respondents referred to agro-climatic and market conditions as the risks related to the external conditions. These aspects were interrelated with one or two aspects used more often, or considered first.

The respondents were also aware of the conflict of interests when evaluating the supporting and impeding factors. For example, they might consider off-farm jobs as both supporting and impeding factors in terms of their commitment towards working on the farm and of their financial capacity. The same applied for the respondents who relied on external help, including middlemen, and for the Rejosari respondents who had good income from vegetable production. The use of external assistance might also suggest that the respondents used a bargaining process when assessing their capacity and problems. This might be evident when they were trying to allocate money for covering family and farming expenses, to access water, and/or to compromise with their neighbours over the use of pesticides. This leads to the next discussion on the repertory grid results related to the bargaining process.

7.2.3. Elements and Constructs Related to the Bargaining Process

The element and construct clusters in the FOCUS and PrinCom analyses suggested that the respondents from both villages were more likely to discuss and negotiate their intention towards "pandu" with their closest people: family members and local non-family people. Such relationships, however, depended on the purpose of interactions and status. The respondents used discussions and negotiations mostly for seeking advice, information, capital, and consents and solutions related to farming practices. With respect to the status of discussers, many respondents considered whether their "significant others" were among the leaders or commoners. This also determined the level of formality in their interactions.

When respondents with a similar bargaining approach were grouped, the results might indicate different groups of farmers useful for identifying different groups of adopters, or non-adopters. Similar results would be obtained from the grouping of respondents based on their attitudes and perceived behaviour control. Nevertheless, these grouping methods might not be practical due to the variability of elements and constructs elicited. The alternative is to run the SocioGrids analysis because it can summarize the elements and constructs elicited by a group of people into a set of characteristics that represent the majority of the group members. This topic will be discussed next.

7.3. Common Elements and Constructs of Adopter/Non-adopter Groups

The SocioGrids analyses used three sets of elements related to (i) the Theory of Planned Behaviour's (TPB) components: attitudes towards "pandu" and perceived behavioural control (PBC), and (ii) the concept of a bargaining process. The analyses focused on identifying the shared constructs within seven groups of adopters/non-adopters, which were determined from the background, TPB and semi-ethnographic interviews (see Table 5.10 page 146). The general characteristics of each group will be discussed next, followed by the SocioGrids results.

7.3.1. Characteristics of Adopters and Non-adopters

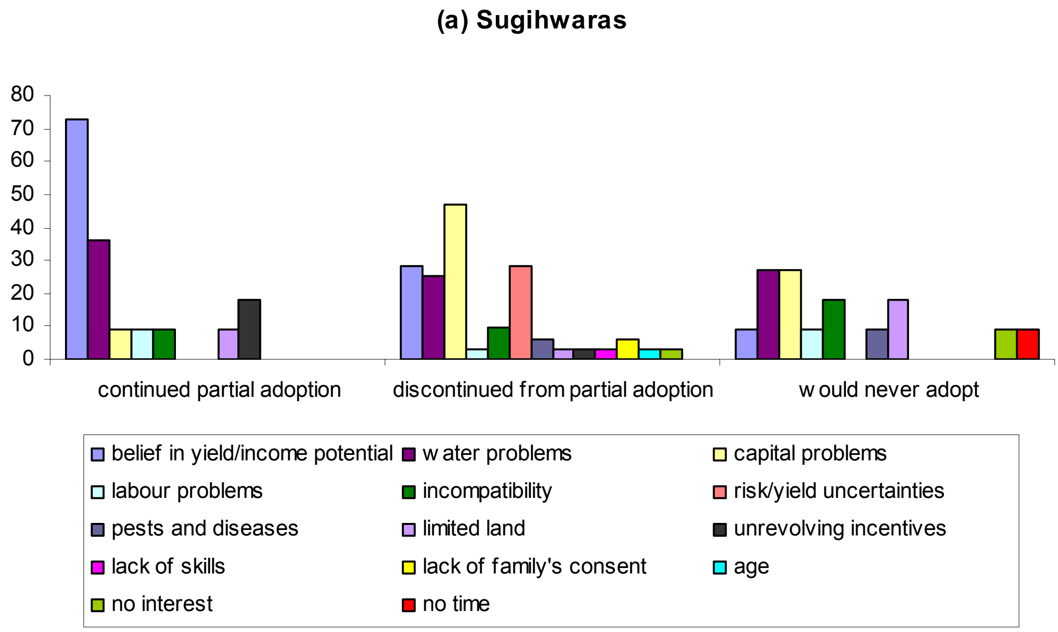
There are three groups of adopters and three groups of non-adopters in both Sugihwaras and Rejosari villages (see Appendix K for more details). However, no one among the respondents from both villages belonged to two groups: new adopters (partial) and new adopters (full). This indicated a limit in the spread of “pandu” among farmers in both villages. This also raised a question about the future application of “pandu”.

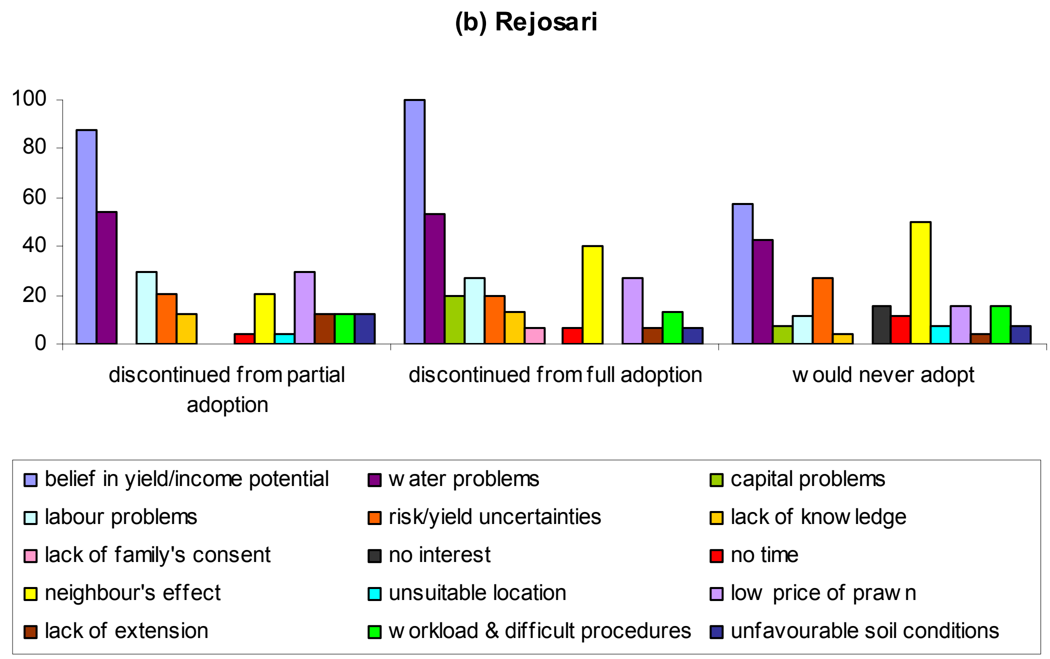
The latter was also justified by the existing adopter and non-adopter groups. Almost 75 percent of the Sugihwaras respondents were among the non-adopters. Two-thirds of them discontinued “pandu” for some reason, while the rest said they would never adopt “pandu”. A larger percentage of non-adopters were found in Rejosari (around 92 percent) with reasons mostly related to either a lack of interest, or discontinuation. The figure in Sugihwaras was better than Rejosari because the introduction process of “pandu” in Sugihwaras was newer than in Rejosari.

A very limited number of respondents continued applying “pandu”, especially the full adopters. In contrast, most respondents seemed to apply “pandu” partially, or modify one or more “pandu” components. These included the ones who decided to give up partial application of “pandu”. These trends were also observed among the respondents who participated in the dissemination of “pandu”. Around 58 percent and 82 percent of the participating farmers from Sugihwaras and Rejosari, respectively, had stopped applying “pandu”. The data indicated a low chance of sustainable and widespread “pandu” application among farmers.

Figure 7.1 presents the main reasons why the three largest groups did, or did not, adopt “pandu” (see Appendix B for the associated open-ended questions). It appeared

Figure 7.1 Distribution of respondents' reasons for their different adoption decisions





that the Rejosari respondents' reasons were more diverse than the Sugihwaras respondents. A closer look at the perception of "pandu" yield/income potential also showed a more positive perception of "pandu" among the Rejosari respondents than the Sugihwaras respondents. This might be a result of the different dissemination coverage between the two villages. In Sugihwaras, the dissemination process involved only 17 farmers compared to 35 in Rejosari. The dissemination of "pandu" in Rejosari was also earlier than in Sugihwaras, so the Rejosari had a longer experience of applying “pandu” and had observed more results. Nevertheless, the positive perception about “pandu’s” potential seemed to provide little incentive for sustainable application.

For the Sugihwaras respondents, the lack of capital seemed to be the main reason for stopping “pandu”. Others also decided to give up “pandu” as low water quantity and quality increased the mortality rate of prawn and led to yield uncertainties (Figure 7.1). Similar concerns were also shared among the respondents who continued partial adoption. The majority of them were also dissatisfied about the distribution of incentives from the “pandu” program which failed to pass from participating farmers to other farmers.

Similar perceptions about water conditions and capital requirement were also found among the Sugihwaras respondents who would never adopt “pandu”. They perceived “pandu” as costly and incompatible with water availability and quality. They believed that these factors had made “pandu” too risky.

Such perceptions, however, were rarely observed among the Rejosari respondents who gave up “pandu”, and who would never adopt “pandu”. Their reasons for abandoning “pandu” were related to water supply problems and pesticides applied by their neighbour. The latter, in particular, appeared to be serious only in Rejosari. They believed it was not possible to apply “pandu” if their neighbours (the surrounding farms) had different cropping systems, especially if their neighbours regularly grew vegetables and applied pesticides, as this could increase the prawn mortality rate. This problem was evident as more farmers in Rejosari preferred to grow vegetables than in Sugihwaras. The respondents perceived that finding a compromise among the neighbouring farms was difficult, as every one of them wanted a profitable result regardless of their neighbours’ commodities. This had also increased the perception of risk among the non-adopters. For the former adopters, the low prawn price and limited labour supply also appeared to be the reasons for discontinuation.

The different responses shown in Figure 7.1 suggest different decision approaches were used by each group of respondents. Some groups showed similarities, but each seemed to have a different priority for determining the most fundamental reasons for their decisions. For example, water conditions in both villages seemed to be the main source of risk in applying “pandu”. However, the Sugihwaras respondents also seemed to put an emphasis on the costs of “pandu”, while the Rejosari respondents were more concerned about the effects of pesticide application by their neighbours on prawn survival.

The characteristics of each group of respondents may become clearer from the results of the SocioGrids analyses. Using the same grouping of respondents, but with the responses collected from the repertory grid interviews, the SocioGrids analysis results were expected to elicit the shared concepts/constructs among the respondents in a group of adopters/non-adopters.

7.3.2. SocioGrids Analysis Results

In this section, the SocioGrids analysis results are discussed. Due to the richness of the SocioGrids results, the discussion will highlight the main features of each adopter’s/non-adopter’s shared elements and constructs. The discussions are based on the attitudes towards “pandu”, perceived behavioural control and the bargaining process. Supplementary information from the SocioNets function was also provided in order to show the link among the respondents based on their construct similarities. The results are summarized in Table 7.1 until 7.6.

7.3.2.1 SocioGrids on attitudes towards “pandu”

The FOCUS results show that all adopters in Sugihwaras and Rejosari commonly compared “pandu” to the current system, i.e. paddy-fish intercropping (Table 7.1 and 7.2, next pages). Table 7.1 also shows that the evaluation of the agro-climatic conditions marked the change in the adoption behaviour in Sugihwaras, from adoption (full or partially) to non-adoption. This was first evident among the Sugihwaras

Table 7.1 Shared decision criteria related to attitudes towards "pandu" among the Sugihwaras respondents

Adopter / non-adopter group *	Eligible respondents	FOCUS results: Element themes	FOCUS results: Construct themes	PrinCom results (Shared decision criteria)	SocioNets (%) **
Continued full adoption	SI006, 013, 021	- Comparison between income from prawn and from fish - Capital, knowledge and skills requirements	- Input-output	- Profit from "pandu"	65.10
Continued partial adoption	SI001, 003, 011, 014, 016, 020, 028, 044, 054, 059	- Comparison between yield from "pandu" and current system - Capital and knowledge requirement	- Farming and family needs - Own efforts and assistance for dealing with local conditions - Commodity preferences	- Prawn as a substitute for current system: paddy and fish	65.00
Reduced practice from full to partial adoption	SI018	- Comparison between yield from "pandu" and current system - Capital, knowledge and agro-climatic requirements	- The extent of own capacity for dealing with "pandu"	- Capital availability and agro-climatic conditions	n.a
Discontinued from partial adoption	SI004, 005, 007, 008, 010, 012, 015, 017, 019, 023, 024, 025, 026, 029, 030, 031, 032, 036, 037, 038, 039, 040, 046, 047, 048, 049, 053, 056	- "Pandu" yield based on current agro-climatic conditions	- Capital availability for successful "pandu" production - The workload and uncertainties in input and output	- Workload and capital for dealing with agro-climatic conditions	52.78
Discontinued from full adoption	SI002	- "Pandu" production requirements: input, agro-climatic factors, knowledge and skills - Comparison between prawn and fish yields - Income from paddy	- Farming capital and income	- Income from paddy - comparison between input and labour costs for prawn and for fish	n.a
Would never adopt	SI022, 027, 034, 043, 045, 051, 052, 057, 058	- Income from paddy-fish production - Capital and agro-climatic requirements	- Family consensus - Capacity of farm production for fulfilling family needs	- Preference on current paddy-fish system based on the available capital and agro-climatic conditions	57.15

* All groups used an 80 percent cut-off point for creating a mode grid.

** SocioNets results indicate the extent of perceptions shared among the group members. A high percentage indicates a high proportion of the group members using similar conceptions for evaluating "pandu". "n.a" means not applicable due to single-group member.

Table 7.2 Shared decision criteria related to attitudes towards “pandu” among the Rejosari respondents

Adopter / non-adopter group*	Eligible respondents	FOCUS results		PrinCom results (Shared decision criteria)	SocioNets (%) **
		Element themes	Construct themes		
Incremental adoption	RI073	- Current farming system - Knowledge of paddy-prawn intercropping - Input availability and costs	- Plant production as primary sources of capital and income	- Labour costs and vegetable production	n.a
Continued partial adoption	Based on element similarities: RI062, 115	- Current farming system - Consequences of harvest failure	- Priority in farming	- Consequences of harvest failure	71.88
	Based on construct similarities: RI062, 115	- Comparison between current system and “pandu” - Side activities - Possibility of failure	- Priority in farming - Achievement	- Time for side activities - Possibility of failure	90.00
Reduced practice from full to partial adoption	RI060, 066, 092	- Comparison between current paddy-fish system and the yield and costs related to prawn production - Labour, knowledge and agro-climatic requirements - Time allocation for working in the field and being home with family members	- Frequency in dealing with family and farming issues	- Level of paddy production for fulfilling family needs	68.91
Discontinued from partial adoption	Ri061, 063, 064, 068, 070, 079, 083, 084, 085, 087, 088, 098, 104, 105, 113, 114, 116, 118, 124, 125, 126, 128, 129, 130	- Input costs and knowledge requirement	- Own capacity in learning, working and making decision - Managerial and financial issues	- Own managerial and financial capacity	56.25
Discontinued from full adoption	RI074, 077, 078, 080, 082, 086, 089, 094, 097, 109, 117, 119, 121, 122, 123	- Current paddy-fish production - Family’s knowledge on paddy-prawn intercropping	- Paddy as main commodity	- Knowledge of paddy-prawn intercropping	61.90
Would never adopt	RI065, 067, 069, 071, 072, 075, 076, 081, 090, 091, 093, 095, 096, 099, 100, 101, 102, 103, 106, 107, 108, 111, 112, 120, 127	- Profit from fish production	- Priority in farming - Profitability	- Profit from fish production	58.33

* The cut-off point for creating a mode grid for “*reduced practice from full to partial adoption*” and “*discontinued from full adoption*” was 73 and 78 percent, respectively. The other groups used an 80 percent cut-off point for creating a mode grid.

** SocioNets results indicate the extent of perceptions shared among the group members. A high percentage indicates a high proportion of the group members using similar conceptions for evaluating “pandu”. “n.a” means not applicable due to single-group member.

respondents who reduced their “pandu” adoption from full to partial application. Interestingly, Table 7.2 also shows the capital and knowledge requirements as the factors for deciding whether to increase or reduce the “pandu” components applied. These factors differentiated between the *incremental adoption* and *reduced practice* groups in Rejosari.

Another interesting finding was that the *continued partial adoption* group in Rejosari seemed to be very concerned about the possibility of failure, especially when comparing “pandu” with the current system. This might represent their risk perceptions. However, a similar risk perception was not found among the non-adopters in Rejosari. Instead, the non-adopter groups were more interested in the capital, knowledge requirements or profit.

The elements shared in each group had also shaped different constructs and decision criteria (see PrinCom results in Table 7.1 and Table 7.2) used in each group. The full adopters in Sugihwaras appeared to be the most practical farmers, as they only focused on the profitability of “pandu” for deciding whether to continue applying “pandu” (Table 7.1). In contrast, the partial adopters evaluated “pandu” on their own capacities, which they felt were lacking with respect to the farming requirements and family needs. These led them to modify or partially apply “pandu” components. For example, the *continued partial adoption* group considered prawn as an optional substitute for fish, while the *reduced adoption practice* group seemed to make adjustments according to their assets and local agro-climatic conditions.

In Rejosari, the PrinCom results exhibited that the fulfilment of family needs appeared to be important for the adopters, while technical and financial limitations became the main concerns of the non-adopters (Table 7.2). From the constructs, it was clear that the attitudes towards “pandu” among the Rejosari farmers were related to their goals/priorities, both in family and farming. The constructs also showed the importance of vegetable or paddy production. Vegetable production was important as it provided cash for covering household daily expenses. Paddy yield was also important because it could assure the family food supply for the following year.

Among the non-adopters in both villages, their shared constructs and decision criteria seemed to relate more to the lack of capital and the lack of knowledge about “pandu”. The non-adopters in Sugihwaras evaluated “pandu” from its productivity level, besides their financial capacity (Table 7.1). Some of them also considered the heavy workload requirements and less suitable agro-climatic conditions. However, a preference for fish production might become another important reason for not applying “pandu” by the many respondents. Such a preference might come from individual choice or a consensus. For example, the *discontinued from full adoption* group tried and obtained results from “pandu” before deciding to return to the previous system. For the *would never adopt* group, the decision seemed to come from the family consensus in contrast to the respondent’s individual choice.

For the non-adopters in Rejosari, the lack of knowledge about “pandu” appeared to be the biggest impediment to continue applying “pandu” (see Table 7.2). Some were also concerned about their limited financial capacity. Among the *would never adopt* group, there was a strong preference for fish production and this becomes their main reason for not considering “pandu” as a potential option.

The combination between the elements and constructs has distinguished the main characteristic(s) of each group. Nevertheless, the *reduced practice* and *discontinued from full adoption* groups in Sugihwaras might be a less valid representation as each only contained one respondent (Table 7.1). This made it impossible to run the SocioNets analysis for these groups. For the rest, the SocioNets suggested that the *continued full adoption*, and the *continued partial adoption*, groups had the strongest conclusion on their characteristics. The members in each group had 65 percent similarities in their perceptions on “pandu” (see Table 7.1).

A similar level of representation of the adopter and non-adopter groups was also found in Rejosari. Table 7.2 shows that the *continued partial adoption* group in Rejosari shared the most similarities in constructs compared to the others. This group also had two possible ways of creating a mode grid, based on either element or construct similarities. All of these were possible because there were only two members in the group. As the number of members in a group increased, however, it was more difficult to find clear similarities, especially among the constructs, as in the other groups in Rejosari. Among these groups, the *reduced practice* and *discontinued from full adoption* groups showed the highest percentage of constructs shared among their members (68.91 and 61.90 percent, respectively).

Overall, the findings provided a more reasonable explanation about the respondents' attitudes towards "pandu". Farmers who participated in the dissemination process exhibited the full range of possibilities, that is, to choose to continue, modify, reduce, or discontinue "pandu". For non-participating farmers, some were interested in trying "pandu", although not all of them continued the application.

Some adopters in Sugihwaras continued full adoption of "pandu" as they were convinced of its high profitability, while some adopters in Rejosari viewed "pandu" as a risky option as it might fail to fulfil the family needs. The latter, however, was not among the reasons why the respondents did not adopt or continue "pandu". Instead, preference for fish production appeared to be the underlying motive of the non-adoption practices in both villages. This was evident as most respondents in both villages, regardless of their adoption behaviour, compared "pandu" to the current farming system. This approach became the basis for further examination of the "pandu" requirements and results. This also indicates how the respondents evaluated their own capacity in dealing with the opportunities and challenges related to "pandu". This will be further confirmed through the SocioGrids analyses related to the respondents' perceived behavioural control presented next.

7.3.2.2 SocioGrids on Perceived Behavioural Control (PBC)

The number of eligible responses for this analysis was less due to some respondents giving fewer than two constructs, or they completely deselected the elements. Some eligible respondents were also excluded, as their responses were too diverse and, hence, had no similarities. Most of the responses also seemed to focus on the

Table 7.3 Shared decision criteria related to perceived behavioural control among the Sugihwaras respondents

Adopter / non-adopter group *	Eligible respondents	FOCUS results		PrinCom results (Shared decision criteria)	SocioNets (%) **
		Element themes	Construct themes		
Continued full adoption	SI006, 013	- Knowledge and experience of paddy-prawn intercropping	- Allocation for farming and family needs - Financial and technical issues	- Knowledge and experience of paddy-prawn intercropping	53.13
Continued partial adoption	SI001, 003, 011, 014, 028	- Access to information, skills and capital	- Level of technical capability - Access to technical and financial sources	- Access to technical and financial sources for applying "pandu"	65.28
Reduced practice from full to partial adoption	SI018	- Extension services for dealing with agro-climatic conditions - Capital requirement	- Extent of current problems	- Problems related to capital, water supply, pests and diseases	n.a
Discontinued from partial adoption	SI004, 005, 008, 010, 012, 017, 019, 023, 025, 032, 033, 038, 048, 053, 056	- Capital and knowledge requirements	- Access to production inputs - Level of own technical and financial capabilities	- Lack of capital - Easy access to external sources of technical support	50.00
	SI024, 029, 030, 035, 039, 040	Two low correlated themes: - Capital - Pest and disease infestation	- Internal and external sources of technical and financial supports	- Sufficient own capital - Lack of technical support for dealing with pests and diseases	62.50
Discontinued from full adoption***		n.a	n.a	n.a	n.a
Would never adopt	SI022, 034, 045, 052	- Pest, disease and debt problems	- Internal and external sources of financial and technical supports	- Own effort to deal with pests and diseases in the beginning of season - Lack of capital and reliance on debt	72.92

* The cut-off point for creating a mode grid for "*continued full adoption*" was 56.25 percent. The other groups used an 80 percent cut-off point for creating a mode grid.

** SocioNets results indicate the extent of perceptions shared among the group members. A high percentage indicates a high proportion of the group members using similar conceptions for evaluating "pandu". "n.a" means not applicable due to single-group member.

*** The only respondent categorized in this group elicited only one construct, which made it impossible to run the FOCUS, PrinGrid and SocioNets analyses.

Table 7.4 Shared decision criteria related to perceived behavioural control among the Rejosari respondents

Adopter / non-adopter group *	Eligible respondents	FOCUS results		PrinCom results (Shared decision criteria)	SocioNets (%) **
		Element themes	Construct themes		
Incremental adoption***		n.a	n.a	n.a	n.a
Continued partial adoption	RI062, 115	- Extension service and capital related to "pandu"	- The importance of own capacity - Technical and financial requirements of the current and new system	- Capital requirement for applying "pandu" and technical assistance from extension service	87.50
Reduced practice from full to partial adoption	RI060, 066, 092	- Knowledge and experience of paddy-prawn intercropping	- Availability of technical assistance	- Unavailability of technical assistance for applying "pandu"	81.25
Discontinued from partial adoption	RI061,063, 079, 083, 088, 114, 116	- Extension service on pest and disease control - Knowledge of paddy-prawn intercropping	- Problems related to technical and financial requirements - Allocation for family and farming needs	- Lack of family's knowledge of paddy-prawn intercropping	58.33
	RI064, 130	- Assets	- Own decision - Lack of capacity	- Own assets - Lack of bargaining power in marketing	97.92
	RI070, 113	- Skills and time requirements	- Own application procedures - Uncertain working hours	- Certain skills requirement - Uncertain working hours	85.42
Discontinued from full adoption	RI077, 080, 122	- Agro-climatic conditions	- Financial problems - The role of farmer group	- Group effort for dealing with pests and diseases - Individual water supply problem	91.67
	RI086, 089, 117	Two low correlated themes: - Extension services - Sale price	- Technical and financial issues	- Lack of technical assistance and low sale price	53.13
Would never adopt	RI067, 072, 075, 076, 081, 095, 096, 099, 120, 127	- Capital	- Decision and effort for dealing with problems - Availability of external assistance	- Lack of access to external sources of capital	66.67
	RI090, 091, 102, 112	- Knowledge from extension services	- Group meeting - Availability of extension services	- Lack of extension services	75.00

* The cut-off point for creating a mode grid for the second group of "*discontinued from full adoption*" was 78.10 percent. The other groups used an 80 percent cut-off point for creating a mode grid.

** SocioNets results indicate the extent of perceptions shared among the group members. A high percentage indicates a high proportion of the group members using similar conceptions for evaluating "pandu".

*** The only respondent categorized in this group elicited only one construct, which made it impossible to run the FOCUS, PrinGrid and SocioNets analyses.

impeding factors. This could be due to the small number of similarities shared among the respondents. The results are presented in Table 7.3 and 7.4.

Among the adopters in Sugihwaras, the *continued full adoption* group seemed to be less concerned about the financial issues (Table 7.3). They also seemed to have sufficient knowledge and experience for applying “pandu”. This was in contrast to the *continued partial adoption* and *reduced practice* groups, which seemed to be concerned with their financial and technical capacities. The *continued partial adoption group*, in particular, cited that the limited access to the technical and financial resources had caused them to modify the application of “pandu”.

Similar findings were also observed among the Rejosari respondents (Table 7.4). Concern over technical capacities, in particular, was found among all groups of adopters. Unavailability of technical assistance, for example, might create a low level of confidence among the respondents for applying “pandu”. The *continued partial adoption* group also seemed to be concerned about their capacity for fulfilling the “pandu” capital requirement.

Similar problems related to technical and financial capacities were also found among the non-adopters in both villages. However, such concerns appeared to vary as some non-adopter groups were split into smaller groups (see Table 7.3 and 7.4). For example, the Sugihwaras respondents who discontinued partial “pandu” adoption was split into two smaller groups. Fifteen respondents who discontinued partial adoption perceived that they had a relatively easy access to technical support but, at the same time, they lacked capital (see Table 7.3). The reverse perceptions, however, applied for the other six members of this group. The lack of capital and reliance on debt was also cited as an impeding factor for the respondents who would never adopt “pandu”. They, however, seemed to have sufficient experience in dealing with pests and diseases, particularly at the beginning of the season.

In Rejosari, the *discontinued from partial adoption* group was also divided into three groups (see Table 7.4). Seven members of this group appeared to be concerned about whether their family had sufficient knowledge of paddy-prawn intercropping. Two other members, on the other hand, perceived that they had the necessary skills, but viewed the workload requirement as the most difficult challenge in applying "pandu". The last two members of this group appeared to have a different perception of control, as they were more concerned about their lack of bargaining power when dealing with middlemen for marketing their products.

The other two non-adopter groups in Rejosari were also split (Table 7.4). However, the FOCUS and PrinCom results for these groups reveals a common concern related to the limited availability/access towards external technical and financial assistance.

Table 7.3 and 7.4 also provides the SocioNets analysis results. Among the adopter/ non-adopter groups in Sugihwaras, the *would never adopt* group seemed to provide the most robust representation as indicated by a 72.92 percent of construct matches. The *discontinued partial adoption* group also showed an adequate representation although it was split into two small groups. In contrast, the *continued full adoption* and the *reduced practice* groups might be the least representative groups due to, respectively, their lowest cut-off point and sample size (see Table 7.3). A low cut-off point indicated a loose approach in determining the shared elements and constructs.

In Rejosari, most of the adopter and non-adopter groups showed a high level of group representation (between 53.13 and 97.92 percent). This especially applied to groups with fewer members. The exception was the second sub-group of the *discontinued from full adoption* group, which had the lowest commonality (Table 7.4), mainly due to the poorly correlated elements.

Overall, the respondents' perceptions of their behavioural control seemed to be influenced by their beliefs about their technical and financial capacities. Such beliefs were also affected by the extent of their access to external technical assistance and financial sources. These factors, however, were described more as problems rather than supporting factors. These included, as noted in Table 7.3 and 7.4, the lack of knowledge, extension services and access to external sources of capital. Heavy workload and problems related to debt, water supply, pests, diseases and marketing practices also contributed to the low level of confidence among the respondents in applying “pandu”.

Despite the lack of external supports, these respondents could ask for help from community members, either their relatives or colleagues. This is relevant in this case study as the respondents still live in a community with a strong socio-cultural influence. Nevertheless, obtaining answers might be difficult as the respondents might have a different preference to their partner(s) when discussing issues. It might be necessary to negotiate to come to a conclusion. This leads to the next discussion on the SocioGrids results related to the bargaining process.

7.3.2.3 SocioGrids on bargaining process

Most of the elements and constructs in the bargaining process that were shared among the Sugihwaras respondents were related to the roles of the respondents’ “significant others”. These included giving advice or information, collaborating in farming, extension or marketing, or discussing general issues (Table 7.5, next page). Some respondents also used “kinship”, “level of knowledge” or “position” in determining their “significant others”. This confirms the findings in the individual construct analyses.

The PrinCom analyses further confirmed the Sugihwaras respondents’ most important “significant others” and the areas where the respondents needed others’ advice or assistance. These included the farmers’ spouse for dealing with product marketing, making decisions and/or applying recommendations (Table 7.5). This indicated the dominance of family in influencing the respondents’ decision making process. The exceptions were the *continued partial adoption* and the *reduced practice groups* who appeared to find a balance in involving family and non-family “significant others”.

Table 7.5 Shared decision criteria related to the bargaining process among the Sugihwaras respondents

Adopter / non - adopter group *	Eligible respondents	FOCUS results		PrinCom results (Shared decision criteria)	SocioNets (%) **
		Element themes	Construct themes		
Continued full adoption	SI006, 013, 021	- People involved in extension activities - People involved in marketing	- Kinship - Topic of discussion	- Spouse as the main partner in dealing with product marketing	65.83
Continued partial adoption	SI001, 003, 011, 014, 016, 059	- Sources of information	- External sources of advice - Position - Level of knowledge	- Researchers as knowledgeable external sources - Neighbours as inexperienced local sources	54.69
	SI028, 044, 054	- Main sources of advice	- Closeness - Role in decision making	- Discuss with extended family and neighbours - Consent from parents	88.89
Reduced practice from full to partial adoption	SI018	- People with trade relation - People for consultation	- Kinship and closeness	- Spouse as the main decision making partner in the family - Researchers as the closest external sources of advice	n.a
Discontinued from partial adoption	SI004, 005, 007, 008, 010, 012, 015, 017, 026, 033, 035, 038, 040, 047, 048	- Mains sources of advice	- Knowledgeable close people - Close people who were partners in making and applying decisions	- Spouse as the main partner in making and applying decision	60.42
	SI023, 023, 030, 031, 032	Two low correlated themes: - Spouse - Neighbouring farmers	- Kinship	- Spouse as the main partner in dealing with product marketing	50.00
	SI019, 029	- Farmer group	- Local sources of capital - Support on farmers	- Farmer group as the main source of assistance	87.50
Discontinued from full adoption***		n.a	n.a	n.a	n.a
Would never adopt	SI022, 034, 056, 058	- Family and non-family issues	- Role in decision making - Local people	- Spouse as the main partner in making and applying decision	72.92
	SI027, 051	- Contribution to farming	- Partner in farming - Closeness	- Neighbouring farmers as the closest people	100.00

* The cut-off point for creating a mode grid for "*continued full adoption*" was 77.50 percent. The other groups used an 80 percent cut-off point for creating a mode grid. ** SocioNets results indicate the extent of perceptions shared among the group members. A high percentage indicates a high proportion of the group members using similar conceptions for evaluating "pandu". "n.a" means not applicable due to single-group member. *** The only respondent categorized in this group elicited only one construct, which made it impossible to run the FOCUS, PrinGrid and SocioNets analyses.

Table 7.6 Shared decision criteria related to the bargaining process among the Rejosari respondents

Adopter / non-adopter group*	Number of eligible respondents	FOCUS results		PrinCom results (Shared decision criteria)	SocioNets (%) **
		Element themes	Construct themes		
Incremental adoption	RI073	- People involved in extension activities - Closest people	- Closeness	- Spouse as a primary source of advice	n.a
Continued partial adoption	RI062, 115	- Closest local people - Farmer group	- Closeness	- Farmer group as the main external source of advice	67.71
Reduced practice from full to partial adoption	RI060, 066, 092	- People involved in extension activities - Sources of innovation	- Closeness and contribution	- Extension officers as the main source of information - Spouse as a closest person	63.19
Discontinued from partial adoption	RI061, 063, 064, 068, 070, 079, 083, 084, 085, 086, 088, 098, 104, 105, 113, 114, 116, 118, 124, 125, 128, 129, 130	- Closest people	- Closeness - Topic of discussions - Kinship	- Spouse as a primary source of advice	56.25
Discontinued from full adoption	RI074, 077, 078, 080, 086, 089, 094, 097,109, 117, 119, 121, 122	- Closest people	- Local sources of advice - Kinship	- Spouse as a primary source of advice	65.63
Would never adopt	RI065, 067, 071, 072, 075, 081, 091, 095, 101, 102, 103, 108, 111, 112, 120, 127	- Closest people	- Closeness - Kinship	- Spouse as a primary source of advice	50.00

* The cut-off point for creating a mode grid for "*reduced practice from full to partial adoption*" was 76 percent. The other groups used an 80 percent cut-off point for creating a mode grid.

** SocioNets results indicate the extent of perceptions shared among the group members. A high percentage indicates a high proportion of the group members using similar conceptions for evaluating "pandu". "n.a" means not applicable due to single-group member.

For example, some members in the *continued partial adoption* group discussed "pandu" with researchers and neighbours, besides siblings and parents.

In contrast to the Sugihwaras respondents, most Rejosari respondents considered their closest people as their main partners in discussions/bargaining process (Table 7.6). The PrinCom results indicated the respondents' spouse as the most influential person in their decision making process, followed by extension officers and farmer groups. The latter appeared to be influential particularly for the partial adopter groups.

The SocioNets analyses also confirmed the results, particularly for the roles of the respondents' spouse (see Table 7.5). For example, the Sugihwaras respondents' spouse appeared to be very influential in deciding whether to fully adopt "pandu" (SocioNets results = 65.83% and 72.92%, respectively). This was also observed in the Rejosari, particularly among the non-adopters (see Table 7.6). Their spouse was in charge of consumption and financial management in the family and, hence, their opinion was important in determining the type of commodities produced in each season. When the respondents' spouse perceived that the recommended paddy planting distance ("jajar legowo") as costly and time consuming, they might decide to give up the recommendation, and/or advise to give up "pandu". This might explain the fast reduction of adoption in Rejosari. On the other hand, this showed the importance of involving the respondents' spouse in the dissemination and training of "pandu" in order to ensure the sustainability of "pandu".

Outside the family, neighbours, farmer groups and researchers appeared to be important for some respondents in both villages. The influence from neighbours and farmer group members might not always come in the form of advice, but relate to the observation of their failure leading to non-adoption.

Overall, the SocioGrids analyses of the bargaining process confirmed the different roles of family and non-family members in influencing the respondents' decision making process. The results also indicated the importance of widening the coverage of the “pandu” dissemination process to include the respondents’ spouse, other family members and other members of the community. Different approaches and preferences between the respondents in Sugihwaras and in Rejosari also suggested that a different culture and social relationships existed in these two neighbouring villages.

7.4. Summary and Contributions to the Adoption Model

The analysis based on the Personal Construct Theory (PCT) provides a more thorough way to understand a farmer’s behavioural motives related to “pandu”. The results are rich in detail, and reveal each farmer’s personal approach “*to make sense of things*” (Walker, 1996, p. 8). Jangu (1997) also referred to these as an elaboration of the cognitive structure of the adopters and non-adopters.

In this study, the cognitive structure of the adopters and non-adopters is depicted in the TPB model described in Chapter Four, Figure 4.4 (p. 95). This model can be further refined and enhanced using the results from the repertory grid analysis. This includes identifying the background stimuli that become inputs for the belief-based components of the model (behavioural, normative and control beliefs). The FOCUS and PrinCom functions in the repertory grid analysis, in particular, can extract the individual farmers’ unique responses that represent the most relevant perceptions and factors involved in the farmers’ decision making process.

Nevertheless, using an individual grid, the analyses could not differentiate decision criteria according to the farmers’ adoption behaviours due to the diverse responses. The SocioGrids function in the RepGrid software can resolve this issue. It can identify the shared elements and constructs of adopters/non-adopters. It creates a composite mode grid from all respondents in one group, which is further analyzed using FOCUS and PrinCom. The results are similar to the ones from FOCUS and PrinCom, but the procedures are more timesaving and can reduce the possibility of error in the interpretation of a large sample size.

The SocioGrids analysis of different groups of adopters/non-adopters in this study revealed the underlying factors in a particular attitude. For example, the changes in agro-climatic conditions had led many Sugihwaras farmers to reduce, or stop, "pandu". SocioGrids results also clarified that the predilection towards fish production underlying the non-adoption practices in both villages seemed to stem from the lack of capital and knowledge about paddy-prawn intercropping. The analyses also showed that spouses and extension activities had a strong influence on the farmers' decisions. The summary of the results and their possible contribution to the TPB model are presented in Table 7.7.

Table 7.7 Summary of the farmers' personal construct system

TPB component	Decision criteria identified from Repertory Grid analysis	Relevant aspects or variables
Attitudes towards "pandu"	- Profitability	Income and expenses
	- Technical requirements	Knowledge, skills and experience especially related to soil and water conditions
	- Commodity preference: "pandu" versus paddy and fish	Workload, water requirement, capital and yield
	- Access to external resources	Cooperation/assistance in obtaining inputs, working and decision making
Perceived behavioural control	- Technical capacities	Knowledge, skills and experience
	- Financial capacities	Own and borrowed capital, incentives, income
	- Risks related to environmental and market conditions	- Water conditions, pests and diseases - Roles of middlemen
Bargaining process	- Closest people	Family and local people
	- Purpose of discussion/negotiation	Problem solving, information exchange, capital supplementation, endorsement

The general conclusion from the decision criteria in Table 7.7 is that they interrelate with each other. The farmers' beliefs on the technical requirements of "pandu" appeared to closely relate to the requirement of better management of the agro-climatic factors, such as water and soil. This influences the farmers' attitudes towards "pandu" requirements. The farmers also perceived the need to seek external assistance if the technical requirements were beyond their current capacities. This showed one aspect of the farmers' control beliefs.

The results also showed that families and villagers were the people from whom the farmers mainly obtain assistance. The farmers used discussion and negotiation with their “significant others” to find solutions to their problems, to obtain additional capital, or to seek justification for their actions. All of these depicted the bargaining process component in the farmers’ cognitive structure. Such interrelationships could not be discovered, however, from simply asking the farmers about their reasons for their adoption or non-adoption decisions (see Figure 7.1 in page 202).

Overall, the findings confirmed the importance of technical and financial aspects for securing a positive perception about “pandu” and improving the farmers’ level of confidence in applying “pandu” procedures. This may be achieved through improving the farmers’ access towards external sources of technical and financial assistance, as well as through expanding the technology dissemination to include the farmers’ significant others.

The results from FOCUS, PrinCom and SocioGrids can also be used for refining the TPB model used in this study. The elicitation procedures and the visual representations (decision trees and two-dimensional plots with contrasting terms) can ease the process of identifying decision criteria and their interrelationships. This could also simplify the process of TPB model development. The elicitation process also has the minimum interviewer bias as the respondent uses her own expressions/ terms when evaluating “pandu”. The results from the SocioGrids analysis are also useful for identifying the links between the background stimuli and the relevant adoption behaviour. It is also possible to develop different TPB models for different groups of farmers according to their adoption behaviour. Different TPB models may help address the concerns of different groups of adopters/non-adopters and be useful in revitalizing the “pandu” program and sustain its adoption.

Nevertheless, to include these procedures into the TPB concept requires some adjustments. This includes the standardization of the procedures and the adjustment in the scoring and the length of the interview. The uniqueness of the results may also require the interview process to tackle the shared responses among respondents. A pilot study, hence, may be necessary. The pilot may be aimed not only at collecting information about the common elements used by the potential respondents, but also in identifying different groups of respondents that may have different preferences and adoption behaviour. The latter is important, as extension programs for a new technology introduction often do not recognize the different groups of adopters/non-adopters in the population. Group identification may also reduce the workload in processing the responses and interpreting the results, i.e. through directly using the SocioGrids function, and help create a more well-targeted policy intervention.

One remaining issue concerns the applicability of the PCT analysis. According to Murray-Prior (1998), the results are often perceived as descriptive rather than predictive. One of the reasons relates to the assumption in PCT that a group of people who use similar constructs may still act differently. This makes sense, as each decision tree shown in FOCUS is unique. However, a change in its variables may affect the grouping of the farmers, and this makes the integration of different decision trees more difficult.

This issue, however, may be tackled through the ethnography decision tree modelling (EDTM). According to Murray-Prior (1998), EDTM can accommodate changes which have resulted from learning, or other conditions, so that the decision tree can be used for prediction in a more dynamic situation. The decision tree can also accommodate the movement of an individual according to changes in their behaviour. All of these will be discussed in the next chapter.

CHAPTER EIGHT: FARMERS' DECISION CRITERIA APPLICATION PATHS

8.1. Introduction

In this chapter, the results from the semi-ethnographic interviews are summarized into several decision trees that represent the respondents' decision making steps. The decision trees were evaluated in terms of the factors involved and the implications relevant to the farmers, extension services and other concerned parties. Some decision trees are also tested using a different set of respondents in order to confirm their consistency and possible application in other cases. Contributions to the adoption model, as described in Figure 4.4 in Chapter Four (p. 95), are also discussed, and this is expected to improve the overall adoption analysis.

8.2. Decision Paths of Sugihwaras Farmers

"Pandu" was disseminated in Sugihwaras in 2004 involving 17 farmers; all were respondents in this study. The other 42 respondents from Sugihwaras were non-participating farmers. All participating farmers received technical assistance and financial incentives. Two demonstration plots were also provided. As the semi-ethnographic interviews were conducted in 2005, the participating farmers had the chance to try "pandu" again and evaluate the results. Therefore, the participating farmers had have three stages of decision making: (i) try or not try "pandu", (ii) apply all or partial recommendations, and (iii) continue or discontinue "pandu".

For non-participating farmers, the decision to "*apply partial or all recommendations*" was not applicable. Most of them might apply "pandu" partially since they might not have received complete information about "pandu". The non-participating farmers also did not receive any incentives and, hence, they had to rely on their own resources or seek external assistance. Nevertheless, they had a chance to observe the participating farmers' practices, compare "pandu" with their own practices, and evaluate the results before making an adoption decision. All of these situations might cause most of the non-participating farmers to adjust their "pandu" application.

8.2.1. Participating Farmers in Sugihwaras

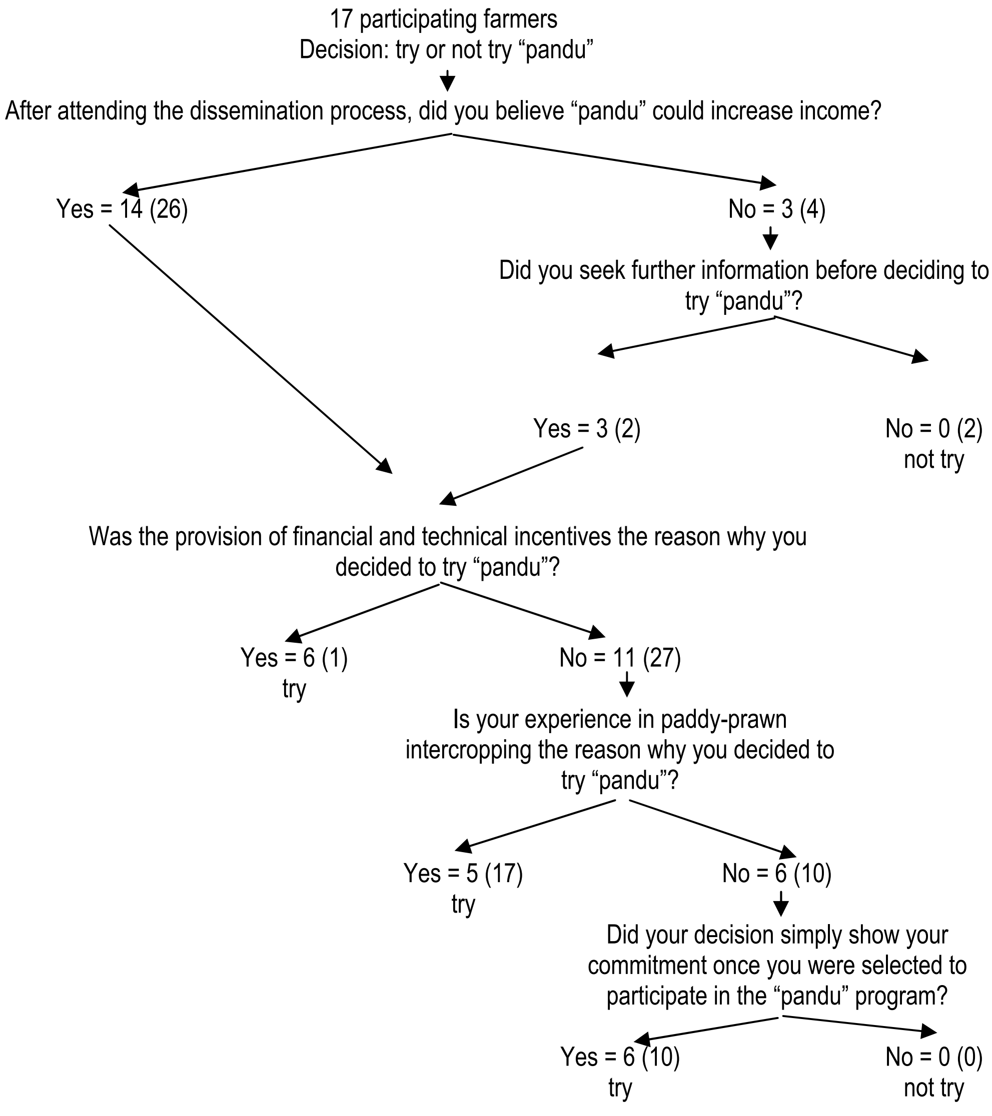
8.2.1.1 Try or not try "pandu"

The first decision to make for the participating farmers from Sugihwaras was "*try or not try pandu*" (Figure 8.1, next page). Four decision criteria were identified for this decision option. First, the farmers were asked whether they believed in the benefits of "pandu" after they attended the dissemination meeting. Fourteen farmers answered "yes", indicating that the dissemination process was successful in delivering information about "pandu" to these farmers. The other three farmers, however, required more information and observations before they were assured about the potential of "pandu". These farmers seemed to carefully digest new information. However, these three farmers had similar reasons for trying "pandu" as other farmers who were convinced by the "pandu" dissemination process.

Out of the 17 participating farmers, six farmers were interested in "pandu" because of the financial and technical incentives (see Figure 8.1, next page). This group included both wealthy and resource-limited farmers. The other five believed they had sufficient experience in paddy-prawn intercropping. These farmers were known in the village as among the hard-working farmers, and one of them had participated in many technology introduction activities. The other six farmers simply showed their commitment to the "pandu" program by trying "pandu". This group included a farmer whose ricefield-pond was used for the demonstration plot, two well-educated farmers who had off-farm jobs, and two farmers who were willing to follow any decisions made by their leaders.

The decision tree model in Figure 8.1 (next page) contained three errors and represented only 82.35 percent of the participating farmers' reasons for trying "pandu". Further tests using the responses from 30 farmers in Sidobinangun village showed that the model predicted 93.33 percent of the test farmers' individual choices regarding "pandu". This was perceived as adequate (80-90 percent is considered adequate, see Fairweather, 1996; Gladwin, 1989a; Jangu, 1993; Murray-Prior, 1998).

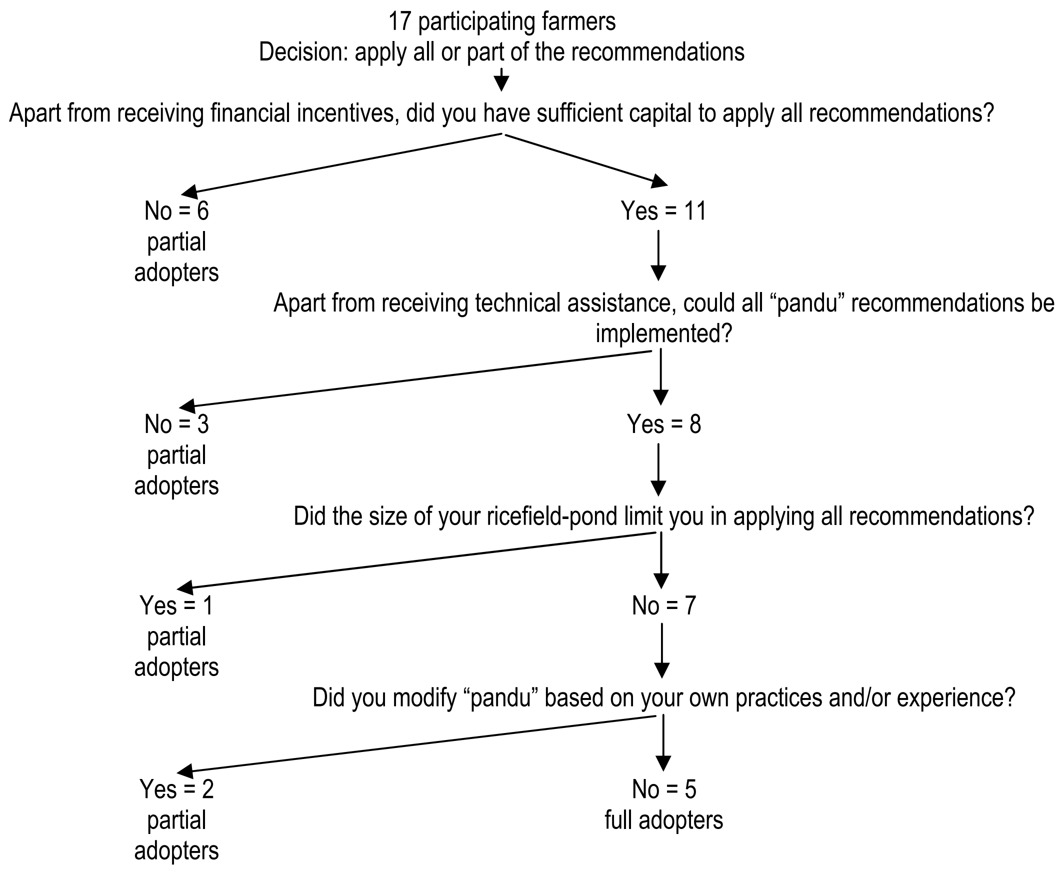
Figure 8.1 Participating farmers' responses to the dissemination of "pandu" in Sugihwaras



Cases = 17; Errors = 3; Correct representation = 82.35%; Predictability = 93.33%
The numbers in brackets indicate the number of farmers from the test sample group who confirm similar answers.

Overall, the decision tree model in Figure 8.1 showed that the technology introduction process required reciprocal responses from the researchers, extension services and the farmers. This was shown as the dissemination alone seemed to be inadequate as three participating farmers still looked for further information after the dissemination. Fortunately, the "pandu" program provided technical assistance and demonstration plots so that all participating farmers were assured over the advantages of trying "pandu". On the other side, the adoption of "pandu" also depended on the farmers' experience and motivation, which seemed to be influenced by the farmers' industriousness, frequent participation in extension services and farmer group activities, level of education, and good leadership in the village.

Figure 8.2 Participating farmers' level of "pandu" application in Sugihwaras



Cases = 17; Error = 1; Correct representation = 94.12%

8.2.1.2 Apply all or part of the recommendations

When the participating farmers tried "pandu", they had to deal with the agro-climatic conditions and uncertainties in the input supply and the market. Meanwhile, the "pandu" dissemination process, technical assistance and financial incentives only covered part of the production requirements. Hence, not all of the participating farmers followed the recommendations; instead, they modified their “pandu” application in order to suit their situation. This is depicted in Figure 8.2.

Six participating farmers appeared to modify “pandu” because of limited capital. The financial incentives were used mostly for buying prawn post-larva. The farmers still had to cover other expenses including the costs of farm labourers. The latter, however, was less affordable as applying “jajar legowo” (the recommended paddy planting distance in “pandu”) required a large number of farm labourers and a longer working time. This caused the farmers to give up “jajar legowo”.

The other three farmers also decided to apply only partial “pandu” recommendations due to technical problems. One farmer did not have sufficient time to apply all the land preparation procedures because he had to get the water quickly before it ran out. His ricefield-pond was far from the water source. The other farmer had reduced his time on the farm due to his age (one of the oldest farmers in the village) and let his son apply “pandu”. However, the son did not attend the dissemination meeting and, at the same time, had to manage his own farm. This might have led to the modification of “pandu” according to the son’s experience and time availability. An almost similar situation applied to the last farmer who had to work off-farm and entrusted “pandu” application to his brother and farm labourers.

One farmer also modified “pandu” because he had a small area of ricefield-pond. He thought that if he applied “jajar legowo” and dug a canal surrounding his ricefield-pond, he would not be able to obtain sufficient rice for consumption. Two other farmers considered they needed to adjust “pandu” according to their practices. For years, they had experienced success in paddy-prawn intercropping and, hence, believed that “pandu” would be more successful if they combined the new knowledge with their own experience. However, they did not mention a specific “pandu” modification.

The last five farmers among the participating farmers in Sugihwaras appeared to apply all the “pandu” recommendations. This included two farmers whose ricefield-ponds were used for the demonstration plots, and three farmers who had positive perceptions about each of the “pandu” components.

Overall, the decision tree model represented about 94 percent of the participating farmers’ decisions about whether to apply all the “pandu” recommendations. The model showed that the technology introduction process should consider the farmers’ cost structure. For “pandu”, the farm labour and the purchase of prawn post-larva were the biggest components in the production costs. If such costs could not be covered by the financial subsidies and the farmers’ own financial capacity, the possibility of a reduced or modified “pandu” application was increased.

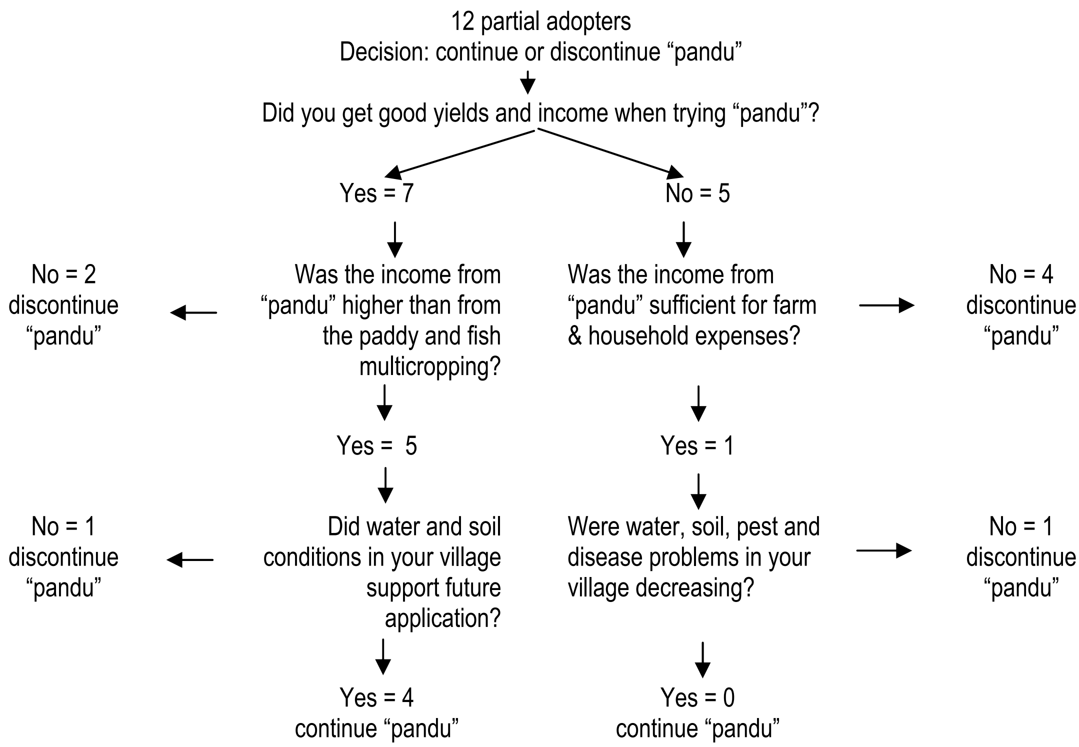
The decision trees also indicated that coverage of the dissemination process should be widened as people not attending the dissemination meeting might have an important role in managing the farm. This applied to the elderly farmers and farmers with off-farm jobs. Meanwhile, “pandu” might need modification to allow it to be implemented for different sizes of ricefield-pond. This, however, might require continuous support from the existing farmer groups and extension services, which in the case of “pandu” in Sugihwaras, appeared to not exist.

8.2.1.3 <u>Continue or discontinue “pandu”</u>

Once the farmers obtained the results from their initial use of “pandu”, they faced a decision choice of whether to continue “pandu”. The relevant decision tree model is presented in Figure 8.3 for the partial adopters (next page), and in Figure 8.4 for the full adopters (page 229).

There were 12 partial adopters, and not all of them experienced success in applying “pandu”. Seven obtained a good yield, while the rest perceived the yield was too low. Among the successful (partial) adopters, two decided to stop applying “pandu” since their perceived “pandu” was still inferior compared to their traditional system (paddy and fish multicropping). One of them preferred to grow paddy, vegetables and fish because the income could cover his household daily needs and the expenses of his daughter's college education. Another reason for giving up "pandu" was related to the declining water and soil conditions (one farmer). As a result, only four of the successful (partial) adopters continued "pandu" in the following year. These farmers appeared to be the frequent participants in the extension activities. Many farmers in Sugihwaras also considered two of them as their role models in farming.

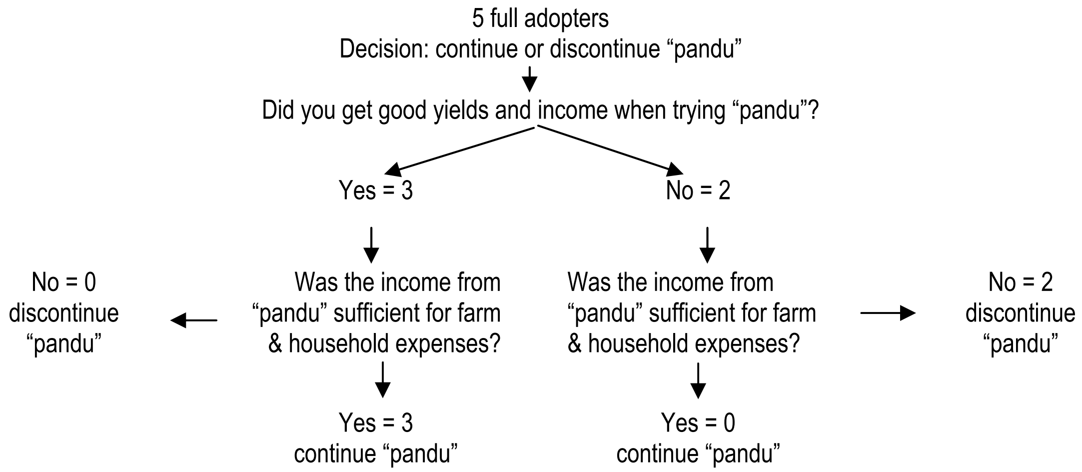
Figure 8.3 Partial adopters' feedback on "pandu" application in Sugihwaras



Cases = 12; Error = 1; Correct representation = 91.67%

Of the unsuccessful (partial) adopters, all decided to give up "pandu" after the first trial. Four of them thought that income from "pandu" was not sufficient to cover the farm and household expenses. Interestingly, these farmers represented the youngest and the oldest participating farmers in Sugihwaras. Two of them appeared to be the ones who were previously less convinced about the potential of "pandu". These farmers had an average income level, and two of them managed their parents' ricefield-ponds. Therefore, a low "pandu" yield might risk their family income and the financing for the subsequent season, and they might not get their family support to continue "pandu". The last farmer in this group decided to give up "pandu" due to water, soil, pest and disease problems.

Table 8.4 Full adopters' feedback on "pandu" application in Sugihwaras



Cases = 5; Error = 1; Correct representation = 80.00%

For the full adopters, not all of them experienced a good result. Three of them obtained income sufficient for both farm and household expenses and, hence, they decided to continue "pandu". Two of them were among the wealthiest farmers in Sugihwaras. All of them also appeared to get full support from their family members for continuing "pandu". Meanwhile, the other two full adopters perceived the income from "pandu" as less optimal and, hence, they decided to discontinue "pandu". One of them appeared to be the farmer whose ricefield-pond was used as one of the demonstration plots. The B/C ratio for this trial plot was 1.069 (Wonocolo Dissemination Laboratory of East Java AIAT, 2004b), which was quite mediocre for a new technology that was expected to increase the farmers' current income.

Overall, both decision tree models show at least 80 percent of correct representations of the participating farmers' adoption behaviour. The economic related criterion appeared to be the most important in determining the continuation of "pandu". This makes sense since a new technology should be superior to the existing practices. However, this is not observed in the case of "pandu". The B/C ratio from the trial plot was mediocre, although the farmers might expect a higher income as the price of prawn is 4-7 times higher than milkfish. This also suggests that the application of "pandu" still faces a big challenge. Less favourable agro-ecosystem conditions, for example, may have an impact on the economic achievement. All these factors may impede the change from the current paddy-milkfish multicropping system to "pandu".

An integrated strategy to handle these challenges is necessary. This, for example, may include providing continuous technical assistance especially in the area of aquaculture, and a financial buffer for the farmers, especially during unfavourable conditions.

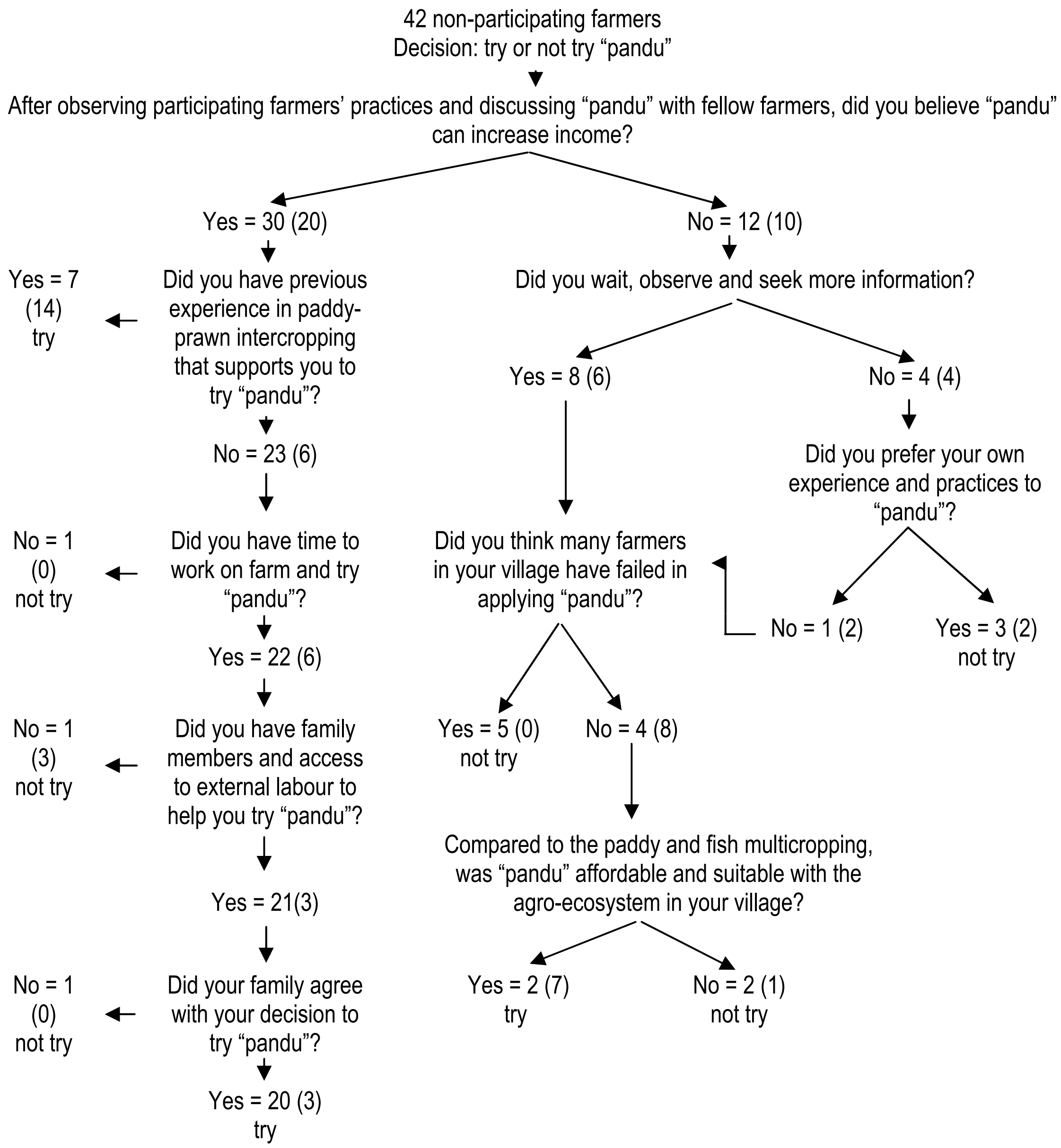
8.2.2. Non-participating Farmers in Sugihwaras

8.2.2.1 Try or not try "pandu"

Out of 42 non-participating farmers in Sugihwaras, 30 thought "pandu" could increase income (Figure 8.5, next page). This evaluation was based on information passed on by their farmer colleagues and observation of the participating farmers' practices. Twenty-seven of them decided to try "pandu". Among this group, seven decided to try "pandu" because they had experience that was compatible with "pandu". The other 20 farmers tried "pandu" because they had time to work on the farm, access to farm labour and support from their family. The lack of these three factors, however, became the main reasons for three farmers, who believed in the potential of "pandu", not to try "pandu". The lack of family support was mainly related to the ownership of the ricefield-pond, which belonged to the farmer's parent-in-law.

Although most of the non-participating farmers in Sugihwaras had a positive perception about "pandu", 12 of them had a contrary view. Some sought further information, e.g. applications in other villages, but five of them found that "pandu" application was unsuccessful and, hence, they did not try "pandu" (Figure 8.5). Another five farmers in this group considered the costs of "pandu" as too high and the agro-ecosystem conditions as infeasible so that they continued the traditional system. Hence, only two among these 12 farmers were willing to try "pandu".

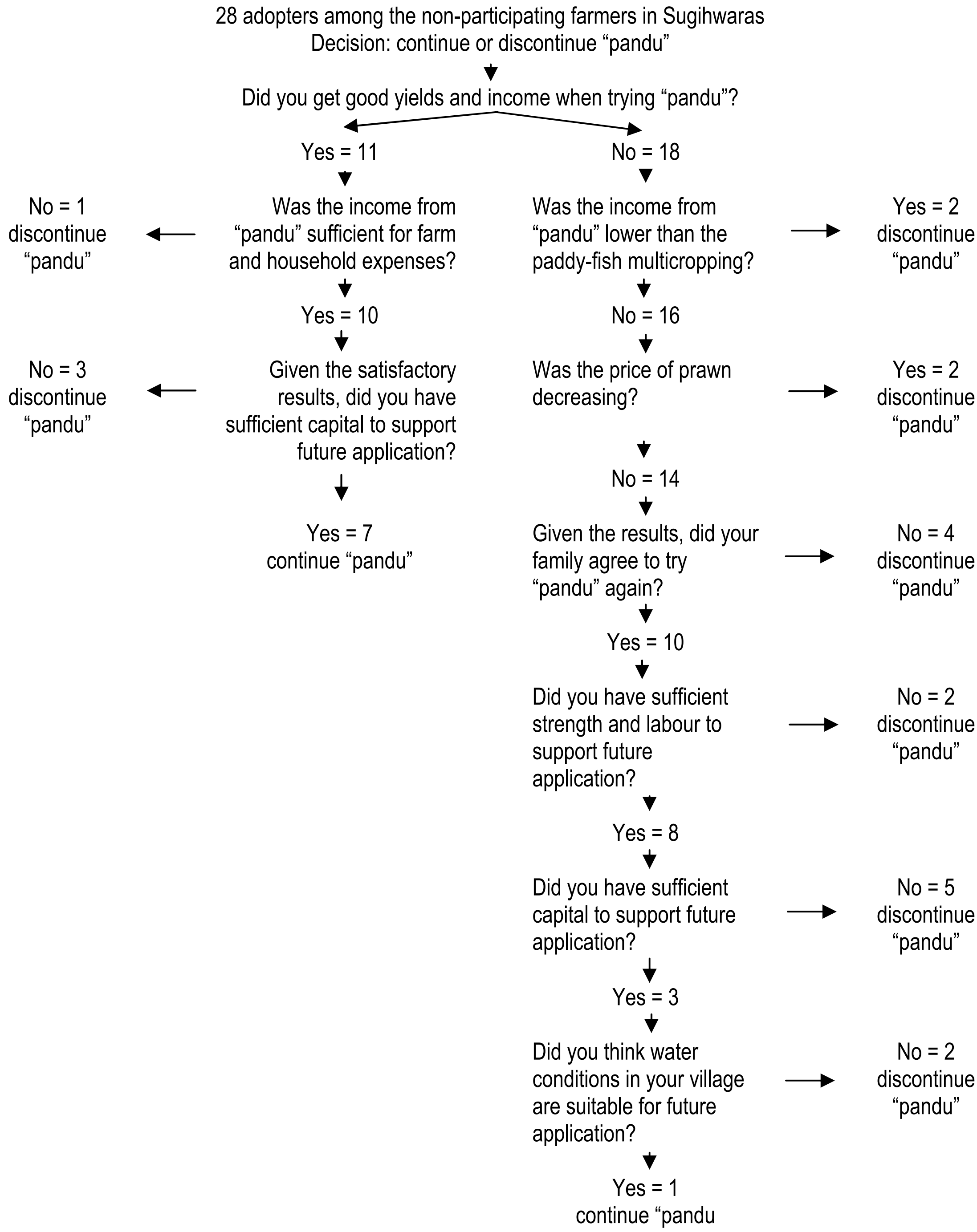
Figure 8.5 Non-participating farmers' decision on "pandu" application in Sugihwaras



Cases = 42; Errors = 3; Correct representation = 92.86%; Predictability = 80.00%
The numbers in brackets indicate the number of farmers from the test sample group who confirm similar answers.

The decision tree model in Figure 8.5 represented around 93 percent of individual choices among the non-participating farmers in Sugihwaras. The model also predicted 80 percent of the test samples' intention to apply "pandu". The latter test, however, had been further modified in order to match the situations of the non-participating farmers. This was done by subtracting the responses related to the dissemination process from the test samples' responses, while adding the responses related to the passive observation and the influence of other farmers in decision making.

Figure 8.6 Feedback from non-participating farmers who tried "pandu" in Sugihwaras



Cases = 29; Errors = 2; Correct representation = 93.10%

Overall, around 69 percent of the non-participating farmers in Sugihwaras seemed to show an interest in trying "pandu". This showed the efficacy of the farmer-to-farmer technology transfer in Sugihwaras. This was also confirmed by the background and TPB analyses (see Chapter Six). On the other side, the decision tree model also indicated that some farmers still preferred the traditional system compared to "pandu". This suggested the need to maintain the success rate of "pandu" in order to attract more adoptions. Continuous extension services could tackle this issue; while also helping farmers deal with the challenges.

8.2.2.2 Continue or discontinue "pandu"

Once the non-participating farmers tried "pandu", they had to choose whether to continue (Figure 8.6). Eleven non-participating farmers appeared to get good results, but only seven of them decided to continue "pandu". These included two farmers known for their frequent efforts in trying new agricultural technologies in Sugihwaras. The other four farmers, however, decided to discontinue "pandu" because of "pandu's" low profitability or the lack of capital.

The other 18 farmers who had tried "pandu" obtained unsatisfactory results (Figure 8.6). Only one of them decided to continue "pandu", while the others stopped applying "pandu" due to various reasons. Two farmers preferred to go back to the paddy and fish system because the results from "pandu" were mediocre. Another two farmers also gave up "pandu" after the first trial because the price of prawn in the following year was decreasing. Family consensus also seemed to be important for the decision of whether to continue "pandu", and without such consensus, four farmers decided to stop "pandu". The other reasons for discontinuing "pandu" were the lack of financial and human capital, and uncertain availability of water.

Overall, the decision tree in Figure 8.6 represented around 93 percent of the non-participating farmers' decision about the continuation of "pandu". It also confirmed the decision trees in Figure 8.3 and 8.4, which suggested that the decision to continue "pandu" depended on the performance of "pandu". The farmers compared the results from "pandu" with their traditional practices, and if the results were inadequate, they easily gave up "pandu". Market prices and financial capacity also played a critical role in providing the incentive for the respondents to continue "pandu". The family's consent, human capital and agro-ecosystem conditions could also determine the sustainability of "pandu". These decision criteria indicated the necessity to tackle the challenges faced by the respondents in a more effective and integrated way.

8.3. Decision Paths of Rejosari Farmers

"Pandu" in Rejosari was introduced earlier than in Sugihwaras, and involved around 40 farmers. Thirty-five of them were included in this study and, given the total of 71 farmers, 36 respondents in this study were the non-participating farmers.

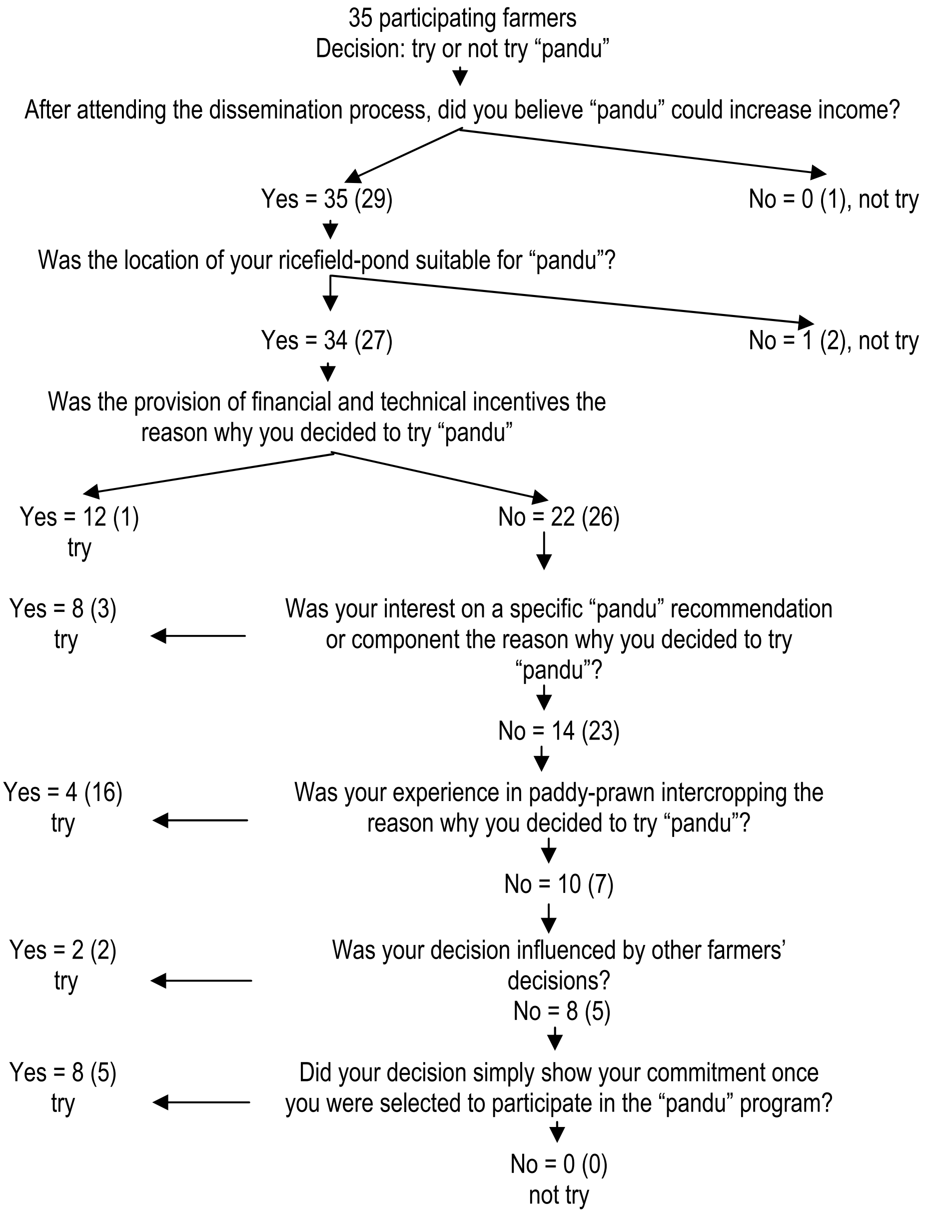
The participating farmers received technical assistance and financial incentives, and were involved in the demonstration plots. Some of them had tried "pandu" several times, while many tried "pandu" only once. Although these farmers had different experiences in applying "pandu", it was assumed that all of them had gone through three stages of decision making: (i) try or not try "pandu", (ii) apply all or partial recommendations, and (iii) continue or discontinue "pandu". The second decision option, however, was not applicable for the non-participating farmers because they were assumed to be partial adopters if they decided to try "pandu". This was determined by their individual preferences and the lack of relevant extension services. The decision tree models for these farmers groups are presented next. The discussion highlights the main findings and contrasts them to the decision trees of the Sugihwaras farmers.

8.3.1. Participating Farmers in Rejosari

8.3.1.1 <u>Try or not try "pandu"</u>

The dissemination of "pandu" in Rejosari seemed to be more effective than in Sugihwaras because all the participating farmers in Rejosari were convinced about the benefits brought by "pandu" (Figure 8.7, next page). Only one of them decided not to try "pandu" due to unsuitable conditions of his ricefield-pond. Another farmer was in a similar situation, but because he rented a ricefield-pond suitable for "pandu" in the later years so that he could try "pandu" once.

Figure 8.7 Participating farmers' responses to the dissemination of "pandu" in Rejosari



Cases = 35; Errors = 3; Correct representation = 91.43%; Predictability = 90.00%
The numbers in brackets indicate the number of farmers from the test sample group who confirm similar answers.

Similar to Sugihwaras, the majority of participating farmers in Rejosari (70.6 percent) were attracted to try "pandu" because of the financial and technical incentives, relevant experience and commitment to the "pandu" program. The rest, however, cited different reasons, such as the specific features of some "pandu" components and the influence/suggestion from fellow participating farmers and the village leader. Nevertheless all seemed to confirm the need for a good dissemination process.

Another interesting finding in Rejosari was related to the shared characteristics among the participating farmers who decided to try "pandu" because of the incentives. This group comprised farmers of different ages, wealth, activities (on-farm and off-farm) and level of education. This suggested that the provision of incentives might become an effective strategy for attracting farmers with different characteristics to try new technologies. However, the decision tree in Figure 8.7 also implied that the effectiveness of the incentives might depend on the compatibility with the farmers' situations, experience and relationships.

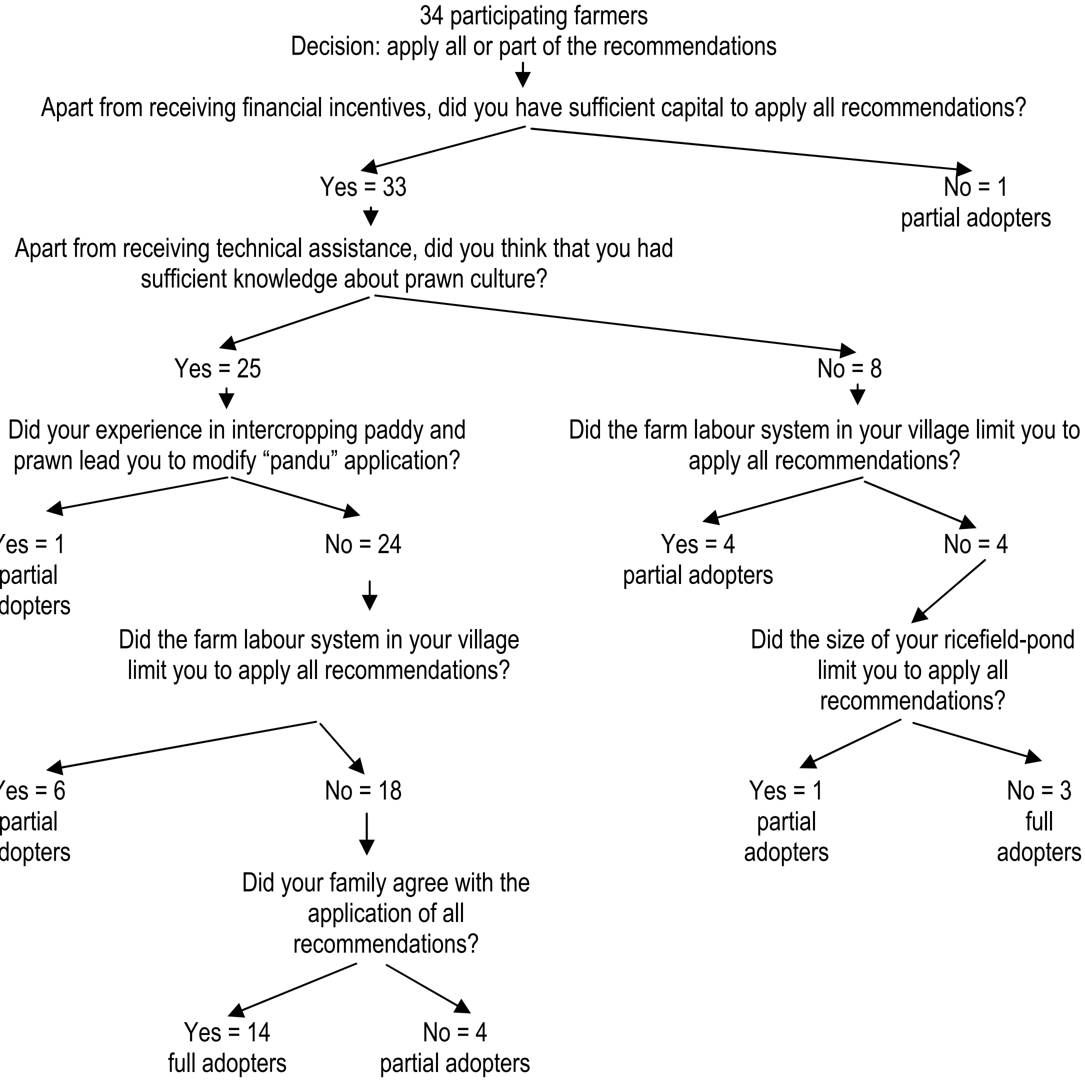
Overall, the decision tree in Figure 8.7 exhibits 91 percent correct representation of 34 participating farmers in Rejosari who decided to try "pandu". The model test also showed a 90 percent predictability rate. This confirmed the model's potential for applications in other case situations.

8.3.1.2 Apply all or part of the recommendations

For this decision choice, a similar trend as in Sugihwaras was identified. Only half of the participating farmers in Rejosari applied all "pandu" recommendations, while the other half modified "pandu" application (see Figure 8.8, next page). The latter was mainly related to the recommended planting distance because the farm labourers were not familiar with the procedures. Some also failed to gain full support from family members, particularly from their spouse and parents who thought the recommended planting distance was complicated, time consuming and costly. Again, this confirmed the need to address the cost structure related to "pandu" application, as the incentives had not considered the labour costs. The other reasons for modification were related to their own experiences/practices and the limited size of ricefield-pond.

One interesting finding was that the lack of knowledge in prawn culture had not stopped three participating farmers in Rejosari to apply all "pandu" recommendations. This suggested the farmers' high motivation to prove the "pandu" potential. Overall, the decision tree represented around 85 percent of the participating farmers' decision regarding the recommendations of "pandu".

Figure 8.8 Participating farmers' level of "pandu" application in Rejosari

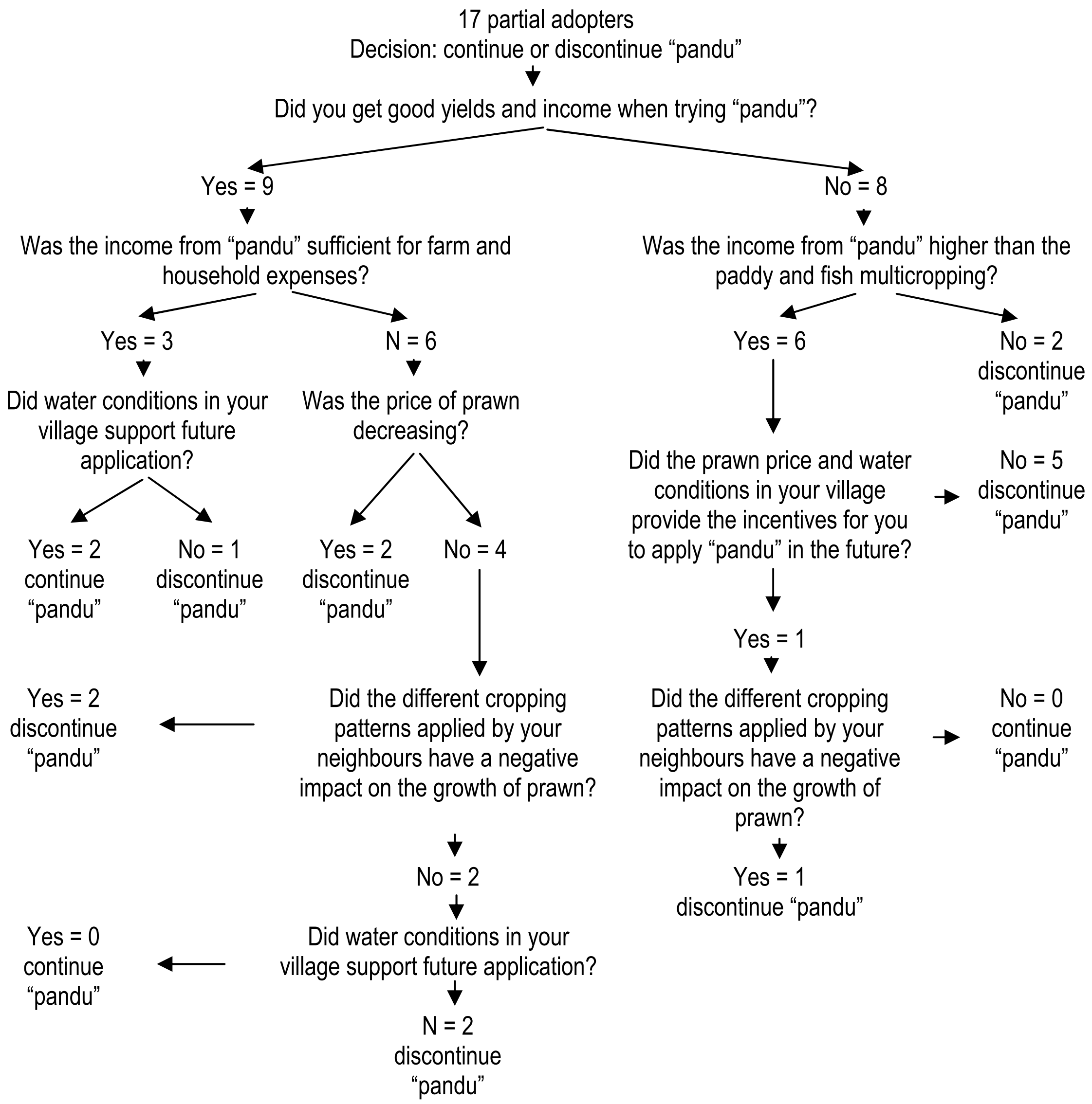


Cases = 34; Errors = 5; Correct representation = 85.29%

8.3.1.3 Continue or discontinue "pandu"

The decision tree models for this decision choice showed a satisfactory representation (82.35% and 88.24%) of the adopters' choices regarding the continuation of "pandu" (Figure 8.9, next page; and Figure 8.10, page 239). However, only two partial adopters and two full adopters in Rejosari decided to continue applying "pandu". The discontinuation was mainly related to the low yields, the decreasing prawn price and the lack of capital. Meanwhile, unfavourable water conditions and different cropping practices among farmers also increased the risk of "pandu" application. This had caused the farmers to lose interest, and their family's support, for continuing "pandu".

Figure 8.9 Partial adopters' feedback on "pandu" application in Rejosari



Cases = 17; Errors = 2; Correct representation = 88.24%

The effects of different cropping practices on the continuation decision seemed to be more serious in Rejosari than in Sugihwaras. The lack of water in Rejosari made farmers use recycled water from their neighbours. If the neighbours grew milkfish, the risk of prawn harvest failure might increase. Milkfish and prawn had the opposite water quality requirements and, hence, water intrusion from milkfish ponds and the low quality of the recycled water might significantly reduce prawn survival. If the neighbours also grew vegetables, they were more likely to apply pesticides which might also significantly increase prawn mortality. These issues were also confirmed by the background and repertory grid interviews.

Figure 8.10 Full adopters' feedback on "pandu" application in Rejosari

Cases = 17; Errors = 3; Correct representation = 82.35%

Many farmers believed that finding solutions to these issues was difficult. They felt uncomfortable about asking their neighbours to compromise since they knew they all wanted to gain a higher income for their family. Nevertheless, such problems might be overcome through the provision of continuous extension services.

The current extension service in the village was irregular and there was none in the area of aquaculture. The farmer groups in Rejosari also lacked resources and activities, which made the farmers seek help only from their colleagues. However, when the reference farmers in Rejosari gave up “pandu”, others may have simply followed them. This was unfavourable for “pandu”. Hence, restructuring the farmer groups and extension services seems necessary to help the farmers agree on cropping systems that could benefit all of them, including water allocation. The extension services could also increase the farmers’ knowledge, skills and motivation for dealing with the challenges. The results would be a better yield and quality, which could secure a better product price.

8.3.2. Non-participating Farmers in Rejosari

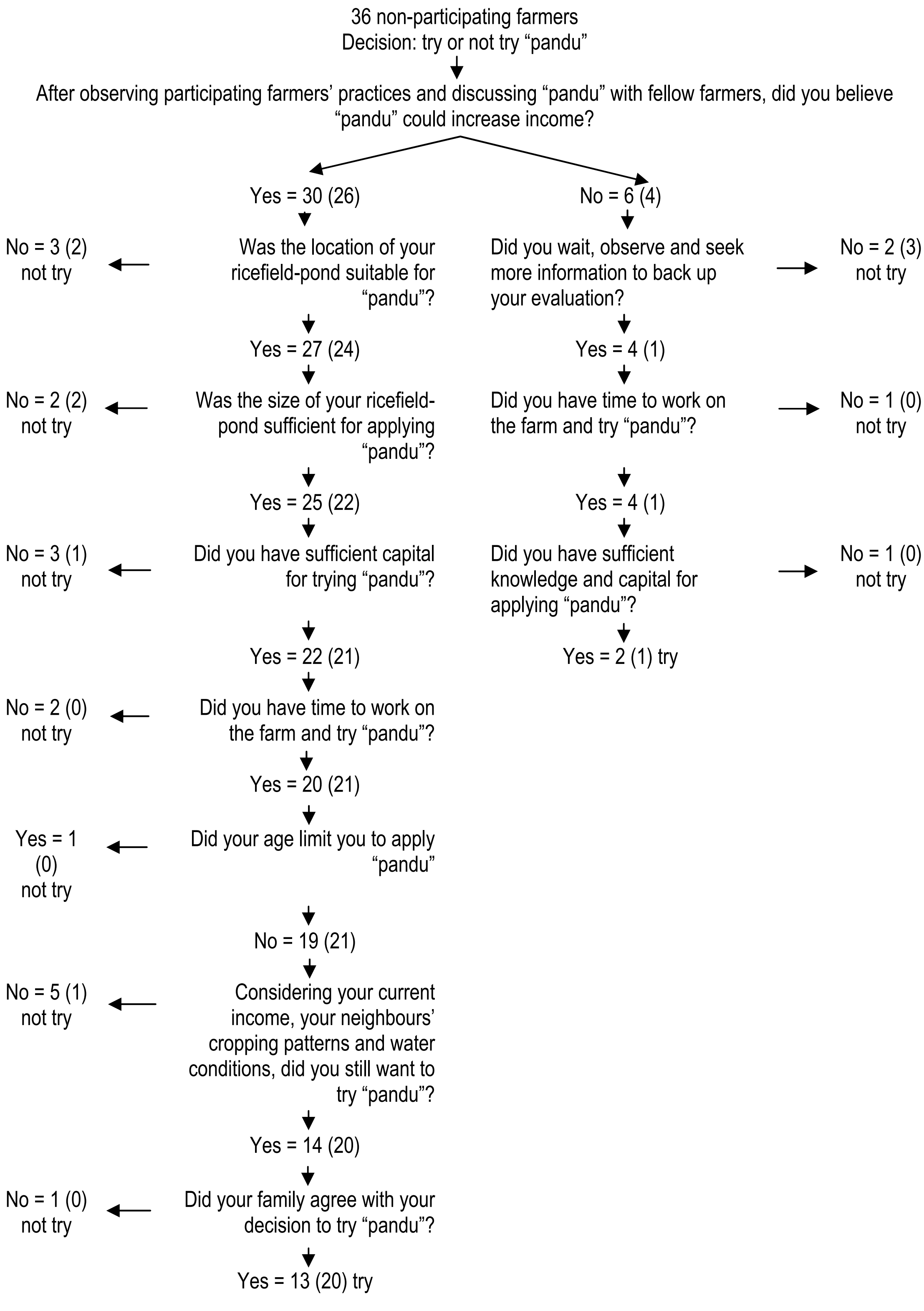
8.3.2.1 Try or not try “pandu”

Similar to Sugihwaras, most of the non-participating farmers in Rejosari were convinced about the potential of “pandu” after observing and discussing the application with fellow farmers (Figure 8.11, next page). This confirmed the potential of an extensive application of “pandu” in Rejosari. Nevertheless, not all of them decided to try “pandu”. Unsuitable locations for prawn culture, the lack of land and capital, off-farm work and preference for the current paddy-milkfish production were among the reasons for not applying “pandu”. The decision also seemed to be affected by age, family’s opinion, current income and neighbours’ practices.

Overall, 15 non-participating farmers in Rejosari decided to try “pandu”. This included two farmers who were not impressesed with “pandu” (Figure 8.11, next page). The characteristics of these adopters were different in terms of age, wealth and commodity preferences. Some actually did not have suitable conditions when they applied “pandu”. Despite these differences, they seemed to have a strong motivation and sufficient resources to apply “pandu”.

The decision tree model represented 86.11 percent of the non-participating farmers’ adoption decisions; however, the test showed a low predictability power (70 percent). Several modifications of the model were considered, but they did not fit with the non-

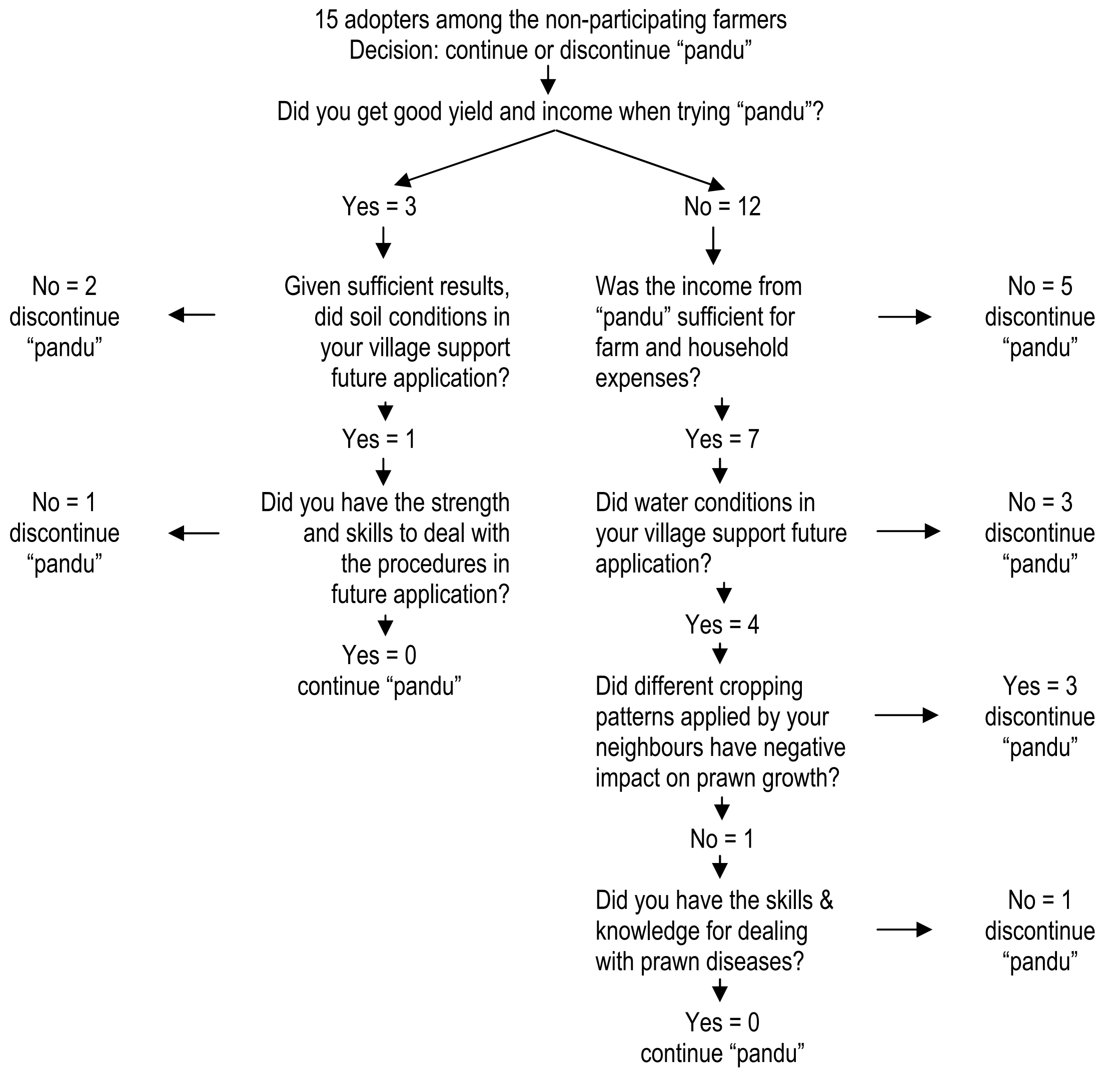
Figure 8.11 Non-participating farmers' decision on "pandu" application in Rejosari



Cases = 36; Errors = 5; Correct representation = 86.11%; Predictability = 70.00%
The numbers in brackets indicate the number of farmers from the test sample group who confirm similar answers.

participating farmers' situations. A similar situation was also found in the decision tree model for the non-participating farmers in Sugihwaras. It appears that the preferences of the test sample farmers were more analogous for the participating farmers than the non participators. This was reasonable since the farmers involved in the test received a simulation of the "pandu" dissemination process, making them more informed than the non-participating farmers in Sugihwaras and Rejosari.

Figure 8.12 Feedback from non-participating farmers who tried "pandu" in Rejosari



Cases = 15; Error = 1; Correct representation = 93.33%

8.3.2.2 Continue or discontinue "pandu"

The last decision tree model is related to the decision of continuing "pandu" (Figure 8.12). It appeared that all non-participating farmers in Rejosari had decided to give up “pandu” after one or more trials even though three of them obtained good results. Age, the absence of family labour, or decreasing soil fertility was their reason for giving up “pandu”. The other 12 adopters who stopped applying “pandu” gave reasons of unsatisfactory results, the unfavourable water conditions, the effect of different cropping practices, and the lack of knowledge and skills for dealing with prawn diseases.

Overall, this decision tree model represented around 93 percent of correct decision paths and criteria of these adopters. The only error was related to a decision criterion that seemed to be less applicable for one respondent. The interview results of this particular farmer showed ambiguous responses, which made the identification of the main decision criteria difficult.

8.4. Discussion and Contributions to the Adoption Model

The semi-ethnographic approach showed a more thorough description of the farmers’ decision making process than the TPB and repertory grid analyses. This approach considered all key terms mentioned by the farmers, while the TPB and repertory grid approaches contained certain requirements that limited the number of responses eligible for the analysis.

The decision tree models from the semi-ethnographic interviews also included consecutive decision options which covered the diversity in the respondents’ preferences and the adoption periods beyond the introduction year. This meant that the respondents, directly or indirectly, learned from their first decision, and they became more informed when making the subsequent decisions. The respondent might decide to modify and/or sustain their first decision. This, however, was not possible in the TPB and repertory grid analyses.

The concept of sequential decision making process was also introduced by Rogers (1993) and Ohlmer, Olson, & Brehmer (1998). Nevertheless, such a learning process might not have to go through all the sequential steps, as suggested by Rogers, and it might be simpler than the non-linear decision making process suggested by Ohlmer et.al. The decision tree models seemed to be more straightforward in describing the pattern of decision making process.

Overall, the analysis of consecutive decision options is believed to provide a better description of the farmers' decision making process. This also meant that a technology adoption analysis should include not only the adoption decision, but also other relevant decisions, such as modifying and sustaining the adoption. This may also improve what Gladwin (1989a) referred to as a real-life decision making analysis.

Besides those advantages, there were three main challenges related to the semi-ethnographic approach. First, during the interview, the respondents tended to mention many factors involved in their decision making process. McGregor, Rola-Rubzen and Murray-Prior (2001) alerted researchers to the importance of a correct decision criteria specification. Otherwise, the criteria only represent the decision makers' beliefs, not their decision rules. In this study, this issue was handled through grouping the criteria according to their specific reference in the respondents' explanations, indicating a decision or a new direction of decision making. This was expected to produce the most relevant decision making criteria for the respondents.

The second challenge was related to the test analysis, which required a sample group covering different types of people who had similar decision choices. In this study, the test analysis could only be carried out on the first decision option: "*try, or not try, pandu*". The other decision options ("*partial or modify pandu*", and "*continue or discontinue pandu*") were not tested because the test sample group had not tried "pandu", although some of them had intercropped paddy and prawn before. The test analysis also could not be applied to the non-participating farmers since the test sample group was given a simulation of the "pandu" dissemination process. Hence, the test sample group had more complete information about "pandu" than the non-participating farmers in Sugihwaras and Rejosari. As a result, the test sample group for the non-participating farmers showed a low level of predictability (see Section

8.2.2.1 and 8.3.2.1). Nevertheless, the validated and the non-validated decision tree models seemed to be representative in explaining the farmers' decision making processes.

The decision tree models in this study might also be applicable across different case studies. This refers to the applicability of the decision criteria identified from the farmers' different decision paths in this study. Some criteria were universal in adoption analyses related to agricultural technologies. These included economic criteria (profit/income, capital/assets, expenses, price and/or financial incentives), managerial criteria (labour, knowledge, experience, information and/or technical assistance), and agro-ecosystem factors (location, water and/or soil conditions).

The other criteria identified in this study might also apply in other case studies. These included off-farm activities, family consensus and crop preferences. The off-farm activities might indicate the decreasing incentives from the agricultural sector, either due to the decreasing size of land possession per farmer, or the lack of workable policies. Nevertheless, the off-farm activities provided the farmers with extra income for covering family expenses, and for financing the farm.

The role of family consensus in the farmers' decision making process seemed to be closely related to the bargaining process within the family. Some decision trees showed that a family consensus/bargaining process was manifested when not all family members agreed with the farmers' decision, either because of land ownership (parents owned the land), task allocation (wife was in charge of financial management and/or planting work) or the family's capacity (lack of labour and capital). Family consent, however, did not appear as a decisive factor in other decision tree models because the farmer might have been successful in convincing his family members, or was the sole decision maker.

Different crop preferences also indicated the influence of the non-family bargaining process in determining "pandu" adoption among neighbouring farmers. Some farmers mentioned difficulties in reaching a consensus, especially in water and pesticide usage. The bargaining process became complicated as the farmers tried to respect others' objectives and choice of commodities. Some, therefore, preferred to give up "pandu" rather than having an argument with their neighbours.

Some farmers mentioned the solution might rest with the provision of relevant guidance/assistance from either the extension officers, or farmer groups. Increasing the farmers' access to external financial sources might also help. These, however, were absent in both villages.

The application of the semi-ethnographic approach is also challenging in terms of avoiding the common deficiencies in decision tree development processes, for example the construction of decision tree models with vine-like decision paths and missing ordering aspects (Gladwin, 1989a). In this study, the decision tree models were constructed as a composite model and, hence, the ordering aspects of options by individual farmers were not clearly observed and the paths appeared to be straightforward. Nevertheless, the decision trees in this study are empirically justified as they best represent the actual circumstances in the farmers' decision making process. This was supported by testing all decision trees in terms of the decision criteria and the farmers who applied the criteria through using the farmers' responses to the open-ended part of the TPB questionnaires (see Section 7, Appendix B). This provides both an assessment of the correctness of the farmers' actual behaviour in the decision tree model and the internal validation for the decision trees.

Overall, the decision criteria identified from the semi-ethnographic approach showed that different groups of farmers might require different approaches for technology introduction. The criteria also appeared to be interrelated and, hence, an integrated solution was needed. Providing incentives was one alternative solution as this could cover diverse situations. However, this study proved that incentives could not ensure full and sustainable adoption as the new technology still required a good design and accountability.

It is also of outmost importance to ensure that a new technology has an observable and superior result than the current system. This is crucial for sustaining the adoption especially among farmers with limited resources. As “pandu” performance was, on average, not as good as the current system, many farmers simply decided to go back to their current system. This situation reduces the possibility of an enduring farmer-to-farmer technology transfer, which was earlier observed among the non-participating farmers. This also conveys a message that an advanced dissemination process, such as in “pandu”, is not enough for ensuring sustainable adoption.

When sustainability became an important issue, revitalizing the extension services and farmer groups was also urgently needed. Otherwise, the farmers might only base their decisions on information and observations from their neighbours or reference farmers. A change in the reference farmers’ decisions can have a big impact on other farmers’ decisions, especially in this case study where social relationships were strong, but access to new and reliable information was limited.

The results from a semi-ethnographic analyses should also contribute to the improvement of the TPB model, particularly for the identification of behavioural stimuli. This could be achieved by using the semi-ethnographic interviews as a pilot interview. The paths in the decision tree models might become the bases for outlining the interrelationships between factors in the TPB model. The semi-ethnographic interview might also help reveal the application of negotiation during the decision making process. The decision trees particularly could help reposition the link between the bargaining process and other decision factors in the existing TPB model of this study.

The other possible contribution of the semi-ethnographic approach is to use it as a substitute for the common TPB interview procedures. The semi-ethnographic interview can be used for the pilot interview and the results become the basis for formulating the main TPB interview. Instead of a common list of full questions, the TPB questionnaire could be in the form of a short list of questions with a 5 or 7 numeric scale. During the TPB interview, the respondents can explain their decision making process using their own terms, but their responses would be guided by using the short list of questions. Once the respondents mention a particular decision criterion, they will be asked to rate the level of importance of the criterion using the 5 or 7 numeric scale. Other relevant criteria can also be added to the question list as the interview continues. This may avoid the interviewer's bias, a common problem in a pre-set questionnaire. The procedures also help reveal the respondents' most relevant decision criteria, and tackle the issue of quantifying the semi-ethnographic results, due to the diversity in the expressions. The interview results then can be evaluated using either a multivariate decision model, or a decision tree.

Finally, the semi-ethnographic analyses are expected to improve the existing paradigm of agricultural decision making processes. This includes the recognition of a dynamic multi-stage decision making process in the TPB and repertory grid analyses. The decision tree models also may be applied to different groups of farmers according to their adoption behaviour. This could provide a better understanding of the farmers' behaviour, despite their simplicity in picturing the real world decision making process (Gladwin, 1989a).

Further modifications of the decision trees using the results from the TPB and repertory grid analyses are also worth trying. This may overcome the shortcomings, while synchronizing the strong points, of each analysis. The results may be a universal model of the adoption process. This is discussed in the next chapter.

CHAPTER NINE: SUMMARY, IMPLICATIONS AND POSSIBLE IMPROVEMENT

9.1. Introduction

To better understand the technology adoption behaviour, particularly in the case of farmers in developing countries, one needs to analyze the mental processes involved in the farmers' decision making systems. This was investigated in this study through tracing the origins of the farmers' beliefs and extracting the decisive and dynamic elements in the farmers' decision making system. The results provided insights into the functioning of farmers' rational strategy as well as the socio-cultural norms and influences on their decision making process. This understanding provides a more realistic and thorough description of the farmers' decision making process in developing countries than was hitherto available.

In this chapter, the analyses and the findings are summarized. The implications relevant to the farmers, extension services and other concerned parties are also presented. This is supplemented by a brief discussion on ways to conceptualize an improved decision making analysis. The results are expected to provide opportunities for relevant analyses in the future.

9.2. The Structure of Farmers' Decision Making Processes

This study was directed at discovering the structure of semi-commercial farmers' technology adoption decision making. The analysis uses a model based on the Theory of Planned Behaviour (TPB), in which the farmers' decision criteria are explained in terms of their attitudes and perceptions of control, as well as social influences. The model was also modified by recognizing a bargaining process (BP) and other decision stimuli to represent socio-cultural influences and sources of perception, respectively. Two supplementary analyses, based on the Personal Construct Theory (PCT) and the

Ethnographic Decision Tree Modelling (EDTM), were also applied to help clarify the farmers' information processing approach and actual decision criteria.

The application of these analyses in agricultural technology adoption process in developing countries is still limited, except for the EDTM. This raises the need to check whether they apply in the case of semi-commercial farmers in developing countries.

This is of relevance considering the complexity of the farmers' situations. These farmers usually have limited cognition and access to information and other productive resources which often hinder their efforts to progress from the traditional and subsistent system to a more commercially oriented system. These situations result in a poor technology uptake. Little information is available for describing the actual process that farmers undertake.

The combination of the TPB, PCT and EDTM approaches deals with the above issues. This was achieved through examining the interrelationships between the farmers' information processing approaches, perceptions, and socio-cultural influences. The recognition of a bargaining process, and an extensive exploration of the farmers' simple decision rules also help understand the farmers' strategies in dealing with their limitations in making adoption decisions. The results provide a thorough conceptualization of the farmers' adoption process.

The analysis used a case situation in two villages in the Lamongan Regency in the East Java Province of Indonesia, where some of the farmers adopted an improved paddy-prawn system ("pandu"). The data collection methods included a structured background interview, a structured interview based on the Theory of Planned Behaviour (TPB), a paper-based repertory grid interview (for PCT), and a semi-ethnographic interview (for EDTM). The responses from the first two interviews were analyzed using a multivariate technique, particularly structural equation modelling. Meanwhile, the repertory grid interview results were analyzed using the

Rep IV software, and the semi-ethnographic responses were used for constructing several decision trees.

The results from the structural equation modelling revealed that the behavioural and normative beliefs influenced the farmers' intention to adopt "pandu". These beliefs appeared in the form of the farmers' attitude toward "pandu", and the social pressures, respectively. This meant that "pandu" would most likely be adopted by farmers who had positive perceptions about the potential of "pandu", and received support from their "significant others" regarding their intention to adopt "pandu".

The other TPB components (i.e. control beliefs and perceived behaviour control—PBC), were found to have insignificant effects on the farmers' intention. This finding was atypical as previous studies had shown a strong effect of PBC on intention and behaviour (see Armitage & Conner, 1999; Notani, 1998). However, Ajzen (1991) believed that the effect of PBC on one's intention seemed to vary according to the behaviour and behavioural settings. In this study, one reason related to the incentives of the "pandu" program which increased the farmers' perception of control. The other possible reasons were the difficulty in creating a representative questionnaire, and the farmers' less than accurate appraisal of their past decision environment. The latter was confirmed by the background interviews indicating the ambiguity in the farmers' evaluation of their problem intensity.

The inclusion of the actual behaviour, the bargaining process, and some background variables in the TPB model improved the total variance explained and the model fit measures. Using the actual behaviour improved the robustness of the TPB model in explaining past behaviour and in predicting future behaviour. The bargaining process accounted for around 51 percent of the behavioural variance (R^2) in the model, higher than most R^2 of other behavioural studies using the TPB (see Armitage & Conner, 1999; Sutton, 1998). The bargaining process also revealed the role of the farmers' communication behaviour as the decisive factor in their decision making process. Such behaviour appeared to be a mixture of the farmers' personality and rational strategy, as well as the socio-cultural norms. This was shown by the farmers' different communication strategies when making decisions involving their family and non-family “significant others”. The farmers sought justification by discussing their intention and the practicality of applying “pandu” with their “significant others”. However, when making the final decision, the farmers chose to act individually, or collectively, depending on their situations. Overall, this helped delineate a more realistic description of the farmer's decision-making process.

The addition of background variables in the TPB model also allowed a more thorough analysis of the sources of the farmers’ perceptions and behaviour. Location, dissemination process, the intensity of interaction with “significant others”, farming practices, assets, objectives and current problems were all found to influence the farmers’ beliefs. These background stimuli showed that different socio-cultural influences did exist even between neighbouring villages, and this had resulted in different responses to “pandu”. The dissemination process also appeared as a key factor for securing a strong motivation and positive perceptions toward “pandu”. Frequent interactions with “significant others” and peer learning also became an essential element in a farmer-to-farmer technology transfer mechanism among farmers in this study. The rest of the background stimuli suggested how these small-scale farmers preferred a steady income in contrast to a higher, but less reliable, income. They preferred to stay with the familiar commodities and practices, despite the potential of “pandu” in bringing higher income. Such lack of interest, however, might also stem from the lack of successful results among the farmers. This appeared to be the biggest disincentives for farmers to try, or continue “pandu”.

Similar conclusions were also obtained from the Personal Construct Theory (PCT) analysis. The difference was that the farmers’ latent motives were identified from the ways they processed and used information. This was crucial when there was a lag in learning and information flow.

The repertory grid analysis involved the farmers’ evaluation of the elements (decision criteria) and the relevant constructs (reasoning). The results showed that, regardless of the levels of adoption, most farmers developed their attitudes towards “pandu” through the comparison between “pandu” and their current farming system. Some continued “pandu” adoption as they obtained good yields, while others viewed “pandu” as a risky option in terms of family income. The latter might stem from the farmers’ preference for fish production, and their lack of capital and knowledge about paddy-prawn intercropping. These factors, together with a heavy workload and current problems (debt, water supply, pests, diseases and marketing practices), influenced the farmers’ perceptions of control toward “pandu” application. Some personality aspects might also be present as indicated by the farmers’ constructs. The application of these decision criteria, however, varied across different farmers.

The analysis also showed that when considering “pandu”, the farmers mainly relied on relatives and local people, particularly their spouse and neighbours. This might relate to the farmers’ limited access to extension services and capital. However, the farmers’ constructs showed that closeness and informality were the main factors for choosing the partners for decision making. The farmers also evaluated their relationships with others based on the status of their “significant others” and the relevancy of the issues. The latter also suggested a certain level of bargaining was involved when the farmers interacted with others. This was evident in the case of resource allocation within the family (whether for covering farming or family expenses), and water allocation/the use of pesticides (whether to compromise with neighbours or not).

The repertory grid analysis showed the farmers’ unique, but complex, decision making process. The results were useful for understanding the ways the farmers classified information that they had, and combined it with what they learnt and observed from their family and surroundings. This clarified the interactions of different decision rules in shaping different adoption behaviours.

The results from the EDTM analysis had a similarity with the TPB model, as both explore the structure of farmers’ decision making process. The difference was that EDTM involved a sequential elicitation of decision criteria, directly showing the hierarchical relationships among the decision criteria in the form of a decision tree.

The results also showed consecutive decisions relevant to different groups of farmers. This suggested the need to focus the adoption analysis on both the adoption decision and the relevant changes, especially when the analysis extended over the introduction year. This allowed the analysis to identify the farmers' learning from past decisions, and how they applied the relevant decision criteria. This could better explain the diversity in the adoption behaviour and confirmed what Gladwin (1989a) referred to as a real-life decision making process.

From the decision trees, it was found that the farmers used decision criteria related to the economic aspects (income, assets, expenses, price, or incentives), the managerial aspects (labour, knowledge, experience, information, or technical assistance), and the agro-ecosystem (location, water, or soil conditions). The analysis also revealed the influences of off-farm activities, family consensus and commodity preferences. Off-farm income was needed to support farm production and family consumption. The family consensus represented the bargaining process within the family, especially where decisions would affect the family income and food security. The bargaining process also occurred when the farmers sought cooperation from their neighbours, especially if their neighbours did not apply "pandu". This was important in order to secure prawn survival. However, where a consensus was difficult to obtain, some farmers preferred to give up "pandu" rather than have an argument with their neighbours. All these factors showed the interrelationships among the criteria.

Overall, the three analyses showed that economic, managerial, technical, socio-cultural, and environmental factors influenced the structure of the farmers' decision making process related to "pandu". The decision criteria appeared to be interrelated, but the combinations could result in different adoption behaviours. The latter depicted the farmers' learning process and responses to the changes in their surroundings. The results appeared in the form of several consecutive decisions, which included not only the implementation decision, but also the modification and continuation decisions.

Despite the presence of these different decision options, the semi-commercial farmers in this study could be classified as "*intuitive*" farmers. Ohlmer, Olson and Brehmer (1998, p. 279) differentiated between those farmers who relied on experience and qualitative measures ("*intuitive*") and the farmers who quantitatively planned their business ("*analytical*"). As "*intuitive*" farmers, the farmers in this study analyzed their options and planned their next actions using their past performance and passive observation on others' practices. Nevertheless, the farmers in this study also used dynamic interactions with others and negotiations as their means of making adoption decisions. This was found to be the decisive factor in the farmers' decision making process and, hence, clarified the decision making final step.

As a case study, "pandu" provided many insights that allowed the analysis to reveal the nuances in the farmers' adoption decision making process. The yield of "pandu" was less clear and observable as it varied across farmers and locations. However, this led the analysis to capture different farmers' adoption practices resulting from their consideration of many aspects related to their conditions and "pandu" requirements. This was clearly manifest when the farmers attempted to adjust their adoption according to the cropping pattern that was compatible not only with the agro-climatic conditions, but also, and most importantly, with their family's goals and their peers' practices. The overall result is that the analyses revealed a more realistic description of the farmers' decision-making process than has been attempted before. The results also provided useful recommendations, which are presented next.

9.3. Implications

The different analyses in this study offered insights that are useful for improving the efficacy of agricultural technology introduction in developing countries, and possibly in other situations as well. This includes the importance of ensuring that the new technology is significantly superior to the existing technology, or the current farming practices, and compatible with the farmers' objectives and their preference towards a more secure income. In the case of "pandu", the lack of clearly superior results became the main reason for many farmers giving up “pandu”. They also viewed “pandu” as a more risky choice than the existing system.

There is also a need to provide a more flexible approach that allows the farmers to observe, learn and decide the most suitable way of applying a new technology. A participatory dissemination process, for example, may allow negotiation, conflict mitigation and the creation of a consensus among the farmers and other relevant parties. Using different introductory approaches may also be useful, as different farmers learn about, interpret and communicate new information differently.

Such an approach should also be supported by a more balanced flow of information to the target farmers. The information should be accessible during and beyond the introduction period, and for everyone in the target areas. This was absent in the case of “pandu”, with the technical assistance only available during the introduction period and limited to the participating farmers. This limited the farmers’ capacity in dealing with technical challenges, and impeded the continuation of “pandu”. The latter, in particular, was partly influenced by the farmers’ “significant others”, such as spouses and neighbours. These people were not involved in the “pandu” dissemination and, hence, had different levels of understanding and opinions about “pandu”.

This problem may be overcome by, for example, providing a family extension activity, increasing the frequency of home visits by the field extension worker, and using a different timing to allow the extension activities to suit the farmers’ free time. In this study, the tradition of an evening-informal discussion in a local coffee shop involving farmers and other villagers appeared useful. These approaches attracted wide participation from household members and the farmers’ colleagues.

All the recommendations above suggest that the farmers are rational decision makers. Different farmers have different ways of making decisions, and each of them can act according to their circumstances. This also means that abandonment, or modification, of a new technology in a certain season does not always infer complete non-adoption.

A specific and well-targeted policy intervention is, therefore, needed. This might be achieved, for example, through the provision of incentives. Such incentives would need to be economically beneficial to the community in the longer run.

Financial and technical incentives have been proven to increase the rate of technology adoption in diverse situations and farmer groups. Nevertheless, the EDTM analysis in this study showed that such incentives need to be well designed, as well as exhibit accountability in order to secure sustainable adoption. This conclusion was based on the incentives in the "pandu" program that were unsuccessful in attracting adoption due to the lack of a clear mechanism. Instead of the short-lived incentives, the farmers in this study seemed to prefer regular, and relevant, guidance/assistance from either the extension officers or farmer groups. The farmers also expected easier access toward external sources of capital. Hence, revitalizing the extension activities in the target area may become one of the solutions. For financial support, the need is to improve the farmers' access to formal lending and/or establishing a reliable revolving fund mechanism. These can also provide financial relief for the farmers, including support during a bad season. Overall, an improvement in the farmers' access toward knowledge and financing may help the farmers deal with the challenges, and sustain the adoption.

The last implication, and certainly a significant theoretical factor in the development of adoption models, is related to the improvement of the adoption analysis. Each of the analyses used in this study has its own strengths and weaknesses. The TPB model provides a more general structure of the decision making process, making it practical for quantitative as well as policy intervention analyses. However, the analysis can provide only a general sense of the latent variables. This may cause the TPB to be less effective as a predictive model. The latter also applies to the PCT analysis (Murray-Prior, 1998), as the uniqueness of the results often makes the integration of different target groups difficult. Nevertheless, the elicitation process in PCT has a minimum of interviewer bias as the farmers used their own terms when evaluating "pandu". The same benefit is also found in the EDTM approach, although it has a more practical analytical procedure than the PCT analysis. The EDTM analysis also allows the inclusion of dynamic aspects because it accommodates behavioural changes resulting from learning, or other conditions (Murray-Prior, 1998), as the adoption proceeds. However, this analysis requires a sample group that covers different types of people who have had similar decision choices. This is often difficult to find.

The alternative to the standard structural models is to create a new approach that can accommodate the strong points of each analysis. This includes a less biased data collection procedure and a more flexible analysis allowing the results to be used for descriptive or predictive purposes, and for different case situations. The latter is particularly important in the case of semi-commercial farmers in developing countries where subsistence and limited access to productive resources is an issue. The conceptualization of the new approach is presented next.

9.4. The New Framework for Adoption-Decision Making Analysis

A new framework for adoption-decision making analysis was developed using the results from the different analyses in this study with the TPB concept as its basis. This framework considers the depth, the relevancy and the practicality of the analysis. It starts from recognizing the dynamic nature of the decision making process, represented by the possible modifications, reversal and/or consecutive decisions. It also includes various factors that influence perceptions, intentions and decision making contexts. The framework is also supported by a new approach in data collection that allows better specification of the decision criteria and their relationships. All are presented next.

9.4.1. Premises of the New Framework

The premises of the new framework are developed using the original hypotheses developed in this study. They are:

a) farmers rely on rules of thumb (heuristics) for making decisions on whether to adopt, delay or reject a new technology, and these rules are constantly under review, i.e. dynamic;

b) farmers' decision heuristics are related to their attitudes and perceptions of control, as well as their socio-cultural influences;

c) farmers use different decision heuristics according to their physical, technical and socioeconomic contexts, as well as different degrees of adoption;

d) a certain degree of intra-household and social bargaining processes influences the structure of farmers' personal construct system; and

e) the bargaining processes may occur repeatedly as the farmers obtain new information and/or seek collective reinforcement at each decision step.

These hypotheses are further improved using the results from the TPB, repertory grid and EDTM analyses in this study. This includes the farmers' consecutive decisions, heuristic applications and case-specific factors.

9.4.1.1 <u>Farmers' multiple decisions</u>

The EDTM analysis suggested that the respondent farmers faced consecutive decision options, such as (i) whether to try "pandu", (ii) whether to apply all recommendations, and (iii) whether to continue "pandu". Different farmers faced different decision options and, for each decision, the farmers involved a different set of criteria. These findings suggest that an adoption-decision making analysis needs to consider the multiple decision options faced by the farmers. The analysis can show that the adoption-decision making process does not stop after the decision to try the technology, but the process continues as the farmers encounter other issues.

The modification option, for example, arises when the farmers have limitations preventing them from applying all recommendations. The limitations may relate not only to financial and environmental aspects, but also access to information, knowledge and skills. The results of any modification, however, are usually less than expected. This often causes a superior technology to fail to spread among its target users as its potential cannot be fully observed from partial adoption. After realizing and evaluating the results from the first trial, the farmers usually have the choice of continuing, or discontinuing, the technology. Good results usually guarantee continuous application, although such a decision may also depend on other criteria. The modification, and continuation, choices, however, are often overlooked when the adoption analysis only considers one decision option, i.e. "try or not try". Such analyses, thus, may contain bias due to incomplete decisions.

It can also be argued that multiple adoption decisions may not be limited to a consecutive set of "trying", "modifying" and "continuing" decisions. A farmer may have a choice of "trying", "modifying" and "further modifying" a technology, as well as a range of other options. This was confirmed by different degrees of adoption behaviour identified in the repertory grid analysis in this study. In addition, each decision making process may require a different length of time, and the farmers may continue with a particular decision for some time before deciding to change permanently. This was confirmed as many farmers in this study had tried "pandu" several times before deciding to modify, or discontinue, the application.

The importance of considering decision changes is also in line with Rogers's (1993) infamous five steps in the "*innovation-decision process*". Rogers indicated the possibility of "*re-invention*", or modification, in the "*implementation"* stage (pp. 174-182), and the options of continuing, or discontinuing, the technology in the "*confirmation"* stage (pp. 184-191). The latter was also included by Ohlmer et al. (1998) in their matrix of the decision making process.

Overall, this premise re-states that an adoption process is a dynamic and continuous process. It may change according to the situations. The recognition of different decisions in the adoption process may cover all aspects of the adoption behaviour, and allow a more thorough analysis.

The different decisions can be represented using several TPB models. This may be the only option for recognizing the dynamic component of the decision making process, while at the same time maintaining the linearity of the TPB model. The latter is important with regard to the practicality of using the model in a quantitative analysis, and the fact that the farmers may not make decisions all at once. These decisions may be related to each other, as the earlier decisions can influence the subsequent decisions. This leads to the next premise on heuristic application.

9.4.1.2 Heuristic application

In Chapters One and Four, a heuristic is described as a simple but directive rule allowing the farmers to make a decision in a manageable time. Ohlmer et al. (1998) refer to a heuristic as the farmers' preference for a quick and simple approach. Such preferences may stem from the farmers' perceptions about the usefulness of a new technology and its compatibility with local situations, or from their learning about past decisions and expectations (Antonides, 1996; Tversky & Kahnemann, 1974, Slovic et al., 1977, the latter two are cited from Heong & Escalada, 1999). The learning process may include personal experience and social interactions, and they influence the decision making process. All become the basis of the next premises.

9.4.1.2.1 Heuristics from past behaviour

The influence of past decisions/behaviour in the farmers' decision making process is relevant since a decision may not be independent from other decisions. Many studies using the TPB framework have also suggested the link between the past and subsequent behaviour, particularly in the case of a recurring experience (see Ajzen, 2001). This link appears to be mediated by the intention and perception of behavioural control (PBC). Ajzen (1991; 2001), however, considered such a mechanism might only result in a mediocre effect. He argued that past behaviour was the result of a group of variables or processes, and if its effects were enduring to the subsequent behaviour, this indicated that the analysis had left out some important variables (see Ajzen, 1991, pp. 202-205; Ajzen & Fishbein, 2000, cited in Ajzen, 2001, p. 46).

Despite Ajzen's argument, the role of past decisions/behaviour may be applicable in the case of semi-commercial farmers' decision making process. This may represent one of the farmers' cognitive approaches in the case of insufficient knowledge and accessible information. This study showed that the farmers used their memory to monitor income/profit, prices, costs, yield and procedures from the previous seasons, and used these variables to decide on the next cropping system. However, not all variables influenced the farmers' intention. The TPB model in this study, for example, included only the yield of milkfish to represent the mixture of influences from past income/performance and from the previous choice of commodity. The yield of milkfish was found to affect the farmers' intention and beliefs about the advantages of "pandu", and on the external impeding factors. This confirmed the role of intentions and PBC in mediating the past and the subsequent behaviour as found in other studies.

Nevertheless, the past behaviour, as outlined in the improved adoption model, is related to neither the frequency of application, nor the roles of intentions and PBC. Here, the effect of past decisions/behaviour is broken down into several variables (e.g. income, costs, etc.) that individually, or together, can represent such an effect. This is relevant considering the farmers' less reliable information management system.

Within the TPB framework, the effects of past decisions/behaviour can be mediated through the development of the farmers' beliefs. This is represented by background variables influencing the farmers' accessible beliefs. These variables may have a single, or multiple, relationship with any of the farmers' beliefs, and such relationships may indicate the use of heuristics. For example, the farmers may base their expectation, and motivation, to apply a new technology on the success or failure of a technology application in the past. This depicts the heuristic of "*event matching*" (Simon, 1959, cited in Antonides, 1996). Another possible heuristic application is related to the farmers' perceptions of handling situational challenges. The farmers in this study, for example, estimated the water supply based on its availability in the previous seasons or last year. This had been proven as inaccurate, but the farmers did not have other sources of information. This may depict the heuristic of "*representativeness*", which usually contains bias due to miscalculation and the lack of knowledge and information (Tversky & Kahneman, 1982).

Overall, the inclusion of past decisions/behaviour as one of the behavioural stimuli may improve the adoption analysis. This indicates the farmers' cognitive approach in dealing with the adoption context, particularly when access to information and knowledge is limited. The relationships between past behaviour and the farmers' beliefs may also depict the farmers' application of heuristics in decision making.

9.4.1.2.2 Heuristics from peer learning

Peer learning may result in decision heuristics related to the farmers' interactions with others. For example, the farmers in this study seemed to learn from their colleagues through peer observations and informal discussions with others. Rogers (1993) recognized this practice in the "*decision choice*" stage (pp. 172-174). Other studies also confirmed the role of observation, comparison and copying practices in farmers' technology adoption process (Case, 1992; see Feder, Just, & Zilberman, 1985; Munshi, 2004; Neill & Lee, 2001; Ohlmer et al., 1998; Pomp & Burger, 1995). These studies found the learning was induced by the limited access to resources, information and skills. Peer learning also indicates a farmer-to-farmer technology transfer process.

Similar conditions were found in this study. A failure for one farmer might prevent the other farmers from adopting "pandu". The farmers might also consider other criteria, besides successes and failures. For example, the farmers in this study had a specific reference person based on closeness and informality. Marsh (2002) refers to this practice as a heuristic of *social affiliation*. Some farmers also seemed to use the heuristic of *social comparison* (Marsh, 2002) when they specified their role models or benchmarks for evaluating success and failure in implementing "pandu". In addition, many farmers shared the same perceptions with others when considering "pandu", indicating the heuristic of *social imitation* (Marsh, 2002).

Similar to the heuristics from past decisions, peer learning may also contain biases, such as related to (i) the trade-off between practicality and precision; (ii) the reliability of the reference group and the information; and (iii) the rigidity of socio-cultural values towards changes (Marsh, 2002). An example from this study was the low prawn price, which was widely cited by the farmers, but overlooked in terms of its causes. Only a few farmers realized that their lack of knowledge of prawn culture was the main cause of low prawn productivity and quality further leading to low prawn price, which they believed as the main reason of abandoning "pandu".

Such a shortcoming can be overcome through the inclusion of different sources of information frequently used by the farmers. This may include the intensity of the farmers' interactions with their spouse, neighbours, and extension officers. These variables can act as behavioural stimuli, and are linked to the farmers' accessible beliefs. Another alternative is to add the effects of the neighbouring farms on the farmers' intention to adopt a new technology. This includes the practices and relevant outcomes. This is important as different preferences among the neighbouring farmers often impede the adoption of a new technology. This was confirmed in the case of commodities in this study. Lastly, success and failure in performing a new technology may also intensify the social pressure among the neighbouring farmers, as they are often required to respond accordingly.

9.4.1.3 Bargaining process

The farmers' social interaction that is represented by peer learning may also involve a certain level of negotiation. Facing a decision choice, the farmers may realize differences in the perceptions, intentions and expectations between them and their significant others; they may try to settle the differences through a bargaining process. This has also been identified in other studies of farmers' decision making (e.g. Asfaw & Admassie, 2004; Conway, 1987; Kaliba, Featherstone, & Norman, 1997; Lawrence, Sanders, & Ramaswamy, 1999; McGregor, Rola-Rubzen, & Murray-Prior, 2001; Romero & Rehman, 2003; Scoones & Thompson, 1994; Sejati et al., 2002; Suradisastra, Sejati, Supriatna, & Hidayat, 2002). Other academics have also noted the role of a bargaining process in one's mental process and behaviour (see Antonides, 1996; Warneryd, 1988).

Nevertheless, the role of a bargaining process is assumed to go beyond the application of social heuristics as outlined by Marsh (2002). It may involve the farmers' closest partners (*social affiliation*) and their role models in farming (*social comparison*), but it is more than just the need to find harmony by adhering to the general norms (*social imitation*). The latter distinguishes the bargaining process from the subjective norms, as the former represented the farmers' active role in communicating their opinion and intention, while the latter is limited to a non-interactive mental process.

The role of a bargaining process is also assumed to mediate the farmers' intention. In this study, this was clarified through the recognition of the farmers' communication behaviour as represented by the farmers' choice of discussing "pandu" extensively, but making the final decision individually or collectively. This might confirm the premise of farmers as rational decision makers (see Murray-Prior, 1998; Ohlmer et al., 1998), and their communication behaviour simply reflects their responses to the changes in their internal and external situations.

The latter suggests a relationship between the bargaining process and other variables. The TPB model in this study, for example, included a link between the farmers' perceived behavioural control (PBC) and the bargaining process in order to show the farmers' appraisal of the practicality of applying "pandu". This is relevant as farmers often refer to their perceptions and knowledge about the situational aspects during the discussion and negotiation. The EDTM analysis also suggests the link between the farmers' bargaining process and objectives, especially when income and food security became an important issue in the family.

Other decision criteria affecting the bargaining process include the changes in (i) land, capital and task allocation, (ii) commodity choices, (iii) product prices and (iv) common resource allocations. In this study, these changes were represented by the farmers' interactions with their family members, neighbours, farm labourers and middlemen, which often caused the change in the farmers' decision on "pandu". The links between these criteria and the bargaining process may help determine the implication of the farmers' bargaining power on their decision.

In general, a bargaining process may occur in every decision making path, regardless of the farmers' knowledge about the technology. In the TPB model, this appears before the final decision. The mediation role of a bargaining process, however, still depends on the case under study. The EDTM analysis showed that the bargaining process might be relevant only in certain decision options and groups of farmers. For example, if a new technology is introduced through a program, the participating farmers may simply be committed to apply the technology and, hence, a bargaining process may not be evident. However, these farmers may involve a bargaining process when making a modification, or continuation, decision.

Overall, an adoption-decision making analysis should always consider the role of a bargaining process. This process may also be related to factors representing the practical aspects reviewed by the farmers during the discussion and negotiation. The inclusion, hence, may clarify the decisive factor that transforms the farmers' intention. This also improves the concept of the TPB created by Ajzen (2002a, updated Jan 06, see Figure 4.3, p. 82).

9.4.1.4 Personality-related variables

Many adoption analyses contain one or more case-specific variables that are clearly specific to the case under study. This may also be applied to the TPB framework as its applications become wider. One possible alternative is to add socioeconomic factors, socio-cultural and agro-climatic factors as the behavioural stimuli to provide a more general representation. All were represented in the TPB model in this study. These took the forms of assets, objectives, past performance, significant others' influences, current problems, farming practices, and locational factors, all being causal factors. The results, in general, improved the overall model explanation. Other variables may also be suitable as a potential background element of the farmers' perceptions. This may include personal characteristics.

The latter might be represented by the different communication methods applied by the farmers in this study. The farmers' choice of communication approach, to some extent, showed the interactions between the farmers' personality, socioeconomic conditions and socio-cultural influences. The personality element appeared to be dominant as the farmers had the authority to choose whether to make a decision alone or collectively. This might indicate a certain level of self-directness in the farmers' decision making process. In the TPB model in Figure 5.5, Chapter Five (p. 131), this was represented by the variable "**DM**" (final decision maker(s)). This variable, however, might only show the commonly observed action as it could vary across different decisions and decision contexts.

Other personal characteristics, although latent, may also be involved. This can be inferred, for example, from the many constructs elicited by farmers during the repertory grid interview. Examples include the constructs (*the work-the results*), (*own effort-need others' help*), (*carefully endeavoured-up to fate*), (*work for living-work for other means*), (*advanced farmer-traditional farmer*), (*open-monopolized*), (*depend on effort-depend on nature*), (*depend on money-not depend on money*), (*own decision-consensus*), (*close people-distance people*), and (*cooperation-rivalry*). Some of these constructs might suggest the farmers' attributes to work and desire to obtain positive results from their own efforts. Some constructs might also indicate a certain degree of entrepreneurship and openness in the farmers' decision making process. These constructs stemmed from the farmers' own expressions when they evaluated a particular decision element. These expressions might depict the farmers' dispositions related to their managerial capacity, self-efficacy and social traits. These traits, however, were unnoticed during the TPB interview. Hence, none of these constructs were included in the TPB model, although they might be implicit in the farmers' perceptions.

The EDTM analysis also confirmed similar inferences. The decision trees revealed the impact of age in determining the farmers' strength and motivation in applying "pandu". Four farmers from Sugihwaras and Rejosari also completely ignored "pandu" as they had a strong adherence towards their current farming system. Other farmers also showed their eagerness to learn and advance their managerial capacity. The latter farmers frequently sought new farming information, participated in various extension activities, and were willing to spend money on trying new things, even though not all of them were wealthy. This might suggest characteristics of industriousness and risk taking. Others also referred to these farmers as their role models, and most of them were among the "pandu" adopters.

The role of personality/personal aspects as a determinant of one's behaviour was also suggested by many studies (see Ajzen, 2001, for the summary; and Chetsumon, 2005; Coleman, McGregor, Hemsworth, Boyce, & Dowling, 2003; Hrubes, Ajzen, & Daigle, 2001). Ajzen (1988; 2001), however, doubted the applicability of any personality factors being added to the TPB framework in a general case situation. His argument makes sense as different situations may induce different responses. The inclusion of the farmers' personal aspects, such as age and the level of education, in the TPB model of this study also did not show a significant effect. Nevertheless, one may argue that part of the rationality of such responses may stem from the decision makers' personality, besides their learning process and knowledge. This shows how the subjective and objective aspects interact and shape one's mental process. Antonides (1996) has recognized such interactions in his concept of a consumer's decision making process (see Figure 4.2, Chapter Four, p. 62).

9.4.1.5 Summary of premises

Overall, the structure of the improved adoption-decision making framework employs the following premises:

a) farmers consider several consecutive decisions when they deal with the option of adopting a new technology; and the decisions include trying, modifying, rejecting, delaying and/or continuing applying the technology;

b) in making adoption decisions, farmers rely on rules of thumb (heuristics) related to the usefulness of the technology and its compatibility with local situations, and these rules are constantly under review, i.e. dynamic;

c) farmers' heuristic application is also influenced by their learning from past decisions/behaviour, and their interactions with their significant others, particularly their close and/or local people;

d) a certain degree of intra-household and social bargaining processes is also involved as the farmers obtain new information and/or seek collective reinforcement;

e) the bargaining processes may be represented by the farmers' communication behaviour, and it may determine the final decision making step; and

f) some personal, and locational, factors also contribute to rationality in the farmers' mental and overall decision making process.

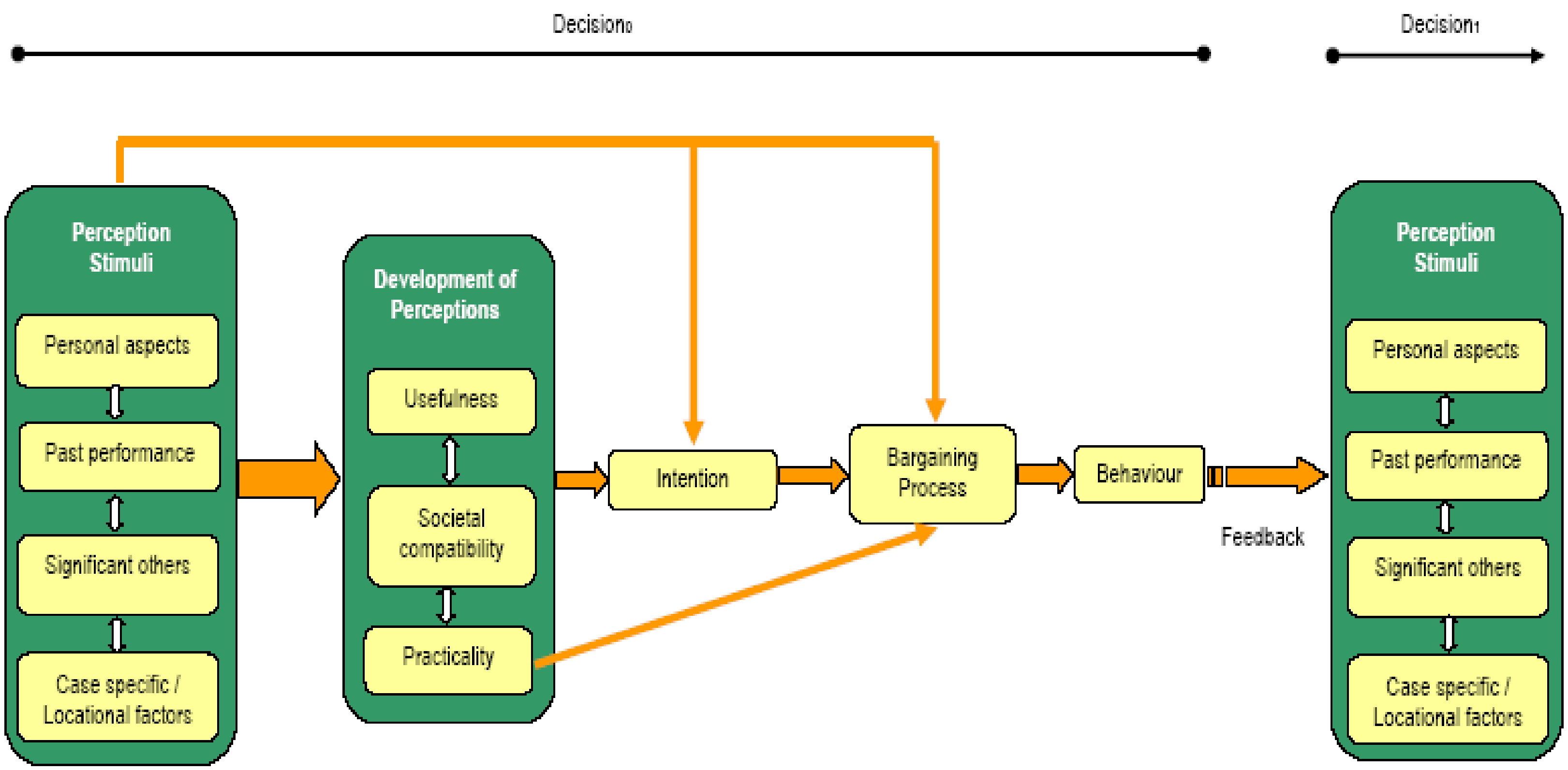
These premises represent a thorough description of the farmers' decision making process. It is more detailed than simply proposing a mental process and, at the same time, allows the identification of the sources of the farmers' beliefs. The recognition of a bargaining process and multiple decisions also indicates the farmers' efforts to deal with the changes in their internal and external environment. All the premises are also in line with the findings from many independent studies in agricultural technology adoption (e.g. Feder et al., 1985; Marra, Pannell, & Abadi Ghadim, 2003; Neill & Lee, 2001).

9.4.2. The General Framework for Adoption-Decision Making Analysis

Based on the premises, an improved adoption-decision making framework is devised. The framework is particularly applicable for analyzing technology adoption practices among semi-commercial farmers in a developing country, although it may also be applicable in other case situations. The framework is presented in Figure 9.1.

The framework includes the components of (i) behavioural stimuli, (ii) perceptions, (iii) an intention, (iv) a bargaining process, (v) a behaviour, and (vi) a forward link

Figure 9.1 An improved framework for analyzing the semi-commercial farmers' adoption decision



with future decisions/behaviour. The behavioural stimuli may relate to the farmers' personal aspects, past performance, the influence of "significant others", and some case specific/locational factors. The farmers' personal aspects may include their objectives, assets, traits, management capability, and other variables; while the effects of past decisions/behaviour can be represented by the outcome and experience from past technology applications. The influences of the farmers' "significant others" in building the farmers' perceptions may relate to the intensity of interactions, the outcome from the neighbouring farmers, and the level of involvement of family members in the farm operation. For the case specific/locational factors, they may relate to the changes in the market, agro-ecosystem, socio-cultural aspects, extension activities, labour relations, commodity choices, incentives, access to information and capital. These behavioural stimuli are also assumed to be interrelated.

In the new framework, these behavioural stimuli are assumed to influence the creation of the farmers' perceptions. The effects may appear in the forms of the perceptions of the usefulness of a technology. This is relevant, as the farmers may prefer to evaluate the potential benefits before considering the shortcomings associated with a new technology application. This was confirmed in this study. The other perceptions are related to the societal compatibility and the practicality of the technology. The former shows whether the society where the farmers live understands and anticipates the farmers' responses to the new technology; while the latter shows the degree of applicability of the technology considering local situations. These perceptions follow the TPB concept. These perceptions are also assumed to be interrelated.

The links between perceptions, intention, practicality considerations, the bargaining process and behaviour in the framework follow the results of the TPB analysis in this study. Similar approaches are also applied to determine the links between behavioural stimuli and intention, and between behavioural stimuli and the bargaining process. A feedback mechanism is also included in the framework to show the forward link between the current and the subsequent decisions/behaviour.

The use/choice of variables and relationships outlined in the framework, however, depends on the type of the technology, the relevant decision to be made, the type of farmers, and the locations. For example, one may find that the perception of practicality is far more important in the case of a "modification" decision related to a new technology application. In contrast, the societal compatibility may be very influential when a new technology is introduced through a mass program involving the whole village, or several villages. Meanwhile, the perceptions of the usefulness of the technology may mainly influence farmers who are not involved in the dissemination process and rely on information and observation from their colleagues.

The new framework includes only the most relevant variables for analyzing the farmers' technology adoption behaviour. One may weigh one or more variables, or relationships, differently in order to match the case situations under study. One may also use the background stimuli identified in this study with care (see Appendix L). This is because not all of stimuli are applicable to other cases, e.g. fully commercial farmers. For example, a significantly observable and superior result may become the basis of a new technology appraisal in the case of both semi-commercial and fully commercial farmers. This factor usually draws on the considerations of other factors. Farmers' objectives, for example, may be involved, and a higher yield and income may become the common objectives of both semi-commercial and fully commercial farmers. Nevertheless, these two groups of farmers may have different use of the yield/income. The semi-commercial farmers in this study, for example, kept most of the rice for family consumption and sold other products to cover their children's school fees and other primary expenses. These farmers also preferred a more secured income-generating activity to a higher income generating—but riskier—option. In contrast, fully commercial farmers may include leisure and expansion as their objectives, and may take risks for a better income.

Semi-commercial farmers also have different decision making methods compared to fully commercial farmers, although most of them can be classified as "*intuitive*" farmers (see the findings for fully commercial farmers in Ohlmer et al., 1998, p. 279). This is because fully commercial farmers may have sufficient access to information, skills and knowledge, while peer learning and passive observation may be the only sources of information for semi-commercial farmers.

In terms of resources, semi-commercial farmers usually have small plots and share limited resources. This condition requires them to adjust their cropping pattern according to the common practice. In the case of "pandu", such an adjustment is important as it may relate not only to the farming issue, but also to social harmony. This shows the interrelationships between socioeconomic, socio-cultural and environmental aspects. The significance of social interactions among farmers and the environmental aspect may also be different depending on the society and location.

Overall, the background stimuli in the proposed framework should be selected according to the case under study. Some background stimuli identified in this study that require adjustment may include factors related to farmers' objectives, skills, information processing capacity, own resources, access to external resources, socio-cultural relations and location.

All of these show that the framework is quite flexible for describing and predicting technology adoption behaviour among farmers. Since the framework is also consistent with theories in the decision making related area (see Antonides, 1996; Gladwin, 1989a; Kelly, 1955; Marsh, 2002; Muller, 2001; Ohlmer et al., 1998; Rogers, 1993; Tversky & Kahneman, 1982), it may tackle the difficulty of conceptualizing a universal adoption process.

9.4.3. An Improved Data Collection Procedure

Another contribution of this study involves an improvement in data collection procedures. This is achieved through combining three different interview methods, i.e. the background, the TPB and the semi-ethnographic interviews. One may also consider including the repertory grid interview, but the interview and interpretation processes are quite time-consuming due to the richness of the information. This happens especially if the study involves a large sample. This suggests repertory grid analysis could be optimally used only in a focused small-scale study.

The improved data collection procedures suggested in this study has two parts. First, a pilot interview is conducted using the semi-ethnographic interview. The results can be used for identifying the most relevant background stimuli of the farmers' perceptions about a new technology. Some simple decision trees may also be developed to determine the relationships between variables relevant to the farmers' adoption decision making process.

The use of the semi-ethnographic interview as a pilot interview, however, would be best if the interviewers have already defined what information should be obtained from the respondents. By preparing a list of guiding questions, the interviewers can avoid the semi-ethnographic interview being lengthy and complicated, but at the same time obtain sufficient information. The interview may also be directed to provide general hints about the relative importance of each of the TPB components in the respondents' decision making process. In sum, having a focus becomes the key requisite for an effective semi-ethnographic interview as a pilot TPB interview.

The results from the pilot interview become the basis for creating the main TPB questionnaire. Some modification, however, may be applied. This includes using a semi-structured interview, instead of a full list of questions such as the standard TPB questionnaire. This allows the respondents to use their own terms in explaining their decisions, and this avoids the interviewer's bias, a common problem in a pre-set questionnaire. Questions related to the respondents' personal, socioeconomic, and socio-cultural aspects may also be added for measuring the background stimuli.

During the interview, the respondents determine the score for every decision criterion mentioned. A high score can indicate the respondents' most relevant decision factor. The scores also allow the responses to be quantitatively modelled and analyzed. The results can be presented and analyzed in the form of a multivariate decision model or a decision tree; either one can be used for explaining a particular decision, or predicting future decisions.

Using a decision tree, however, requires a test analysis to ensure its predictive power. This means that an additional sample group who have similar decision choices is required. Provided that this can be fulfilled, the results may improve the applicability of the model for predicting future decisions. The use of decision trees may also be adjusted to different levels of adoption behaviour, making it possible to create a more well-targeted policy intervention.

9.4.4. Future Direction

This study has delineated a more realistic and thorough description of semi-commercial farmers' decision making process in developing countries. The results are expected to improve the understanding of the mental processes involved in farmers' decision making systems. Some suggestions on the application of the rules of thumb (heuristics) in the farmers' decision making process were also presented.

Nevertheless, some aspects of the analyses and the results require further explorations. These include:

a) identifying different groups of adopters and non-adopters based on the similarity in the use of heuristics. In this study, this was done the other way around due to the lack of standard procedures. Jangu (1993) successfully achieved this, but involved only a small number of advanced farmers;

b) exploring the relationships between the farmers' communication behaviour and the role/status of the farmers' "significant others". The latter was detected in this study, but how age, gender, level of education and wealth effectively influence the farmers' choice of partners in the bargaining process is still unknown;

c) exploring the role of personality, particularly managerial strategies and risk attitudes of the farmers in relation to their communication behaviour and decision making approach. One, for example, may consider the works of Aromolaran and Olayemi (2000), Feder et al. (1985), Gladwin (1989b), Nuthall (2001), Rougoor, Trip, Hurine and Renkema (1998) and others. Such an analysis is believed to improve the understanding of the farmers' choice of heuristics;

d) evaluating the effectiveness of the cognitive process, especially in relation to rigidity in the farmers' beliefs. In this study, this issue was represented by the farmers' predilection on milkfish production;

e) explaining the feedback mechanism that links one decision to the subsequent decision. This may include the analysis of whether a bargaining process is also present, especially when the farmers face failure in applying a new technology. This is believed to provide a better understanding about the farmers' belief in farming as a way of life;

f) exploring the variables that may better represent the socio-cultural norms. In this study, this was represented by only one variable called "**Vil**". A better representation of socio-cultural aspects is needed especially in case situations where socio-cultural relations are still strong; and

g) exploring the possibility of using the repertory grid or the EDTM analysis for creating a decision support system for a particular group of adopters/non-adopters. This would be good follow-up for the adoption-decision analysis, and a good foundation for creating targeted policy intervention.

All of these research opportunities should use the concepts developed in this study as the starting point. The results would contribute to the advancement of agricultural research, extension and policy approaches, particularly with respect to developing countries.

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Appendix A. Agricultural Technology Adoption Analysis

Table A.1. The methods and results from several analyses related to agricultural technology adoption

Authors	Methods	Significant variables*	Goodness of fit	
Adesina & Zinnah (1993)	Binary Tobit on the adoption of new rice variety			
	• using only farm and farmer specific variables	Participation on on-farm trials (+, 10%), contact with extension (+, 10%)	Log-likelihood function	-76.378
	• using only technology-specific variables	Yield (+, 1%), ease of cooking (+, 5%), tiller capacity (+, 1%), ease of threshing (+, 1%)	Log-likelihood function	-28.941
	• using farm and farmer specific variables and technology-specific variables	Yield (+, 1%), ease of cooking (+, 5%), tiller capacity (+, 1%), ease of threshing (+, 5%)	Log-likelihood function	-27.538
Asfaw & Admassie (2004)	Binary Logit on the adoption of fertilizer			
	• effect of education on adoption of chemical fertilizer	Education of household head (+, 10%), education of household members (+, 1%), value of livestock (+, 1%), availability of credit (+, 1%), level of development (modern or traditional, +, 1%)	Log-likelihood function X^2 (df)	-636.1998 278.88 (11)
	• effect of education on adoption of fertilizer under different socioeconomic conditions	Education of adult member in household (+, 1%), value of livestock (+, 1%), availability of credit (+, 1%), level of development (+, 1%), interaction between education and level of development (-, 1%)	Log-likelihood function X^2 (df)	-639.8402 271.60 (11)
Baidu-Forson (1999)	Binary Tobit model of specific soil and water management technologies	Extension availability (dummy, +, 5%), risk attitude (-, 5%), goal of obtaining short-term profit (+, 10%), % of degraded land/problem (+, 1%)	Log-likelihood function Squared correlation	-37.462 0.478
Batz, Janssen, & Peters (2003)	Modified logistic models (6 models)	Relative complexity (-, 1, 5 & 10%), relative risk (-, 1 & 5%), relative investment (-, 5%)	Adjusted R^2	0.40-0.56
Doss & Morris (2001)	Two-stage Probit:			
	• modern varieties adoption (3 models)	Ecological conditions (+, 1 & 5%), education (+, 1%), land tenure (+, 5%), extension (+, 1%), infrastructure (+, 5 & 10%), seed availability (+, 1%)	Log-likelihood	-206.99 - -210.49
	• fertilizer adoption (3 models)	Ecological conditions (+, 1, 5 & 10%), age (-/+, 5 &10 %), extension (+, 5 & 10%), infrastructure (+, 5%), experience (+, 5%)	Log-likelihood	-169.48 - -170.91

* Information between brackets indicates the type of data, the sign of the coefficient and/or the significant level.

Table A.1. The methods and results from several analyses related to agricultural technology adoption (continued)

Authors	Methods	Significant variables*	Goodness of fit	
Gockowski & Ndoumbe (2004)	Binary Logit to predict adoption determinants and the elasticity of adoption for certain policy variables	Age (-, 1%), number of men (+, 10%) and children (+, 5%) in household, yield (+, 10%), women as decision makers (-, 1%), monoculture yield (-, 1%), transportation costs (-, 5%)	McFadden R^2	0.319
Herath & Takeya (2003)	Binary Logit to analyze the effect of socioeconomic factors on the adoption of intercropping practices	Visits by extension workers (+, 1%), farmers' perception about intercropping (+, 1%), off-farm jobs (dummy, -, 1%), experience in other crops (+, 1%), land tenure (dummy, -, 1%), education of main decision maker (+, 10%)	Log-likelihood function Estrella R^2 Adjusted R^2	-74.34 0.85 0.79
Hintze, Renkow & Sain (2003)	Binary Logit to predict levels of adoption of improved maize varieties in two locations in Honduras	Road quality index (-, 5 & 10%), yield (+, 5 & 10%), family size (-, 1%, one location), cropped area (+, 10%, one location), early maturity (+, 10%, one location)	pseudo R^2 % correct prediction	0.532-0.591 86-89
Kaliba, Featherstone, & Norman (1997)	Binary Probit			
	• participation in cattle stall feeding	Gender of household head (+, 5%), area of cultivated land (-, 1%), frequency visit of extension workers (+, 1%), location (+, 5%), seminar attendance (+, 5%), male children in household (+, 10%)	% correct prediction	84.188
	• adoption of water melon for cattle feeding	Gender of household head (+, 5%), area of cultivated land (-, 1%), number of indigenous cattle owned (+, 1%), location (-, 1%), seminar attendance (+, 1%), male children in household (+, 10%)	% correct prediction	81.19
	• Heckman two stages model for the adoption of stall-fed cattle	Gender of household head (-, 1%), number of men (-, 1%), women (+, 1%) and female children (-, 5%) in household, field day attendance (+, 10%), location (+, 1-10%)	R^2	0.597
Lapar & Ehui (2004)	Binary probit to predict levels of adoption of dual-purpose forages	Education (+, 1%), household income (+, 10%), access to credit (dummy, +, 10%), location (dummy, +, 10%)	Log-likelihood	-73.12
Negatu & Parikh (1999)	Ordered and binomial Probit to predict two-way relationships between farmers' perception and adoption practices			
	• Perception of marketability with predicted adoption	Gross margin for cultivated land (+, 5%), distance from town (+, 5%), frequency visit to local market (-, 10%), frequency visit to city (+, 5%)	Count-R^2 / X^2	0.79/29.79
	• Perception of yield with predicted adoption	Proportion of vertisol soil (+, 5%), frequency visit to local market (-, 5%)	Count-R^2 / X^2	0.79/34.45
	• Adoption with predicted marketability	Area of cultivated land (+, 10%), gross margin for cultivated land (+, 10%), proportion of vertisol soil (+, 10%), perception of marketability (+, 5%)	Count-R^2 / X^2	0.94/34.72
	• Adoption with predicted yield	Area of cultivated land (+, 10%), gross margin for cultivated land (+, 5%)	Count-R^2 / X^2	0.94/39.14

* Information between brackets indicates the type of data, the sign of coefficient, the significant level and/or the particular location involved.

Table A.1. The methods and results from several analyses related to agricultural technology adoption (continued)

Authors	Methods	Significant variables*	Goodness of fit	
Neil & Lee (2001)	Bivariate Probit (2 models) for 2 decisions:		For both decisions	
	• adoption of cover crops	Road access (-, 5 & 10%), land tenure (+, 1%), farm size (+, 10 & 5%), slopes (+, 1 & 5%), family labour (+, 10%)	Log-likelihood	-302.69 - -307.00
	• abandonment of cover crops	Road access (-, 5 & 10%), age (-, 1%), problem with cover crops (-, 10%), reseed practice (+, 1%), land allocated for maize (+, 5 & 10%), cash crop (+, 5%), experience, (+, 10%)	likelihood ratio test	66.44-67.03 (sig. 1%)
Pingali et al. (2001)	Binary Logit, 4 types of innovations, 4 locations	Different types of innovation and different locations have different composition of adoption variables	R^2	0.40-0.74
Pomp & Burger (1995)	Bivariate Probit to predict adoption propensity of new cocoa crop	The number of previous adopters (+, t-stat = 3.2), education (+, t-stat = 3.2), age (+, t-stat = 2.8), off-farm jobs (-, t-stat = 2.5), female headed household (-, t-stat = 2.5)	not available	
	Bivariate Tobit to predict adoption propensity of new cocoa crop	The number of previous adopters (+, t-stat = 2.7), education (+, t-stat = 3.4), age (+, t-stat = 2.8), off-farm jobs (-, t-stat = 2.7), female headed household (-, t-stat = 2.4)	not available	
	Biaviate Probit to test the effect of education on peer copying	The number of previous adopters with > 1 year of schooling (+, t-stat = 2.6); the number of previous adopters with > 6 years of schooling (+, t-stat = 2.1)	not available	
Ransom, Paudyar & Adhikari (2003)	BinaryTobit for predicting the effect of adoption variables of new maize varieties	Location (+, 5%, one location), off-farm income (+, 1%), extension contact (dummy, +, 1%), hired farm labour (dummy, -, 1%), ethnic group (dummy, +, 1%), experience in using fertilizers (+, 5%)	likelihood ration	48.2 (sig. 1%)
Shiferaw & Holden (1998)	Ordinal Logit for analyzing farmers' perceptions on the soil erosion problem	Rate of time preference (-, 5%), technology awareness (+, 1%), land-man ratio (-, 5%), possession of livestock (-, 1%), slopeness of land (+, 0.1%), soil retention (+, 0.1%), and agro-climatic zone (dummy, +, 10%)	Adjusted R^2	0.347
	Ordinal Logit for analyzing the intensity of soil conservation adoption	Perception on problem (+, 10%), age (-, 0.1%), family size (-, 1%), attitude to small-scale own trial (dummy, +, 5%), farm group (dummy, -, 10%), technology awareness (+, 1%), land/man ratio (+, 1%), type of house (+, 10%), slopeness of land (+, 0.1%), productivity (+, 5%), and agro-climatic zone (dummy, -, 1%)	-2 Log-likelihood	302.9

* Information between brackets indicates the type of data, the sign of the coefficient and/or the significant level.

Table A.2. Adoption analyses by Pingali et al. (2001)

Technology	Factors and their significance			
	Philippines	China	Vietnam	India
Super High-Yielding Variety	Education (0.34, 5%) Membership in farm group (-2.31, 5%)	Age (0.7, 5%) Education (0.67, 5%) Farm size (1.75, 5%) Wealth (-0.34E-04, 10%)	Education (-0.27, 5%) Farm size (-0.46, 1%)	Gender (-1.62, 1%)
High-Quality Variety	Gender (-1.43, 1%) Age (0.07, 5%) Membership in farm group (-2.04, 5%)	Education (-0.91, 1%) Wealth (0.5E-04, 10%)	Gender (1.34, 5%)	Education (-0.22, 1%)
Integrated Post Management	Education (0.28, 1%)	Age (-0.19, 5%) Type of job (off-/in-farm, 1.47, 1%)		Tenure (0.94, 1%)
Mechanical Stripper-Harvester	Gender (2.97, 5%) Age (-0.12, 5%) Membership in farm group (4.5, 10%)	Education (-1.46, 5%) Farm size (-3.67, 5%) Wealth (0.41E-04, 1%)	Farm size (0.5 1%)	Education (0.37, 1%) Farm size (-3.23, 5%)

Note: numbers in parentheses show the estimated coefficient and the significance level; R^2 range from 0.40 to 0.74;

INTERVIEW QUESTIONNAIRE

Decision making processes of semi-commercial farmers: a case study of technology adoption in Indonesia

You will not be identified as a respondent without your consent. You may, at any time, withdraw your participation, including withdrawal of any information you have provided. If you complete the interview, however, it will be understood that you have consented to participate in this research and consent to publication of the results of this research with the understanding that anonymity will be preserved.

Identity No.

Number of persons attending the interview: _____ persons
Remarks: ____

____

Section 1. Farm Household Attributes

1. Demographic characteristics of the farm household and roles in the farm:
   a. Age of farmer: _____ years old
   b. Number of people living in the family: _________ persons
   c. Number of children:
      ≤ 5 years old: ___   6-14 years old: ___   > 14 years old: ___
   d. Education of family members:
      Farmer: ___________________   Spouse: ______________________
      Children: Primary: ___   Jr. High School: ___   High School: ___   Uni: ___
   e. Family members who help operate the farm: ________________________________
      ____

2. a. The size of ricefield pond: _____ hectare or m2
   b. What is the status of your own land? _____________________________________
   c. Do you borrow additional land? [ ] No   [ ] Yes, _____ hectare or m2

3. Please explain your objective(s) in farming _____________________________________
   ____
   ____

Section 2. Farm System

4. a. Cropping pattern, production and income in the past three cropping seasons:

Commodity	Size of land cultivated (m^2, hectare)	Yield (100 kilogram, ton)	Income per commodity (IDR)
Planting season 1			
Planting season 2			
Planting season 3			
Planting season 4			

b. How long have you been involved in cultivating or growing:
[ ] paddy: _____ years [ ] fish: _____ years [ ] prawn: _____ years

5. a. Do you or your family members have off-farm job(s)?
[ ] No [ ] Yes, specify: ____
b. Please indicate other productive activities that you have in the farm: _______________
____

6. Total production cost and sources of capital in 2004 (IDR)

	Production costs	Own capital	Borrowed capital	Remarks
Season 1				
Season 2				
Season 3				
Season 4				

7. Trend of yield, income and production costs (*show cards: 1 = far higher, 2 = higher, 3 = unchanged, 4 = lower, 5 = far lower, 6 = uncertain/sometimes higher or lower*):

	Yearly trend	Remarks
Paddy yield		
Prawn yield		
Fish yield		
Paddy price		
Prawn price		

	Yearly trend	Remarks
Fish price		
Fertilizer cost		
Pesticide cost		
Seed cost		
Yearly profit		

8. What problems have you had in cultivating rice, fish, prawn or other products in recent years? Please rate the intensity (*show cards: 1 = very serious, 2 = serious, 3 = quite serious, 4 = becoming serious, 5 = common, 6 = becoming marginal, 7 = quite trivial, 8 = trivial, 9 = very trivial, 10 = no problem*).
Problem 1: ____
____ (...........)
Problem 2: ____
____ (...........)
Problem 3: ____
____ (...........)
Problem 4: ____
____ (...........)
Problem 5: ____
____ (...........)
Problem 6: ____
____ (...........)
Problem 7: ____
____ (...........)
Problem 8: ____
____ (...........)
Problem 9: ____
____ (...........)
Problem 10: ____
____ (...........)

9. What methods do you use for marketing your products? And where?
[ ] Direct marketing
  [ ] local markets within the same district
  [ ] markets in other districts and/or provinces   [ ] export

[ ] Indirect marketing through [ ] middlemen, [ ] cooperatives, [ ] other: _______________
  [ ] local markets within the same district
  [ ] markets in other districts and/or provinces   [ ] export

10. Types of technology applied (including machinery and improved practices/systems)

Type	Years of application	Remarks

Section 3. Farm Information Management

11. a. How do you keep track of information about planting date, yield, input, cost, credit and profit? [ ] Memory [ ] Notes on calendar [ ] Farm record book
[ ] Other: ____
b. Please indicate data that are kept or continuously monitored, recorded, and/or memorized, and provide brief explanation

Data	Remarks

12. Where do you find information about how to cultivate rice, fish, prawn and other products? Please indicate the intensity (*show cards, check (✓) where appropriate, suggest intensity*: *1 = always, 2 = often, 3 = sometimes, 4 = rarely, 5 = never*) and provide brief explanation

Sources	Rate	Remarks
[ ] family		
[ ] neighbours		
[ ] village leaders		
[ ] religious leaders		
[ ] farmer group meeting		
[ ] middlemen		
[ ] input retailers		
[ ] extension officers		
[ ] researchers		
[ ] buyers		
[ ] school		
[ ] training		
[ ] seminars and/or workshops		
[ ] learning by doing		
[ ] manuals		
[ ] television program		
[ ] radio program		
[ ] newspapers and/or magazines		
[ ] brochures, booklets, posters,		
[ ] bank		
[ ] cooperative		
[ ] other:		

13. Where do you find information about loan or credit? Please indicate the intensity (*show cards, check (✓) where appropriate, suggest intensity*: *1 = always, 2 = often, 3 = sometimes, 4 = rarely, 5 = never*) and provide brief explanation

Sources	Rate	Remarks
[ ] family		
[ ] neighbours		
[ ] village leaders		
[ ] religious leaders		
[ ] farmer group meeting		
[ ] middlemen		
[ ] input retailers		

Sources	Rate	Remarks
[ ] extension officers		
[ ] researchers		
[ ] buyers		
[ ] training		
[ ] seminars and/or workshops		
[ ] television program		
[ ] radio program		
[ ] newspapers and/or magazines		
[ ] brochures, booklets, posters,		
[ ] bank		
[ ] BPR		
[ ] cooperative		
[ ] other:		

14. Where do you find information about new seeds, new fertilizers, new pesticides, new practices and new machinery? Please indicate the intensity (*show cards, check (✓) where appropriate, suggest intensity*: *1 = always, 2 = often, 3 = sometimes, 4 = rarely, 5 = never*) and provide brief explanation

Sources	Rate	Remarks
[ ] family		
[ ] neighbours		
[ ] village leaders		
[ ] religious leaders		
[ ] farmer group meeting		
[ ] middlemen		
[ ] input retailers		
[ ] extension officers		
[ ] researchers		
[ ] buyers		
[ ] school		
[ ] training		
[ ] seminars and/or workshops		
[ ] manuals		
[ ] television program		
[ ] radio program		
[ ] newspapers and/or magazines		
[ ] brochures, booklets, posters,		
[ ] cooperative		
[ ] other:		

15. Where do you find information about the market and prices? Please indicate the intensity (*show cards, check (✓) where appropriate, suggest intensity*: *1 = always, 2 = often, 3 = sometimes, 4 = rarely, 5 = never*) and provide brief explanation

Sources	Rate	Remarks
[ ] family		
[ ] neighbours		
[ ] village leaders		
[ ] religious leaders		
[ ] farmer group meeting		
[ ] middlemen		
[ ] input retailers		
[ ] extension officers		
[ ] researchers		
[ ] buyers		
[ ] school		

Sources	Rate	Remarks
[ ] training		
[ ] seminars and/or workshops		
[ ] television program		
[ ] radio program		
[ ] newspapers and/or magazines		
[ ] brochures, booklets, posters,		
[ ] bank		
[ ] BPR		
[ ] cooperative		
[ ] other:		

16. a. Do you participate in farmer group meeting? [ ] Yes, [ ] No, please explain the reasons: ____

____

b. What are the benefits from the farmer group? ______________________________

____

c. Besides farmer group, are you involved in other organizations in and/or outside the village?

Name	Position	Active [1] Inactive [2]

17. a. In what kinds of extension activities do you participate? Please provide brief explanation (*check (✓) where appropriate*).

Type of extension activity	Remarks
[ ] Village meeting	
[ ] Farmer group meeting	
[ ] Field visit	
[ ] Demonstration plot	
[ ] House visit	
[ ] Field training	
[ ] Class training	
[ ] Seminars and/or workshops	
[ ] Comparative study	
[ ] Other	

b. Please briefly explain the reason(s), if you have never participated in any extension activities ____

____

Section 4. Responses to New Information

18. What aspects do you usually consider when evaluating the feasibility of a new type of seeds, fertilizers, pesticides, machinery, or new practices? Please provide brief explanation (*check (✓) where appropriate*).

Variables	Remarks
[ ] yield	
[ ] profit	
[ ] neighbours have applied	
[ ] decision of farmer group	
[ ] easy to apply	

Variables	Remarks
[ ] soil conditions	
[ ] water availability	
[ ] water quality	
[ ] capital availability	
[ ] seed availability	
[ ] market price	
[ ] training	
[ ] composition	
[ ]	
[ ]	

19. Could you briefly explain what you usually do once you obtain new information, for example, about a new innovation? ____________________

____

____

____

____

20. a. To what extent do you involve others in discussing new information or other farming matters? (*show cards*)

	Always	Often	Sometimes	Rarely	Never
1. Spouse					
2. Children					
3. Parents					
4. Extended family					
5. Head of farmer group					
6. Extension worker					
7. Middlemen					
8. Other farmers					
9. Village leaders					
10. Religious leaders					
11. Other					

b. Why do you prefer to discuss the information or other farming matters with certain persons but not with others? ____________________

____

____

21. a. What are the benefits you get from discussing farming matters with significant others?

____

____

____

b. What do you usually do if significant others have different opinion with you? ________

____

____

____

c. Do you often negotiate your opinion/decision with your significant others? And why?

____

____

____

d. Whose opinion is finally accepted? And why? ________________________________
____
____
____

Section 5. Semi-ethnographic interview

Knowledge on the Improved Paddy-prawn System

1. a. Did you participate in the paddy-prawn dissemination program?
   [ ] No (*skip to question no. 2*)
   [ ] Yes (*continue to questions no. 1b-1e and 2*)
   b. Who introduced the system? ____
   c. Could you briefly describe the components of the improved system and their purposes?____
   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____

   d. Could you explain the incentives provided to support the application of the improved system? (*check (✓) where appropriate*)

Incentives	Remarks
[ ] class training & demonstration	
[ ] sample & field demonstration	
[ ] technical assistance & consultation	
[ ] manual	
[ ] financial calculation	
[ ] credit	
[ ] market information	
[ ] paddy seeds, fish fry or prawn larva	
[ ] other	

2. *Only for non participating farmers in the diffusion program*
   a. Where did you learn about the improved paddy-prawn system from? ______________
   ____
   b. Could you briefly describe the components of the technology? ___________________
   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____

Semi-ethnographic questions (a list of alternative questions/brief guidance, modified from Spradley (1979, pp. 61-66) [1] and the researcher's personal experience)

- I am interested in your explanation about the improved paddy-prawn system.
- How do you understand the components of the system?
- Is it difficult if I want to learn about and apply the system? Why?
- Could you describe your first impression about the benefits of the system?
- Could you describe your perception about the shortcomings of the system?
- Are there any other concerns that you remember when you realize the difficulty of applying the system?
- Now, I would like to ask your suggestion. If I want to start cultivating rice and prawn in this village, what factors should I carefully monitor in order to be successful?
- How can I solve problems that may arise in the field? How can I identify the problems?
- To whom should I talk about the problem(s)? If nobody can help me solve the problem(s), what should I do?
- If I am not successful, should I stop intercropping rice and prawn in the future? Why?
- Could you give me an example of your experience when you find difficulties in cultivating rice together with prawn?
- Now, if the AIAT decided to improve the system again or introduce a new intercropping system, what would you do? What considerations will you take to come to a decision that the system is feasible?
- You mentioned about factor "X", is it the most important? What is the difference between factor "X" and factor "Y"? Are they related?
- Do you consider from the first time you hear about the new system that regardless of its advantages, the results might not be as expected? Are there any conditions that enable you to deal with the challenges and uncertainties during the implementation of the new system?
- Are there any other concerns that you may have regarding the new system? Could you elaborate your answers?
- Do you always discuss any innovations, introduced to you, with your family? How about with other people outside your family? Who? Why?

[1] Spradley, J.P. (1979). *The ethnographic interview*. New York: Holt, Rinehart and Winston.

- This is quite interesting, but how can you make others to agree with you? Alternatively, how do you usually make decision(s) after discussing with others? Why?
- Now, if later, other kinds of innovations are introduced, will you take the same process of evaluation and use the same considerations? Why?

Section 6. Repertory Grid Interview

- The purpose of this interview is to identify your motives concerning the improved paddy-prawn system in more detail. The procedures will involve three sets of 15-19 cards. First, I will show you three cards, and I will ask you to divide the three cards into two groups. Then, I will ask you to name each group and to assign a value for the rest of the cards according to the groups that you have identified.
- Now let us first practice. For example, I have five cards; each contains a different name of animal. The cards are "*chicken", "cow", "fish", "pigeon", and "frog".* Now, I show you three cards:

frog
chicken
pigeon

"*Can you choose two of these three cards which are in some way alike and different from the other one*?"

After you indicate the two cards (for example: chicken and pigeon),

"*Now I want you to think what you have in mind when you separate the pair from the other one. Please name each pole to remind you what you are thinking or feeling when you use this*."

(For example, the respondent mentions that chicken and pigeon have two legs, while a frog has four legs). Could you provide a brief explanation of why you chose this particular way of differentiation. Based on your explanation, the poles can be defined as follows:

Left pole rated 1 {*chicken-pigeon*}: *have two legs*
Right pole rated 9 {*frog*}: *have four legs*

Now, "*According to how you feel, please assign to each of the other cards (fish and cow) a provisional value from 1 to 9. Please refer the scale to the poles you have decided*."

cow _____ fish _____

If the animals have no legs, you can assign no value, or “5”, indicating that the animals do not measure on the chosen pole scale. After you assign the value for each card, you will be asked to give a brief explanation of why you assigned a certain value for a certain card.

- Proceed with the interview by asking the respondent to recall the conditions when they first heard about the improved paddy-prawn system, and use the following guidelines[2] .
- Present the first list of elements, i.e. the ones related to attitudes (Table B.1), to the respondent.
- Explain that the list presented may represent the potential advantages and disadvantages that the respondent considered when she/he appraised the improved system. To make the list more precise, ask the respondent to confirm whether the elements are correct representations of her/his decision criteria, or whether she/he wants to add or reduce the elements.

Table B.1. Possible lists of elements for the PCT interview

Elements related to:		
Attitudes	Perceived behavioural control	Significant others involved in bargaining process
Income	Capital	Spouse
Paddy yield	Size of ricefield-pond	Children
Prawn yield	Off-farm work	Parents
Fish yield	Sale price	Extended family
Harvest failure	Production costs	Neighbouring farmers
Input costs	Access to information	Farmer group
Input availability	Number of buyers	Village leaders
Working hours in the field	Transportation cost	Religious leaders
Hired farm labourer	Levies	Extension officers
Off-farm work	Water availability	Researchers
Time for family	Pest & disease	Middlemen
Knowledge of paddy-prawn intercropping	Knowledge of paddy-prawn intercropping	Buyers
Farming skills	Working hours in the field	Input retailers
Length of time to learn new technology	Experience in cultivating paddy & prawn	Bank
Soil & water conditions	Extension services	Cooperatives
	Input availability	Government
	Household daily expenses	
	Farming skills	
	Debt	

- Once the list of elements is confirmed, start eliciting the respondent’s construct by asking a question related to a triad comparison, such as:

[2] All procedures are adopted from different sources (e.g. Fransella, Bell, & Bannister, 2004; Gaines & Shaw, 2004; Jangu, 1997), including the researcher’s personal experience.

"*Can you choose two of this triad of outcomes from applying the improved paddy-prawn system which are in some way alike and different from the other one*?

income
prawn yield
off-farm work

- Once, the two cards are selected, for example, "*income, off-farm work*", ask the respondent to name the poles, which represent the respondent's constructs:

  "*Now I want you to think what you have in mind when you separate the pair from the other one. Please name each pole to remind you what you are thinking or feeling when you use this*."

  Left pole rated 1 {income, off-farm work}: (fill in the name)
  Right pole rated 9 {prawn yield}: (fill in the name)

- Continue by asking the respondent why he chooses these names and record the explanation.
- Ask the respondent to rate all elements based on his constructs:

  "*According to how you feel about the outcome, please assign to each of the other outcomes a provisional value from 1 to 9. Please refer the scale to the poles you have decided*."

  rice yield _____ fish yield _____ harvest failure _____
  input costs _____ hired labour _____ off-farm work _____
  working hours in the field _____ knowledge and skills _____

- Some elements may be irrelevant to the constructs; thus, suggest the respondent select "5", or not put any value for this element. After all elements are scored, ask the respondent to provide a brief explanation of why she/he gives a certain value for a particular element.
- After the respondent rates all elements, ask her/his confirmation about the answer before proceeding to the next triad comparison. Repeat until the respondent does not have any more constructs to be elicited.
- Repeat all the procedures for the second and third list of elements.
- The guiding statement for the second list of elements relates to asking the respondent to recall their beliefs on the conditions that enable him/her to deal with the requirements and challenges for adopting the improved paddy-prawn system.

- The guiding statement for the third list of element stems from asking the respondent's opinion about the interest of the people/organization in the list with regards to her/his intention to adopt, delay or reject the improved paddy-prawn system.

Section 7. TPB questionnaire

Farmers' impression on the improved paddy-prawn system

Adopters

1. In general, do you think the improved system can help achieve your objectives in farming?
____
____
____

2. Which component from the system did you apply? And why? ____________
____
____
____

3. What modification did you make on the system? And why? ____________
____
____
____

4. What components are the most useful from the system? And why? ________
____
____
____

5. What aspects from the system that you think require improvement? And why?
____
____
____

6. Could you explain the factors that would hinder you to implement the system for a certain season? ____________________________________
____
____
____

7. Do you plan to continue using the system?
[ ] Yes, please explain: ______________________________
____
[ ] No, please explain: ______________________________
____

8. Would you suggest other farmers to use the system? Why? ________________________
____
____

9. Could you suggest another farmer that, according to your opinion, can be interviewed? Could you please explain the reason for your suggestion? ________________________
____
____
____

Non Adopters

10. In general, do you think the improved system can help achieve your objectives in farming?
____
____
____

11. Do you plan to use the system in the future?
[ ] Yes, please explain: ____
____
[ ] No, please explain: ____
____

12. Which components from the system are you interested in applying? And why?
____
____
____

13. What aspects from the system do you think require improvement? And why?
____
____
____

14. Could you explain the factors that would enable you to implement all components of the system? ____
____
____
____

15. Would you suggest other farmers use the system? Why? ________________________
____
____

16. Could you suggest another farmer that, according to your opinion, can be interviewed? Could you please explain the reason for your suggestion? ________________________
____
____
____

TPB Questionnaire

General guidelines

There are two types of scale description. The first one does not have numbers, so that responses are recorded by marking the space that corresponds to the respondent's view. For example, for the same statement and answer, the response is recorded as follows:

The price of rice is high:
unlikely _________:_________:_________:_________:____x____ likely
very quite neither quite very
Thus, the answer is very likely.

The second scale uses a five-point scale representing five different opinions ranging from strongly agree to strongly disagree. The response should be recorded by selecting the number that corresponds with the view of the respondent. For example, the respondent is asked to express her/his view on the following statement:

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
The price of rice is high.	**1**	**2**	**3**	**4**	**5**

If the respondent ***strongly agrees*** with this statement, please circle the corresponding number as follows.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
The price of rice is high	**1**	**2**	**3**	**4**	**5**

Questionnaire

1. I had a strong intention to apply all components of an improved paddy-prawn system when first heard about/observed the system:
   unlikely _________:_________:_________:_________:_________ likely
   very quite neither quite very

2. I had a strong intention to apply the recommended land preparation technique and dimension of the dikes ("caren") when first heard about/observed the system:
   unlikely _________:_________:_________:_________:_________ likely
   very quite neither quite very

3. I had a strong intention to apply the recommended rice planting distance ("jajar legowo") when first heard about/observed the system:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

4. I had a strong intention to apply the recommended dosages of fertilizer when first heard about/observed the system:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

5. I had a strong intention to apply the recommended plant-based pesticides and water management when first heard about/observed the system:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

6. I had a strong intention to follow the quality requirements of rice seeds and prawn post-larva when first heard about/observed the system:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

7. I have applied all components of an improved paddy-prawn system for improving production and income:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

8. I have applied the recommended land preparation technique and dimension of the dikes ("caren") for increasing prawn yield:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

9. I have applied the recommended rice planting distance ("jajar legowo") for increasing rice and prawn yield:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

10. I have applied the recommended dosages of fertilizer for maintaining a balanced growth of rice and prawn, and improving production:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

11. I have applied the recommended plant-based pesticides and water management for maintaining and improving the survival rate of prawn:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

12. I have followed the quality requirements of rice seeds and prawn post-larva for increasing rice and prawn yield:
unlikely _________:_________:_________:_________:_________ likely
very quite neither quite very

A. Attitudes towards the adoption of an improved paddy-prawn system	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. Applying all components of the improved paddy-prawn system helps me achieve higher production	**1**	**2**	**3**	**4**	**5**
2. Applying all components of the improved paddy-prawn system helps me achieve higher income	**1**	**2**	**3**	**4**	**5**
3. Applying the recommended land preparation and dimension of the dikes ("caren") increases prawn yield	**1**	**2**	**3**	**4**	**5**
4. Applying the recommended rice planting distance ("jajar legowo") increases rice and prawn yield	**1**	**2**	**3**	**4**	**5**
5. Applying the recommended dosages of fertilizer increases rice yield	**1**	**2**	**3**	**4**	**5**
6. Applying the recommended plant-based pesticides and water management helps increase rice and prawn yield	**1**	**2**	**3**	**4**	**5**
7. Applying the quality requirements of rice seeds and prawn post-larva increases rice and prawn yield	**1**	**2**	**3**	**4**	**5**
8. It is important that I have an improved practice in cultivating rice and prawn	**1**	**2**	**3**	**4**	**5**
9. I prefer to apply the improved paddy-prawn system for achieving higher production and income	**1**	**2**	**3**	**4**	**5**
10. All components are completely different with the current knowledge in rice cultivation and prawn culture	**1**	**2**	**3**	**4**	**5**
11. All components of the improved paddy-prawn system are difficult to apply	**1**	**2**	**3**	**4**	**5**
12. Learning to apply the components of the improved paddy-prawn system is time consuming	**1**	**2**	**3**	**4**	**5**
13. Applying all components of the improved paddy-prawn system increases working hours	**1**	**2**	**3**	**4**	**5**
14. Applying all components of the improved paddy-prawn system increases production costs	**1**	**2**	**3**	**4**	**5**
15. Applying the recommended rice planting distance ("jajar legowo") takes time and complicated procedures	**1**	**2**	**3**	**4**	**5**
16. Applying the recommended dosages of fertilizer increases costs	**1**	**2**	**3**	**4**	**5**
17. Applying the recommended plant-based pesticides and water management increases working hours	**1**	**2**	**3**	**4**	**5**
18. Applying the quality requirements of rice seeds and prawn post-larva increases costs	**1**	**2**	**3**	**4**	**5**
19. Applying the improved paddy-prawn system increases risks of production failure	**1**	**2**	**3**	**4**	**5**

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
B. Subjective norms related to the adoption of an improved paddy-prawn system					
20. My spouse thinks I should have adopted the improved paddy-prawn system	1	2	3	4	5
21. My parents think I should have adopted the improved paddy-prawn system	1	2	3	4	5
22. My children think I should have adopted the improved paddy-prawn system	1	2	3	4	5
23. My farmer group think I should have adopted the improved paddy-prawn system	1	2	3	4	5
24. Researchers and extension officers think I should have adopted the improved paddy-prawn system	1	2	3	4	5
25. My religious leaders think I should have adopted the improved paddy-prawn system	1	2	3	4	5
26. My village leaders think I should have adopted the improved paddy-prawn system	1	2	3	4	5
27. If most people who are important to me think I should adopt the improved paddy-prawn system, then I will do it	1	2	3	4	5
28. Generally speaking, I want to do what my spouse think I should do	1	2	3	4	5
29. Generally speaking, I want to do what my parents think I should do	1	2	3	4	5
30. Generally speaking, I want to do what my children think I should do	1	2	3	4	5
31. Generally speaking, I want to do what my farmer group think I should do	1	2	3	4	5
32. Generally speaking, I want to do what researchers and extension officers think I should do	1	2	3	4	5
33. Generally speaking, I want to do what my religious leaders think I should do	1	2	3	4	5
34. Generally speaking, I want to do what my village leaders think I should do	1	2	3	4	5
C. Perceived behavioural control related to the adoption of an improved paddy-prawn system					
35. Water is sufficiently available for applying the improved paddy-prawn system	1	2	3	4	5
36. Pests and diseases are still under control	1	2	3	4	5
37. I have enough land for applying the improved paddy-prawn system	1	2	3	4	5
38. I have sufficient capital for applying the improved paddy-prawn system	1	2	3	4	5
39. I can easily borrow money from the banks or cooperatives	1	2	3	4	5
40. I can easily borrow money from family or other farmers	1	2	3	4	5
41. I can work off-farm	1	2	3	4	5
42. I have sufficient experience in rice cultivation and prawn culture	1	2	3	4	5
43. I have sufficient knowledge in dealing with new practices and innovations	1	2	3	4	5

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
44. I can find information about the improved paddy-prawn system	**1**	**2**	**3**	**4**	**5**
45. I can consult on problems with extension workers	**1**	**2**	**3**	**4**	**5**
46. I participate in my farmer group meeting to discuss problems and find solutions	**1**	**2**	**3**	**4**	**5**
47. I can run a small-scale trial and apply the improved paddy-prawn system with my own resources	**1**	**2**	**3**	**4**	**5**
48. I can rely on my fellow farmers' practices and follow their practices	**1**	**2**	**3**	**4**	**5**
49. I can purchase inputs according to my need	**1**	**2**	**3**	**4**	**5**
50. I can get additional farm labour any time I need	**1**	**2**	**3**	**4**	**5**
51. I can sell my products at fair prices	**1**	**2**	**3**	**4**	**5**
52. Having a demonstration plot on the improved paddy-prawn system is useful	**1**	**2**	**3**	**4**	**5**
53. Having technical assistance and advisory during the application of the improved paddy-prawn system is useful	**1**	**2**	**3**	**4**	**5**
54. The wet season lasts longer than the dry season	**1**	**2**	**3**	**4**	**5**
55. Pest and disease can still be controlled with the available pesticide	**1**	**2**	**3**	**4**	**5**
56. It is difficult to borrow land	**1**	**2**	**3**	**4**	**5**
57. The costs for applying the improved paddy-prawn system might be expensive	**1**	**2**	**3**	**4**	**5**
58. Family expenses are increasing	**1**	**2**	**3**	**4**	**5**
59. Borrowing money is risky	**1**	**2**	**3**	**4**	**5**
60. Working off-farm is more important	**1**	**2**	**3**	**4**	**5**
61. My experience and knowledge in rice cultivation and prawn culture make it difficult to make decisions with regards to the improved paddy-prawn system	**1**	**2**	**3**	**4**	**5**
62. Applying the improved paddy-prawn system reduces the time available for family as well as community and religious activities	**1**	**2**	**3**	**4**	**5**
63. I do not have sufficient time to follow all recommended practices	**1**	**2**	**3**	**4**	**5**
64. The number of extension officers is limited	**1**	**2**	**3**	**4**	**5**
65. Inputs are expensive	**1**	**2**	**3**	**4**	**5**
66. Output prices are fluctuating	**1**	**2**	**3**	**4**	**5**
67. Harvest lost is high	**1**	**2**	**3**	**4**	**5**
D. Bargaining processes related to the decision of adopting the improved paddy-prawn system					
Intra-household bargaining processes					
68. I often have different opinions to my family members	**1**	**2**	**3**	**4**	**5**
69. I ask and listen to my family members' opinions about the improved system.	**1**	**2**	**3**	**4**	**5**
70. I discuss my intention to adopt, reject or delay the improved system with my family.	**1**	**2**	**3**	**4**	**5**
71. I discuss the benefit and cost of the improved system with my family.	**1**	**2**	**3**	**4**	**5**
72. I discuss with my family about what they think other people think of me.	**1**	**2**	**3**	**4**	**5**
73. I discuss with my family about the strategy to deal with supporting and impeding factors with regard to the improved system.	**1**	**2**	**3**	**4**	**5**

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
74. I sometimes change my intention after discussing the improved system with my family.	**1**	**2**	**3**	**4**	**5**
75. I sometimes change my beliefs after discussing the benefit and cost of the improved system with my family.	**1**	**2**	**3**	**4**	**5**
76. I sometimes change my beliefs after discussing what other people think of me with my family.	**1**	**2**	**3**	**4**	**5**
77. I sometimes change my beliefs after discussing my capacity in dealing with the improved system with my family.	**1**	**2**	**3**	**4**	**5**
78. When coming to a conclusion on whether to adopt, delay or reject the improved system, it often takes a long discussion with my family.	**1**	**2**	**3**	**4**	**5**
79. I believe the discussions with my family are very important to make a good decision.	**1**	**2**	**3**	**4**	**5**
Social bargaining processes					
80. I often have different opinions with the rest of the community	**1**	**2**	**3**	**4**	**5**
81. I ask and listen to significant others' (outside family) opinions about the improved system.	**1**	**2**	**3**	**4**	**5**
82. I discuss my intention to adopt, reject or delay the improved system with significant others (outside family).	**1**	**2**	**3**	**4**	**5**
83. I discuss the benefit and cost of the improved system with significant others (outside family).	**1**	**2**	**3**	**4**	**5**
84. I discuss with significant others (outside family) about what they think other people think of me.	**1**	**2**	**3**	**4**	**5**
85. I discuss with significant others (outside family) about the strategy to deal with supporting and impeding factors with regard to the improved system.	**1**	**2**	**3**	**4**	**5**
86. I sometimes change my intention after discussing the improved system with significant others (outside family).	**1**	**2**	**3**	**4**	**5**
87. I sometimes change my beliefs after discussing the benefit and cost of the improved system with significant others (outside family).	**1**	**2**	**3**	**4**	**5**
88. I sometimes change my beliefs after discussing what other people think of me with significant others (outside family).	**1**	**2**	**3**	**4**	**5**
89. I sometimes change my beliefs after discussing my capacity in dealing with the improved system with significant others (outside family).	**1**	**2**	**3**	**4**	**5**
90. When coming to a conclusion on whether to adopt, delay or reject the improved system, it often takes a long discussion with my significant others (outside family).	**1**	**2**	**3**	**4**	**5**
91. I believe the discussions with significant others (outside family) are very important to make a good decision.	**1**	**2**	**3**	**4**	**5**

Appendix C. Data Collected from Background Questionnaires

Table C.1. Farmers' characteristics

No.	Variable	Definition	Unit	Remarks
1	Age	Age of farmers	Years	
2	HH	Current size of household	People	
3	Cu15	Number of children aged under 15 years	People	
4	Co15	Number of children aged 15 years or over	People	
5	Edu	Farmers' years of schooling (formal)	Years	
6	Edus	Spouse's years of schooling (formal)	Years	
7	Educ	Average years of schooling of a farmer's children	0-5 score	0 = 0 year, 1 = 1-3 years, 2 = 4-6 years, 3 = 7-9 years, 4 = 10-12 years, 5 = >12 years
8	FL	Number of family labour units available	People	
9	Land	Area of ricefield-pond owned by farmer	Hectares	
10	Rent	Area of ricefield-pond rented by farmer	Hectares	
11	Ten	Land ownership indicated by the possession of land certificate	0-2 score	0 = no land certificate, 1 = only part of the land, 2 = have land certificates for all area
12	EP	Years of experience in paddy cultivation	Years	
13	EPr	Years of experience in prawn cultivation	Years	
14	EM	Years of experience in milkfish cultivation	Years	
15	On	On-farm productive activities not in the ricefield-pond	0-2 score	0 = none, 1 = yes but not related to paddy-prawn intercropping, 2 = yes and related to paddy-prawn intercropping
16	Off	Off-farm productive activities	0-5 score	0 = none, 1 = construction & transportation, 2 = non agricultural trade & services, 3 = education, 4 = government official, 5 = agricultural related activities
17	OC	Percentage of self-provision capital	Percent	
18	Tool	Number of agricultural machines used by farmer	Units	
19	Usage	Average years of application of agricultural machinery by farmer	Years	

Appendix C (continued)

Table C.2. Farm practices

No.	Variable	Definition	Unit	Remarks
1	Obj	Farmers' objective(s) in farming	1-13 score	1 = side activities, 2 = human capital improvement, 3 = higher production, 4 = higher income, 5 = human development & religious goals, 6 = income & local development goals, 7 = side activities & income related goals, 8 = income & human capital improvement, 9 = higher income & production, 10 = income-human capital-religious goals, 11 = better income-production-human capital; 12 = two goals related to better prosperity, 13 = three goals related to better prosperity
2	Crop	Farmers' cropping pattern between May 2004 and mid 2005	1-4 score	1 = only monoculture, 2 = mostly monoculture, 3 = mostly intercropping, 4 = intercropping
3	Veg	Whether or not farmers cultivate vegetables in 2004-2005	0-1 score	0 = no, 1 = yes
4	Inc	Farmers' average monthly gross income (May 2004 – April 2005)	IDR (000)	
5	Y1 – Y4	Annual total production of paddy (Y1), prawn (Y2), milkfish (Y3), other fish (Y4)	Ton	
6	S1 – S4	Annual cash received from sales of paddy (S1), prawn (S2), milkfish (S3), other fish (S4)	IDR (000)	
7	Pro1 – Pro8	Farmers' perception on the intensity of problems affecting paddy and prawn intercropping, which relate to pest & disease, water & irrigation, prawn sale price, soil conditions, prawn growth & mortality, input availability & cost, household financial condition, household human capital	1-10 score	1 = very serious, 2 = serious, 3 = quite serious, 4 = becoming serious, 5 = common, 6 = becoming marginal, 7 = quite trivial, 8 = trivial, 9 = very trivial, 10 = no problem
8	PY1-PY3	Farmers' perception on yearly production (paddy, prawn, fish)	0-5 score	0 = unchanged, 1 = far lower, 2 = lower, 3 = fluctuating, 4 = higher, 5 = far higher
9	PPr1-PPr2	Farmers' perception on the average of yearly sale prices (paddy, prawn, fish)	0-5 score	0 = unchanged, 1 = far lower, 2 = lower, 3 = fluctuating, 4 = higher, 5 = far higher
10	PPest, PFert, PSeed	Farmers' perception on the average of yearly input costs (pesticides-PPest, fertilizers-PFert, seeds-PSeed)	0-5 score	0 = unchanged, 1 = far lower, 2 = lower, 3 = fluctuating, 4 = higher, 5 = far higher
11	PAI	Farmers' perception on the average of annual income	0-5 score	0 = unchanged, 1 = far lower, 2 = lower, 3 = fluctuating, 4 = higher, 5 = far higher
12	Met	Average method used by farmers for marketing rice, prawn & milkfish	1-3 score	1 = indirect, 2 = both indirect & direct, 3 = direct
13	Tar	Average market destination of rice, prawn & milkfish produced by farmers	1-3 score	1 = local; 2 = local & outside districts; 3 = outside districts

Appendix C (continued)

Table C.3. Farmers' information management and extension activities

No.	Variable	Definition	Unit	Remarks
1	Record	Farmers' means in keeping track of information about farm past performance	1-5 score	1 = memory, 2 = keep receipt, 3 = brief written calculation prior planting, 4 = farm record book, 5 = combination of written and unwritten records
2	Info	Information continuously recorded, maintained and/or remembered		Qualitative responses containing 13 types of information
3	It1 – It10	Information sources commonly used by farmers related to paddy, prawn and fish production techniques (including the intensity of usage; 10 sources)	0-4 score	0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always
4	IL1 – IL11	Information sources commonly used by farmers related to loans (including the intensity of usage; 11 sources)	0-4 score	0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always
5	New1 – New14	Information sources commonly used by farmers related to new inputs, including machinery (including the intensity of usage; 14 sources)	0-4 score	0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always
6	Mk1 – Mk9	Information sources commonly used by farmers related to markets and prices (including the intensity of usage; 9 sources)	0-4 score	0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always
7	FG	Whether or not farmers actively participate in farmer group	0-1 score	0 = no, 1 = yes
8	Jext	Whether or not farmers have ever participated in extension activities	0-1 score	0 = no, 1 = yes
9	Org	Whether or not farmers participate in other organizations	0-1 score	0 = no, 1 = yes
10	FGPlus	Farmers' perception on the benefits of farmer group		Qualitative responses containing 5 classifications of benefit
11	NotFG	Farmers' main reason for not participating in farmer group		Qualitative responses containing 7 classifications of reason
12	ExtLevel	Types of extension activities that farmers have participated in		Qualitative responses containing 5 classifications of activities

Appendix C (continued)

Table C.4. Farmers' decision making practices related to new technology adoption

No.	Variable	Definition	Unit	Remarks
1	Think	Farmers' main consideration(s) when evaluating the feasibility of a new technology	Label	Qualitative responses containing 22 classifications of feasibility factors
2	Follow	Farmers' action(s) once receive information about a new technology		Qualitative responses containing 11 classifications of actions
3	SO1 – SO13	The degree of farmers' interaction with their significant others (SO): spouse, children, parents, extended family members, neighbours, head of farmer group, village leaders, religious leaders, FEO, researcher, farmers from other villages, middlemen, input retailer	0-4 score	0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always
4	WhySO	Farmers' reason(s) for discussing farming practices with only their significant others		Qualitative responses containing 11 classifications of reason
5	DisPlus	Farmers' perception on the benefit(s) from the discussion with their significant others prior to decision making		Qualitative responses containing 8 classifications of benefit
6	Respond	Farmers' way(s) of responding to different opinions during the discussion with their significant others		Qualitative responses containing 8 classifications of response
7	DM	Final decision makers when farmers discuss a new technology with their significant others	1-4 score	1 = individual significant other, 2 = myself, 3 = depend on situation, 4 = consensus with significant others

Appendix D. Data Collected from the TPB Questionnaires

No.	Variable	Definition	Unit	Remarks
1	a045	The degree of farmers' adoption practices in 2004/2005 season	0-2 score	0 = not adopt, 1 = partial/ modified adoption 2 = full adoption
2	Act	Whether or not farmers will apply "pandu" next year	0-2 score	0 = will not apply, 1 = conditional, 2 = will apply
3	Whynext	Farmers' main reason for future application of "pandu"		Qualitative responses containing 11 classifications of reason
4	Meet	Farmers' perception on whether "pandu" meets their farming objective(s)	0-1 score	0 = no; 1 = yes
5	Comp	Farmers' opinion on the most important/useful components of "pandu"		Qualitative responses containing 7 classifications of component
6	Improve	Farmers' opinion on which of pandu's component(s) require improvement		Qualitative responses containing 7 classifications of component
7	Obstacle	Farmers' opinion on factors that may impede the application of "pandu"		Qualitative responses containing 15 classifications of factor
8	Suggest	Whether or not farmers will suggest others apply "pandu"	0-1 score	0 = no; 1 = yes; and qualitative responses containing 11 classifications of reason
9	Friend	Farmers' closest person outside family who may have similar adoption behaviour		Qualitative responses containing 8 classifications of person
10	AB	Direct measure of adoption behaviour	1-5 score	Factor analysis result from TPB questionnaire, part 1 No. 7-12
11	INT	Direct measure of intention to adopt "pandu"	1-5 score	Factor analysis result from TPB questionnaire, part 1 No. 1-6
12	AT2	Direct measure of attitude towards adopting "pandu"	1-5 score	TPB questionnaire, part 2 No. A9
13	ad	Farmers' belief on the benefits brought by "pandu"	1-5 score	TPB questionnaire, part 2 No. A1-A7
14	ds1-ds3	Farmers' belief on the consequences brought by "pandu"	1-5 score	TPB questionnaire, part 2*: No. A14r, A16r, A17r, C57r (ds1 = costs); A13r, A12r, A15r (ds2 = time & work burden); A19r, A18r (ds3 = risks)
15	SN	Direct measure of social pressures (subjective norms) concerning the adoption of "pandu"	1-5 score	TPB questionnaire, part 2 No. B27
16	n1-n2	Farmers' belief on their significant others' expectation about the adoption of "pandu"	1-5 score	TPB questionnaire, part 2: No. B26, B24, B23 (n1 = non family); B22, B21, B20, B25 (n2 = family)
17	m1-m2	Farmers' beliefs on the compliance of significant others' expectation	1-5 score	TPB questionnaire, part 2: No. B33, B34, B32, B31 (m1 = non family); B28, B30, B29 (m2 = family)
18	PBC1r*	Direct measure of perception that they can successfully implement "pandu"	1-5 score	TPB questionnaire, part 2 No. A11r*

* The scale for negatively worded statements was reversed in order to provide the same pattern of responses, which is from negative to positive responses. This is shown by the "r" following the question number.

Appendix D. (continued)

No.	Variable	Definition	Unit	Remarks
19	Ext6-10	Farmers' beliefs on external (situational) factors that can support/impede adoption of "pandu"	1-5 score	TPB questionnaire, part 2*: No.C35, C54 (Ext6 = water); C55, C36 (Ext7 = pest & disease); C45, C46 (Ext8 = consultation); C49, C65r (Ext9 = input availability & cost); C51, C66r (Ext10 = sale price)
20	In1-In4	Farmers' beliefs on internal factors (own capacity) that can support /impede adoption of "pandu"	1-5 score	TPB questionnaire, part 2*: No. C42, C43 (In1 = farming experience); C38, C37 (In2 = own capital); C60r, C41r (In3 = off-farm work); C47, C61r, C63r (In4 = skills & time to try)
21	BP1-BP6	Bargaining process within household concerning the decision to adopt "pandu" (BP = bargaining process, DMP = decision making process)	1-5 score	TPB questionnaire, part 2: No. D83, D84, D82, D85, D81, D91 (BP1 = BP with non family significant others); D70, D71, D72, D69, D73 (BP2 = BP with family members); D75, D76, D74, D77 (BP3 = DMP involving non family significant others); D89, D87, D88, D86 (BP4 = DMP involving family members); D80, D68, D79 (BP5 = BP starting point); D90, D78 (BP6 = BP intensity)

* The scale for negatively worded statements was reversed in order to provide the same pattern of responses, which is from negative to positive responses. This is shown by the "r" following the question number.

Appendix E. Summary of Constructs Elicited by Farmers

Table E.1 Constructs elicited by respondents from Sugihwaras

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SI001	Water Scientist Working	Land Worker Learning	Farming experience Informational supply Knowledge requirement	Business experience Water supply Cash requirement	Community Novice Consultation	Family Teacher Research
SI002	Costs Determinant of Success	Harvest Success (result)	Financing	Marketing	Non-family	Family
SI003	Can be handled by myself Output Mutual assistance Superior farmers	Needs helps from others Capital Own responsibility Inferior farmers	Utilizing information Related to capital Solution	Disseminating information Related to work Problem	Family relationship Agent Trading Corporate farmers	Business relationship Consumer Advising Traditional farmer
SI004	Goods Education Sufficient	Money Activities during spare time Deficient	Lack of knowledge Personal needs	Lack of cash Field requirement	Closest persons Source of advice Frequent interaction	Distant persons Source of loan Occasional interaction
SI005	Requirement The information	Result The source of information	Common source of problem Difficult	Source for solution Easy	Always in the village Consultation Give education	Rarely in the village Trade Give a prayer
SI006	Stable Output Obtain through cooperation	Fluctuating Outlay Spend money to acquire	Source of knowledge Learning	Source of capital Application	To whom we ask for advice Price information	To whom we sell our products Farming information
SI007	Ask others before taking actions Effort	Take action without asking others Result	Related to costs	Related to skills	Near Disseminate information	Far Apply information
SI008	Production inputs Recommen-dation from extension activities	Production outputs Inputs for applying recommen-dation	The price Extension services	The goods Financial incentives	Money gained Direct assistance for success	Money spent Indirect assistance for success
SI009	Objective	Achievement	For the wealth of the farmers	For the growth of the plant	Obtain income	Use the income

Appendix E (continued)

Table E.1 Constructs elicited by respondents from Sugihwaras (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left Pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SI010	Output Problem related to paddy For financing	Work Problem related to prawn For food	Money matters Source of knowledge Special problems Personal problems	Operational matters Source of financing Common problems Production problems	Important persons One way communica-tion Near Friends for sharing thoughts	Common people Two way communica-tion Far Friend for sleeping with
SI011	Human capacity Result Managerial matter Production structure Farm expenses	Financial capacity Work Financial matter Revenue structure Household expenses	Financial capacity Certain Production components Expenses	Knowledge capacity Uncertain Marketing components Assets	Family Government Family relation Source of advice	Non-family Populace Trade relation Source of production inputs
SI012	Resource for growing fish Labour requirement Related to thought	Skills for growing fish Fieldwork requirement Related to cost	Work focusing on yield Related to financing Resources for fulfilling household needs	Work focusing on quality Related to idea Resources of knowledge	Family Deal with saving and loan Near	Non-family Deal with religious matter Far
SII013	Farming output Requirement for success Gain money	Farming input Achievement Spend money	Essential for farming Agro-climatic requirements	Essential for family Personal requirements	From whom I demand attention Source of capital	To whom I give attention Source of information
SI014	Primary factors for prawn growth Jobs handled by myself Beginning of work	Secondary factors for prawn growth Jobs handled by farm labourer End of work	Work capacity Source of knowledge	Production capacity The knowledge	Non-family Near Rarely meet	Family Far Meet almost every day
SI015	Profit Consensus	Expenses Instruction	The goods	The price of the goods	Social relationship Family	Trade relationship Non-family

Appendix E (continued)

Table E.1 Constructs elicited by respondents from Sugihwaras (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SI016	Completion of fieldwork Related to thinking Family needs	Effort for achieving yield Related to expenses Fellow farmers' needs	Source of revenue Effort to meet quality standard	Source of loan Quality standard	Give advice Non marriage relationship	Implement advice Marriage relationship
SI017	Internal factors Not limited to own decision Working	External factors Own decision Thinking	Always Production requirements I like	Occasionally Family needs I dislike	Distant people Officer Business relation	Closest people Commoner Social relation
SI018	Bringing money in Abundance Already available	Giving away money Shortage Still being searched for	Less stressful Requirement that are still being searched for	Frustrating Requirement that are available	Guest From whom have never received advice	Family From whom I receive advice
SI019	Easy to handle Certain	Difficult to handle Uncertain	Becoming sufficient Need less work Many offers	Becoming deficient Need hard work Lack of offers	Support farmers Rarely give advice to people Easy to approach	No interest in supporting farmers Often give advice to people Difficult to approach
SI020	All always be utilized Every day Result	Not all utilized Occasionally Requirement	Abundance	Shortage	Village people To whom I ask for help Household daily needs	Outsider To whom I have never asked for help Production requirements
SI021	Something I own Requirement Capital	Something I do not have Result Profit	-	-	Disseminate information Factors for success Focus of agricultural research	Collect information scientifically Non success factors Not the focus of agricultural research
SI022	Beginning Work completed Primary objectives	End More works needed Secondary objectives	New practices Investment	Existing practices Profit	Personal responsibility Officer Live in sub-district	Community responsibility Commoner Live in the village

Appendix E (continued)

Table E.1 Constructs elicited by respondents from Sugihwaras (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SI023	Effects Secondary	Causes Primary	Source of money Self-taught person	The money Teacher	Buyer Family	Seller Non-family
SI024	Rarely available Problems related to capital	Always available Problems related to work	Production requirements Have problems	Family needs No problems	Villager Quick responses if asked for help	Outsider Not always willing to help
SI025	Result Requirement Gain experience	Effort Outcome Gain money	Do not need money Subjects acquired by farmers for work	Need money Subjects mastered by buyers for work	Family	Non-family
SI026	Inflow Work in progress Fish cultivation Primary farming requirements	Outflow Work completion Plant cultivation Secondary farming requirements	-	-	Farming matters Every day interaction Near	Religious matters Occasional interaction Far
SI027	Gain money Minimal break even Every day	Spend money Bankrupt Once a year	Handled by the help from others	Handled by myself	Other kinds of friend Closest persons	Friend for sleeping with Distant persons
SI028	Primary consideration Sufficient Lower price	Secondary consideration Deficient Higher price	Adequate Life necessities	In short Farming necessities	To whom I seek advice Family relation	To whom I ask for consent Business relation
SI029	Carefully endeavoured Still being search for Get at least in minimum amount	It is up to the fate Always available Total failure	Seek through other sources of information Unfamiliar sources of information Serious problems	Seek through discussion Familiar sources of information Trivial problems	Farming requirements Farming related interactions Most important	Farming outputs Social interactions Less important
SI030	Difficult Work for living End of the year	Not too difficult Work for other means Beginning of the year	Farming matters Do next Trivial needs	Family matters Do first Urgent needs	Consensus with non-family persons Secondary source of loans	Consensus with family Primary source of loans

Appendix E (continued)

Table E.1 Constructs elicited by respondents from Sugihwaras (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		**Perceived behavioural control related to the adoption of "pandu"**		**Persons with whom the respondents negotiate their intention to adopt "pandu"**	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SI031	Easy tasks	Difficult tasks	Problems related to middlemen	Problems related to individual capacity	Non-family	Family
	Results	Effort	Internal information	External information	Not always hold a position	Hold a certain position
	Determine earnings	Determine yields	Resources	Challenges		
	Fish cultivation	Plant cultivation				
SI032	Requirement for obtaining fertilizer	Requirement for effective fertilizing	For family	For outside family	Core family members	Distant relatives
	Successful	Unsuccessful	Sufficient	Deficient	Certainly having kinship	Not always have kinship
			Source of capital	Source of expenses	Bargain	Abide
SI033	Farming matters	Family matters	Less risky	Risky	Give money	Give advice
	Not always available	Always available	Important	Less important	Secondary source of information	Main source of information
	Shortage	Abundance			Togetherness	Not always have mutual assistance
SI034	Fixed	Indefinite	Own capacity	Help from others	Decision	Advice
	End	Beginning	Trouble-free	Difficult	Give instruction	Implement instruction
	Often	Rarely	Beginning	End	Non-family	Family
SI035	Affluent	Poor	Available	Still being searched for	Teaching about life	Teaching about farming
	With consensus	Without consensus	Important	Trivial	Discuss in the beginning	Discuss in the end
	Collect in the beginning	Collect at the end	Sufficient	Deficient		
SI036	Input	Outcome	Sufficient	Deficient	Family	Non-family
	Fluctuating	Stable				
SI037	Take action directly	Wait before taking action	Financing	Practice	Ask first	Inform later
	Few	Many				
	Cheap	Expensive				
SI038	Money	Time	Still being searched for	Available	Often meet	Rarely meet
	Gain	Loss	Farming practices	Farming outcome	Main source of advice	Secondary source of advice
	Depend on money	Not depend on money				
SI039	Spend money	Gain money	Can borrow from others	Impossible to borrow from others	-	-
	Beginning of season	Harvest time	Family needs	Farming needs		
	Self-taught	Need a teacher				
	Depend on money	Not depend on money				

Appendix E (continued)

Table E.1 Constructs elicited by respondents from Sugihwaras (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SI040	Every day The work Requirement for fish cultivation	Occasionally The gain Family needs	Sources for solution Money	Sources of problem Advice	Non-family To whom I often ask advice	Family To whom I rarely ask advice
SI041	-	-	-	-	-	-
SI042	-	-	-	-	-	-
SI043	Deficient Always experience this Consensus	Sufficient Never experience this Disagreement	Endeavour	Fate	Discuss prices Do not follow my opinion	Discuss farming practices Follow my opinion
SI044	Easy Related to earnings Cheap	Difficult Related to financing Expensive	Supporting factors Easy to find	Constraints Difficult to find	Distant friends Occasionally meet Difficult to communicate with	Close friends Meet everyday Easy to communicate with
SI045	Effort The quality of goods Successful	Outcome The quality of a person Failed	Thinking Easy Theory	Money Difficult Practice	Family	Non-family
SI046	Suitable First season Important	Incompatible Last season Trivial	Internal	External	I follow their advice	They follow my advice
SI047	Successful Always available Outcome Money out	Unsuccessful Rarely available Effort Money in	-	-	Everyday Have a job Family	Occasionally Still learning Non-family
SI048	Talk not about problems Have plenty experience Certain	Talk about problems Less experienced Uncertain	Plenty sources From friends Monopolized Share with others	Lack of sources From God Open access Keep oneself	Decide together Meet everyday Always fair Always support my decisions	Sole decision maker Rarely meet Often unfair Not always in agreement
SI049	Unsuccessful Gain money Cheaper Get in the end	Successful Spend money More expensive Get in the beginning	Farming	Side activities	With whom I rarely consult farming matters	With whom I often consult farming matters

Appendix E (continued)

Table E.1 Constructs elicited by respondents from Sugihwaras (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SI050	Low	High	Easier	More difficult	Family matters	Farming matters
					Live in the village	Live outside the village
					Discuss farming practices	Discuss prices
SI051	Every day	Occasionally	-	-	The same role as before	Changing role
	Fish cultivation	Paddy cultivation			Every day	Certain days only
	Available	Need to buy				
SI052	Affordable	Too expensive	From relatives	From friends	Reserved	Open
	Fruitful	Fruitless	Difficult	Easy		
	Own money	Not all own money	Determined by the market	Determined by myself		
	Seasonal	Everyday				
	Difficult	Contingent on situation				
SI053	Easier to provide	More difficult to provide	Everyday	Occasionally	No need to discuss	Must be discussed
	Effort	Profit	Easier	More difficult		
	Occasionally	Everyday				
SI054	Secondary target	Primary target	-	-	Secondary source of advice	Main source of advice
	Certain	Uncertain				
	Cheaper	More expensive			Partner in farming	Partner in life
	Supporting factors	Main factors			Follow decision	Make decision
SI055	Beginning	End	Not everyday	Everyday		
SI056	Seasonal	Everyday	Learning activities	Income generating activities	Everyday	Only when buying supplies
	Fulfilled expectations	Missed expectations				
			Seasonal	Daily		
SI057	Sufficient	Deficient	Advice	Practice	Family	Non-family
	Main factors	lesser factors	Not always suitable	Always suitable		
	Own decisions	Consensus				
SI058	For family needs	For farming needs	Certain	Uncertain	Meet everyday	Never meet
	Need money	No money needed			Close persons	Distant persons
	Certain	Uncertain				
	Time to learn farming	Time to get to know family members				

Appendix E (continued)

Table E.1 Constructs elicited by respondents from Sugihwaras (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
SII059	Predictable	Unpredictable	Mental resources	Cash resources	Interconnected	Independent
	Always successful	Not always successful	Real	Unreal	Farming issues	General issues
	Suitable	Not always suitable	Certain	Uncertain	Free	Structured
	Need money	No money needed	Can be solved	Depend on natural forces	Majority eligible for farmer group	Only some eligible for farmer group
	Possible to intercrop with paddy	Not possible to intercrop with paddy				
	Brain work	Physical work				
	Main determinant	Secondary determinant				

Table E.2 Constructs elicited by respondents from Rejosari

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "Pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI060	First priority	Side priorities	Available	In short	Main needs	Additional needs
	Secondary commodities	Main commodities	Effects	Causes	Give information	Receive information
	Family matters	General matters				
RI061	Cash in	Cash out	Software	Hardware	Overall	Partly
	Farming needs	Family needs	Farming expenses	Family expenses	Wider than farming issues	Limited to farming issues
	Pest cannot be detected	Pest can be detected	Have been experienced	Not yet experienced	Give advice	Receive advice
RI062	Successful	Unsuccessful	Predictable	Unpredictable	Always together in good and bad time	Not always together in good and bad time
	Main commodities	Side commodities	Affordable	Too expensive	Give advice	Receive advice
	Rely on motivation	Rely on cash available	Almost alike	Different	Often meet	Rarely meet
RI063	Beginning	End	Related to farming	No always related to farming	Many	Just one
	Old experience	New experience	Cash	Goods	Give advice	Implement advice
	Seasonally	Annually	Observable	Undetectable	Community issues	Governmental issues
	Wider	Limited				

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI064	Predictable	Unpredictable	Sufficient	Deficient	Close	Far
	At home	Outside home	Bargain	A must	Family	Non-family
	Follow other's instruction	Own motivation	Can ask others for advice	None can be asked for advice	Have to be called for a meeting	No need to call first for a meeting
RI065	Easy	Difficult			Near	Far
	For paddy cultivation	For vegetable cultivation			Family	Non-family
RI066	Practice	Analysis	Depend on nature	Depend on the work	Family	Non-family
	Sufficient	Deficient	Mental related issues	Cash issues	Sources of information	Sources of innovation
	In the field	Not in the field	Principles	Procedures	To whom one should show respect	The persons who should show respect
RI067	Need no money	Need money	Dependent factors	Determinants	Personal matters	Public matters
	Priority	Supplement	Solutions	Problems	Farming issues	General issues
	Uptight	Relax			Close	Far
RI068	Many	Few	Successful	Unsuccessful	No appointment needed	Need an appointment
	Main income	Side income			Often meet	Rarely meet
	Yield requirements	Work requirements			Farming matters	Matters related to letters/license
RI069	Predictable	Unpredictable	Season II	Anytime	Social matters	Farming matters
	On the field	At home				
	Anytime	Certain time				
	Routine	Special				
RI070	Gain money	Spend money	Practice	Advice	Farming issues	Social issues
	Low profit	High profit	Non-stop	Depend on conditions	Additional persons to have a discussion with	Main persons to have a discussion with
	No holiday	Plenty of holiday	Second	First	Give advice	Implement advice
RI071	Easy	Difficult	-	-	First persons to have discussions with	Additional persons to have discussions with
	Depend on money	Do not depend on money			Household issues	Village issues
	Non-food necessities	Food			Often give advice	Only follow advice

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI072	Work everyday	Sometimes have a break	Successful	Unsuccessful	Everyday	Never
			Supporting factors	Constraints	Near	Far
	Requirements	Outcomes			Practice	Theory
	Need others	Own effort	Spend money	Gain money		
	Abundance	Shortage				
RI073	Produce earlier	Produce later	-	-	Far	Near
					Additional persons to have discussions with	First persons to have discussions with
	Spend money	Gain money				
	In the ricefield-pond	On the ridge				
RI074	On the field	At home	Successful	Unsuccessful	Family	Non-family
	Work	Earnings			My responsibility	Not my responsibilities
	Learning	Working				
					Services	Trade
RI075	Important	Trivial	Important	Trivial	Discuss farming practices	Discuss prices
	Ready available	Still being searched for	Expensive	Cheap		
			Need help from others	Own effort		
	Raw materials	Products			Secondary consideration	First consideration
	Outside home	At home			Everyday	Only during harvest time
RI076	First efforts	Later efforts	Farmer group matters	Individual farmer matters	-	-
	Results	Requirements				
	Farming matters	Family matters				
			Family consensus	Own decision		
			Need others' help	Own effort		
RI077	Results	Requirements	Advice	Practice	Everyday	Only during harvest time
	On the ricefield-pond	On the ridge	Few types	Various types		
			Group	Individual	Family	Non-family
	From family	From friends			Deal with diseases	Deal with prices
	Need money	Need worker				
RI078	Need money	No money needed	Requirement	Results	Leader for farmers	Leader for people in the village
			Goods	Cash		
	Wealth	Intelligence				
	Unsuccessful	Successful			Living in the same house	Outsider
					Discuss family needs	Discuss farming issues
RI079	Effects	Causes	Requirement	Results	Disagree	Abide
	Family matters	Farming matters	Goods	Cash	Problem solvers	Problems
	Main products	Side products				

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI080	Supplement Mental capability Results Money in	Priority Physical capability Work & time spent Money out	Spend money Beginning Results	Gain money End Requirements	Everyone Give knowledge Commoners	Certain persons only Give cash People with high position
RI081	Something gained (experience) Occasionally On the field Cash Own effort	As expenses Routine At home Thinking Need others' help	Others decide Do not have Assets	I decide Have Income	Not everyday Daily Meet directly	Everyday Hourly Need to collect people first
RI082	Beginning Gain money	End Spend money	Utilization	Sources	With whom I do not discuss planting seasons Family	With whom I discuss on planting seasons Non-family
RI083	Can be delayed Certain Medium of discussion	In a rush Occasionally Topic of discussion	Effects From others Always	Causes My own efforts Occasionally	I have to search them for a meeting Non-family Need no money	I do not have to search them for a meeting Family Need money
RI084	Have money Abundance In the field	Lack of money In shortage At home	Familiar with	Have no knowledge about	Need no money Family issues	Need money Farming issues
RI085	Much cheaper In the form of money	Much more expensive Not in the form of money	-	-	Assertive Family	Timid Non-family
RI086	Labour Farming commodities	Thought Farming technologies	Thought Sell	Money Buy	Commoners Lack of farming knowledge	Officials Have farming knowledge
RI087	Goods Decided through discussions Work	Thought Decided without discussions Outcome	-	-	Family Difficult to meet	Non-family Easy to meet

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI088	The ongoing work More difficult & low outcomes	The experience Easier & abundant outcomes	Sources of consideration Occasionally	Source of money Everyday	Discuss issues related to harvest Often	Discuss issues related to inputs Rarely
RI089	Not a priority Second to master Less suitable	Priority First to master Suitable	Stable Receive income	Fluctuating Receive knowledge	Farming issues Personal role model Give guidance	Other issues People's role model Share thoughts
RI090	Farming issues Labour Learning	Family issues Harvest Experience	Need others Have to be searched	Own efforts Accumulated through time	Do not know my field conditions Family Everyday	Know my field conditions Non-family Occasionally
RI091	Can fulfil family needs Spend money Primary	Cannot fulfil family needs Gain money Secondary	Fair The information	Unfair Sources of information	Do not know my field conditions Family Everyday	Know my field conditions Non-family Occasionally
RI092	Occasionally Farming issues Spend money	Everyday Family issues Gain knowledge	Occasionally Always available End	Everyday Sometimes rare Beginning	Limited interactions Give information Not always together during good or bad times	Unlimited interactions Use information Together in good and bad times
RI093	Labour Low Not always available	Thinking High Constantly available	-	-	People who are led Family	Leader Non-family
RI094	Persons who need Cash capital For farm and family	Things that are needed Brain capital Only for family	Do not exist	Exist	People who are led Family	Leader Non-family
RI095	For family needs Own decisions Practice	For personal needs Family decisions Theory	Sufficient Never been in a shortage From others	Deficient Possible in a shortage Own efforts	Always meet Discuss depending on the needs Give advice	Rarely meet Discuss about everything Implement advice
RI096	Farming financing Spend money Wide Learn one thing	Farming techniques Gain money Narrow Learn everything	Becoming difficult Decreasing	Becoming uncertain Increasing	Have not given capital	Give capital

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		**Perceived behavioural control related to the adoption of "pandu"**		**Persons with whom the respondents negotiate their intention to adopt "pandu"**	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI097	Only in certain occasions	Everyday	Does not always lead to harvest failure	Causing harvest failure	Occasionally	Everyday
	For major family expenses	For family daily expenses			Other issues	Farming issues
	Work outcome	Discussion outcome			People who are led	Leader
	Trivial	Important				
RI098	Own decisions	Consensus	-	-	Own decisions	I have to follow his decision
	Often	Rarely			Community members	Government structure
	Need money	Need no money			With whom I always have discussions	With whom I occasionally have discussions
					Farming issues	Social issues
RI099	Harvest	Labour	Need no money	Need money	Discuss at home	Discuss in the field
	Need a lot of water	Need moderate amount of water	Depending on time	Depending on climate		
	Depending on skills	Not depending on skills	Increase harvest	Reduce harvest		
RI100	Collected	Spent	According to the need	Everyday	Family	Non-family
	For financing	For discussion				
RI101	Priority	Subsequence	Individual	Group	Formal	Informal
	Side income	Main source of income	Determinant	Dependence	Village level	Sub-district level
	Learn from extension activities	Learn from family	Fair	Unfair	Internal	External
	Do not gain money	Gain money				
RI102	Abundant	Few	Field requirements	Family needs	Buy and sell relationships	Mutual relationships
	Need money	Need no money	Need no money	Need money	Near	Far
	Discuss together	Figure out by myself	Expensive	Cheap	Give advice in certain time	Give advice anytime
RI103	Subsequence	First	Easier	Difficult	Rarely	Often
	Depending on conditions	Certain			Farming issues	Family issues
	Limited	Abundant			Stranger	Partner in life

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI104	Farming issues	Family issues	-	-	More often	Occasionally
	Input utilization	Input sources			Discuss general issues	Discuss farming capital
RI105	Work	Outcomes	-	-	Near	Far
	Work for myself	Work for others			Farming issues	Social issues
	Harvest	Requirements			Relatives	Non relative
RI106	In open air	In the room	Solutions	Problems	-	-
	Few	Plenty				
RI107	Effects	Causes	-	-	-	-
	Need others	Own efforts				
	Subsequence	First				
RI108	Profit	Financing	Next important factors	Most important factors	Inside house	Outside house
	Farming issues	Other issues			Making decisions	Ask opinion
	Discuss with family	Discuss with friends				
	Work in own ricefield-pond	Work in others' ricefield-pond				
RI109	Production requirements	Harvest	Buying	Selling	Agricultural services	Public services
	Primary	Secondary	Can be predicted	Cannot be predicted	To whom I ask for an opinion	To whom I ask for a consent
	First	Next				
	Cannot be arranged	Can be arranged			Dealing with farming issues	Dealing with community issues
RI110	-	-	-	-	-	-
RI111	Certain	Uncertain	-	-	More important	Less important
	Primary	Secondary				
	Need money	Need no money			First persons with whom I discuss farming issues	Next persons with whom I discuss farming issues
	Mandatory	Can be postponed				
					Farming issues	Community issues
RI112	Gain results	Gain nothing	Certain	Uncertain	Near	Far
	Familiar with	Have no knowledge about	Often	Occasionally	Often	Rarely
			Difficult	Easy	Individual	Group
	Primary	Secondary				

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI113	Continuously monitored	Occasionally monitored	Capable	Incapable	Do not get money	Gain money
	Received financial incentives	Own capital	Important	Trivial	Cooperation	Rivalry
	Discuss farming issues	Discuss family issues	Various	One type	With whom I discuss	Whom I follow
	Suitable	Unsuitable				
RI114	Serious things to be considered	Trivial things to be considered	Continuously	Seasonal	Family	Non-family
	The work	The thinking	Still need to be done	Already done	Discuss farm plan	Discuss problems
	Business requirements	Plant growth requirements	Related to problems	Related to survival		
RI115	Primary	Secondary	Trivial	Serious	Near	Far
	All directly sold	Sold according to demands	Technical problems	Financial problems	Living in my house	Living outside my house
	According to certain schedule	Everyday	Liabilities	Assets	People who ask	Reference
	Fruitful	Unfruitful				
RI116	Final monitoring	Everyday monitoring	Predictable	Unpredictable	Internal	External
	Theory	Practice	Must be experienced	Unsure whether or not to happen	Dealing with each one's household	Dealing with the whole village
	Cheaper	More expensive	Common things	New things	Living not in the same house	Living in the same house
RI117	In the ricefield-pond	On the ridge	Financial resources	Knowledge resources	Actively involved in farm operation	Only observe the progress of the farm
	More expensive	Cheaper	Things provided by extension services	Things not provided by extension services	Farming issues	Governmental issues
	Consumption	Capital				
RI118	Next	First	Need helps from other	Personal responsibility	Need no money	Need money
	Plant growth requirements	Business requirements			Commoners	Persons with certain positions
	Farm financing	Farming knowledge			Togetherness for certain things	Till death do us part
					Never give advice	Always give advice

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	Left pole	Right pole	Left pole	Right pole	Left pole	Right pole
RI119	The work	The thinking	-	-	Not yet familiar with farming techniques	Know farming techniques
	Farming issues	Family issues			Commoners	Officials
	Next	First			Daily life issues	Farming issues
RI120	Family needs	Work requirements	Problems	Solutions	Relatives	Strangers
	Know in certain	Still need to discuss	Own financial resources	Need helps from others	Living in the same house	Living not in the same house
	Many impediments	No impediment	Coming instanta-neously	Must be searched for		
RI121	Discuss costs	Discuss prices	-	-	Discuss farming issues	Discuss general issues
	In the ricefield-pond	On the ridge			Gather in the house	Visit outside house
	The work	The thinking			Most suitable	Less suitable
RI122	Need labour	Need money	Looking for profit	Looking for knowledge	Related to farming practices	Related to credit application
	Farming requirements	Family needs	Applied	Required	Witnessing	Giving consent
	Small	Big	The bigger the better	The fewer the better	Sources of fertilizer loans	Sources of additional capital
	At home	In the field				
RI123	The work	Work requirement	Deficient	Sufficient	Rarely	More often
	Fish	Plant	Knowledge	Money	Family	Non-family
RI124	Need money	Need labour	Beginning	End	Near	Far
	Application	Learning			Family	Non-family
	Discuss	Decide			Certain	Uncertain
RI125	Next	First	-	-	Discuss occasionally	Discuss everyday
	The capital	The work			Discuss farming matters	Discuss price
					Monitor	Give knowledge
RI126	Certain	Uncertain	-	-	With whom I sometimes discuss farming issues	With whom I must discuss any issues
	Determined	Determining			Next	First
	Predictable	Unpredictable				

Appendix E (continued)

Table E.2 Constructs elicited by respondents from Rejosari (continued)

	Elements related to:					
	Respondents' attitudes toward the adoption of "pandu"		Perceived behavioural control related to the adoption of "pandu"		Persons with whom the respondents negotiate their intention to adopt "pandu"	
Respondent	**Left pole**	**Right pole**	**Left pole**	**Right pole**	**Left pole**	**Right pole**
RI127	A must	Optional	The capital	Capital utilization	Non-family	Family
	Thinking	Labour	Farm work	Farm marketing	The member	The group
	Core	Supplement	Should be provided	Should be avoided	Sib	Opposite
RI128	In the ricefield-pond	On the ridge	Most difficult	Quite difficult	Next	First
	Always self-provisioned	Sometimes buy from others			Family matters	Administrative matters
	The work	The profit			Farming issues	Community issues
					More difficult	Easier
RI129	Own efforts	Need others' help	Always in short	In short only in the first season	Living not in the same house	Living in the same house
	Sources	Utilization			Non trader	Trader
					Every time	Occasionally
RI130	End	Beginning	Still being searched	Already available	First	Next
	Still to be decided	Certain	Trivial	Serious	Discuss everyday	Discuss according to the situation
	Own efforts	Need others' help				

Appendix F. Procedures for the Semi-ethnographic Interview

Components:

- a semi-ethnographic interview, aiming at eliciting farmers' decision criteria and paths with regard to the improved rice-prawn system ("pandu"); and
- a test interview, aimed at confirming a decision tree model which will be built based on farmers' decision criteria and paths obtained from the first interview.

F.1. Procedures for semi-ethnographic interviews (some are modified from Gladwin, 1989a, pp. 21-45; Spradley, 1979, pp. 61-66)

- Briefly explain the purpose of the interview and the procedures.
- Proceed the interview by asking the respondent about the source of knowledge about "pandu" and the associated components, and record her/his responses.
- Proceed the interview by asking the respondent using a list of alternative questions (see Appendix B, Section 5), and record her/his responses.
- Continue by asking further explanation and confirmation about her/his responses to the questions, and focus the discussion on the decision criteria. Use "*If-then*" types of question and avoid offering explanation to the respondent.
- Once all responses have been confirmed, conclude the semi-ethnographic interview, and proceed to the next interview method.

F.2. Procedures for testing an ethnographic decision tree model

- Show the video of "pandu" and allow the respondents to ask questions.
- Briefly explain the purpose of the interview and the procedures.
- Proceed the interview using a questionnaire (see Appendix H).
- Ask the respondent to provide additional, but brief explanation, if she/he answers "it depends", which is not included in the option.
- Once all responses have been confirmed, conclude the interview by thanking the respondent for her/his participation.

Appendix G. Farmers' Knowledge on "Pandu" Based on the Semi-ethnographic Interviews

No.	Variable	Definition	Unit	Remarks
1	Diss	Whether or not farmers participated in the dissemination of "pandu"	0-1 score	0 = no, 1 = yes
2	Tell	Farmers' source of information about "pandu"	1-7 score	1 = own observation, 2 = family, 3 = neighbouring farmers, 4 = village leader, 5 = head of farmer group, 6 = FEO, 7 = AIAT
3	Know	Farmers' general level of knowledge on "pandu"	Score based on interval	< 2 = almost no recollection / no knowledge 2 ≤ x < 3 = partial knowledge 3 = full knowledge
4	Know1 – Know6	Farmers' average level of knowledge about the components of "pandu": - rice cultivation practices (Know1) - prawn cultivation practices (Know2) - land & ditch preparation (Know3) - fertilizer application (Know4) - water management (Know5) - monitoring & maintenance (including IPM, Know6)	Score based on interval	< 2 = almost no recollection/no knowledge 2 ≤ x < 3 = partial knowledge 3 = full knowledge
5	Incentive	Incentives received by participating farmers		Qualitative responses containing 9 classifications of incentive
6	EPP	Whether farmers have experience in paddy-prawn intercropping prior the dissemination of "pandu"	0-1	0 = no; 1 = yes
7	Intr	The degree of farmers' adoption practices in the year of introduction	0-2 score	0 = not adopt, 1 = partial/ modified adoption 2 = full adoption

* Participating farmers do not always indicate that they are among the first adopters, although their knowledge about "pandu" may be more superior. By following their neighbours' practices, some non-participating farmers may also apply "pandu" directly after the dissemination process of the "pandu".

SEMI-ETHNOGRAPHIC TEST INTERVIEW QUESTIONNAIRE

Decision making processes of semi-commercial farmers: a case study of technology adoption in Indonesia

You will not be identified as a respondent without your consent. You may, at any time, withdraw your participation, including withdrawal of any information you have provided. If you complete the interview, however, it will be understood that you have consented to participate in this research and consent to publication of the results of this research with the understanding that anonymity will be preserved.

Identity No.

Number of persons attending the interview: _____ persons
Remarks: ____
____

- Please answer the following questions and provide a brief explanation regarding your answer.

No.	Questions	Yes	No
A.	***Factual Questions***		
1	Do you have previous experience in cultivating paddy together with prawn?		
2	Is it profitable to grow paddy-prawn intercropping?		
3	Are you interested in adopting the improved paddy-prawn system?		
B.	***Decision Criteria***		
	General expression		
1	Is the improved system rational?		
2	Will the improved system bring more benefits to your farming business?		
3	Can the improved system help you achive your objectives in farming?		
4	Will the improved system allow you to expand your farming business?		
	Effects on yield, productivity and income		
5	Can the improved system help you achieve higher paddy and prawn yields?		
6	Can the improved system help you achieve higher income?		

No.	Questions	Yes	No
7	Can the improved system increase land productivity?		
8	Can the improved system minimize the risk of production failure?		
9	Will the implementation of the improved system result in a decreasing income?		
10	Can the production failure from implementing the improved system lead to total income loss?		
Advantages and disadvantages of each component			
11	Can the recommended land preparation technique increase paddy and prawn yields?		
12	Can the improved system help you make use of the previously vacant dikes ("*caren*")?		
13	Can the recommended dimension of the dikes ("*caren*") increase prawn yield?		
14	Do the dikes ("*caren*") decrease paddy yield?		
15	Are you familiar with applying paddy planting distance?		
16	Will applying the recommended paddy planting distance ("*jajar legowo*") be difficult and time consuming?		
17	Can the recommended paddy planting distance ("*jajar legowo*") increase the number of paddy clump?		
18	Can the recommended paddy planting distance ("*jajar legowo*") increase the efficacy of maintenance?		
19	Can the recommended paddy planting distance ("*jajar legowo*") increase paddy yield?		
20	Can the recommended paddy planting distance ("*jajar legowo*") help maintain the field temperature at a favourable level for the prawn?		
21	Can the recommended paddy planting distance ("*jajar legowo*") provide ample space for prawn's movement in the field?		
22	Can the recommended paddy planting distance ("*jajar legowo*") increase prawn yield?		
23	Can the recommended plant-based pesticide reduce pest and disease in paddy effectively and, at the same time, be safe for prawn?		
24	Is the recommended plant-based pesticide easy to prepare?		
25	Do you apply pesticides for paddy when you also grow prawn in the same field?		
26	Does the use of non organic pesticide for paddy have a negative affect on the growth of the prawn?		
27	Is the recommended size of prawn post larva too small for securing the survival rate of the prawn in the field?		
28	Is it important to integrate the provision of prawn post larva in the village?		
29	Can the recommended spreading time of prawn post larva into the field guarantee better prawn survival rate and growth?		
Relevant experience and current practices			
30	Will the improved system be easy to follow and implement?		
31	Does the improved system require new skills and knowledge?		
32	Do you have adequate experience in cultivating paddy together with prawn?		
33	Is the improved system suitable with your experience and current practices?		

No.	Questions	Yes	No
34	Are there similarities between your experience, your current practices and the improved system?		
35	Do you have successful practices other than the ones recommended by the improved system?		
36	Is your own experience more proven than the improved system?		
37	Can your experience in cultivating paddy and prawn help you adopt the improved system?		
38	Does the success of the paddy-prawn intercropping depend on hard work and carefulness?		
39	Does the success of the paddy-prawn intercropping depend on advanced practices?		
40	Does the success of the improved system depend on ample field work experience?		
41	Will the improved system enhance your knowledge and experience?		
	Observable results and past failure(s)		
42	Are you going to apply the improved system through a small-scale trial?		
43	Will you try again the improved system if the trial is unsuccessful?		
44	Are observable and successful results from the improved system important?		
45	Are you concerned that past failure(s) in paddy-prawn production will happen again?		
	Extension services and dissemination process		
46	Are extension services in aquaculture available in the village?		
47	Are extension services in food crop production available in the village?		
48	Are the recommendations from the field extension workers relevant to the local conditions and your practices?		
49	Is it important to have a demonstration plot on the improved system?		
50	Should the field demonstration be successful in order to confirm your intention to adopt the improved system?		
51	Is it important to have a regular couching from the field extension workers during the implementation of the improved system?		
52	Is an informal and friendly process of dissemination more effective in encouraging farmers to apply the improved system?		
53	Is it important to have modern dissemination processes, such as using visual presentation?		
	Types of information still required by farmers		
54	Does the improved system provide adequate information on water management?		
55	Does the improved system provide adequate information on methods for growing prawn effectively?		
56	Does the improved system provide adequate information on methods for reducing prawn mortality?		
57	Does the improved system provide adequate information on methods for dealing with white spot virus and green moss in prawn?		
58	Is the recommended number of prawn post larva per hectare sufficient to		

No.	Questions	Yes	No
	secure prawn survival rate and yield?		
59	Does the improved system provide adequate information on affordable methods for measuring the soil and water acidity?		
60	Does the improved system provide adequate information on (non organic) pesticides that are safe for prawn?		
	Incentives		
61	Are financial incentives important for encouraging farmers to apply the improved system?		
62	Is the provision of extension services more important than financial incentives for encouraging farmers to apply the improved system?		
63	Are you still interested in applying the improved system given that there are no financial incentives available?		
64	Does the provision of financial incentives demand farmers to demonstrate accountability in using the incentives?		
65	Does the availability of seed and fertilizer loans help you decide whether to adopt, delay or reject the improved system?		
	Household and farm conditions		
66	Do you make regular analysis of your farm performance?		
67	Has your prawn production been fluctuating recently?		
68	Is income gain and loss common in farming?		
69	Is your current farming income sufficient to support household needs?		
70	Have you had difficulties in fulfilling daily basic needs?		
71	Are you satisfied with your current standard of living?		
72	Is your off-farm job as important as your on-farm job?		
73	Is your off-farm income higher than your on-farm income?		
74	Are you concerned that you will not be able to payback your loans?		
75	Have you had emergency issues lately?		
	Land and capital		
76	Is your land sufficient for implementing the improved system?		
77	Do you own the land yourself?		
78	Do you have sufficient money for implementing the improved system?		
79	Do you have other sources of capital?		
80	Could you easily borrow money for financing your farm?		
81	Do you rely on advanced sales from middlemen for financing your farm?		
82	Do you use the revenue from the previous planting seasons to finance the current planting season?		
83	Is your water pump still working well?		
	Costs from implementing the improved system		
84	Are you willing to spend more money for the success of the improved system?		
85	Does paddy-prawn culture require higher initial working capital?		
86	Are the costs for testing soil and water acidity affordable?		
87	Are the costs of farm labourers expensive?		
88	Are the costs for gasoline increasing?		
89	Can the improved system reduce the costs of pesticides?		

No.	Questions	Yes	No
90	Can the improved system reduce the costs of fertilizer?		
91	Is the cost of prawn larva expensive?		
92	Are you concerned with additional costs from applying the recommended paddy planting distance ("*jajar legowo*")?		
93	Are you concerned with additional costs from applying the recommended land preparation procedures?		
	Work load, time allocation and labour availability		
94	Will the improved system add more work?		
95	Will the improved system be time consuming?		
96	Do you rarely stay in the village?		
97	Do you have adequate time to work in the field?		
98	Do you have enough time to prepare the land and seeds?		
99	Does your age hinder you to implement the improved system?		
100	Is there sufficient family labour?		
101	Is it easy to find farm labourers?		
102	Is the improved system suitable with the current working system of the farm labourers?		
103	Do you use farm labourers from your village?		
104	Can farm labourers be instructed to apply the paddy planting distance?		
	Environmental issues		
105	Is the improved system suitable with the agro climatic conditions?		
106	Can the improved system be implemented at any planting seasons?		
107	Is there enough water available throughout the year?		
108	Is your field close to water sources?		
109	Are there irrigation canals for distributing water supply and disposal?		
110	Is the quality of water suitable for applying the improved system?		
111	Is the location of your field suitable for applying the improved system?		
112	Is the soil fertility in your field declining?		
113	Can prawn culture dissipate soil fertility?		
114	Have you had any severe pest or disease problems lately?		
115	Can pest and disease reduce the potential of the improved system?		
116	Is it important to maintain the rotation of aquaculture-aquaculture-paddy?		
117	Is it important to provide a special place for the prawn to moult (changing skin)?		
118	Do farmers apply to much supplements for their products?		
119	Is it important to apply organic fertilizer in order to restore soil fertility?		
120	Is it more practical to use non organic pesticide?		
	Intercropping issues		
121	Is paddy suitable to be grown together with prawn?		
122	Is the paddy-prawn intercropping suitable with local conditions?		
123	Is the paddy-prawn intercropping only suitable for large field?		
124	Is prawn suitable to be grown in fresh water?		
125	Do different methods of pest and disease control between paddy and prawn affect the yield of the paddy-prawn intercropping?		

No.	Questions	Yes	No
126	Is prawn more suitable to be grown together with milk fish than with paddy?		
127	Is paddy more suitable to be grown together with silver barb and common carp, than with prawn?		
128	Do different cropping patterns between neighbouring farmers affect the yield of paddy-prawn intercropping?		
129	Will the paddy-prawn intercropping be successful if a farmer does not grow vegetables in the same field?		
	Commodity preferences		
130	Are milk fish and paddy your main commodities?		
131	Is the income from milk fish more certain than prawn?		
132	Is the income from paddy more certain than prawn?		
133	Is the income from vegetables more certain than prawn?		
134	Is the profit from prawn higher than milk fish?		
135	Is the income from vegetables higher than prawn?		
136	Is the price of prawn higher than milk fish?		
137	Is the price of prawn higher than vegetables and rice?		
138	Has the trend of prawn price been decreasing in recent years?		
139	Can milk fish be harvested at any time?		
140	Can prawn be harvested at any time?		
141	Is growing prawn more suitable for wealthy farmers?		
142	Can you easily predict the development of prawn?		
143	Can you easily predict the survival rate of the prawn?		
144	Is the production loss of prawn culture certain?		
145	Do you cultivate different products in the same season in order to reduce the possibility of loss?		
146	Is the profit from growing fish and vegetables higher than the paddy-prawn intercropping?		
147	Is the profit from the paddy-prawn intercropping higher than the milk fish-prawn intercropping?		
148	Are the costs of the paddy-prawn intercropping relatively the same with the milk fish-prawn intercropping?		
149	Is the maintenance of prawn more difficult than milk fish and other fish?		
150	Is the maintenance of paddy-silver barb-common carp intercropping easier than the paddy-prawn intercropping?		
151	Is growing vegetables easier and cheaper than prawn?		
152	Is the yield of prawn largely determined by fate?		
	Motivation to apply innovations		
153	Do you always have a strong motivation to try an innovation and prove the results yourself?		
154	Have you given up trying innovations when the results of a particular innovation are unfavourable?		
155	Are you concerned with the possible risk of trying an innovation?		
156	Will you discuss the innovation and the potential problem with other farmers?		
157	Do you actively seek more information once you hear about an innovation?		

No.	Questions	Yes	No
158	Do you seek previous experience of implementing the innovation from other villages?		
159	Are you confident that innovations can bring advancement for your farming business?		
160	Are you interested in applying the improved system because you have a similar plan before?		
161	Will the improved system burden your thinking?		
	Influence of significant others		
162	Is your interest in the improved system affected by your peers' interest?		
163	Will your decision whether to adopt, delay or reject the improved system be affected by others' suggestions and challenge?		
164	Will you adopt the improved system if others decide to do so?		
165	Do you often follow your colleague's practices in adopting innovations?		
166	Does following others' practices bring you advancement in business?		
167	Will you wait and see other farmers to try the improved system before deciding whether to adopt, delay or reject the improved system?		
168	Does your decision highly depend on your parents' consent?		
169	Does your decision highly depend on your spouse's consent?		
170	Is your decision affected by family members' opinion?		
171	Is neighbours' tolerance important to be successful in farming?		
172	Does the quality of water in your neighbouring fields affect the quality of the water in your field?		
173	Does the neighbours' practice of pest and disease control affect the yield of your paddy-prawn intercropping?		
174	Does the implementation of the improved system require neighbourhood unity, such as by having a similar cropping pattern?		
175	Do you follow others' practices in order to avoid negative consequences, such as water shortage, pest and disease?		
176	Will you adopt the improved system if it is suggested by the village leaders?		
177	Will you adopt the improved system if it is suggested by the farmer group?		
	Other aspects		
178	Does leadership in the village affect your decision whether to adopt, delay or reject the improved system?		
179	Is it important that the improved system should be introduced and implemented accountably and in democratic way?		
180	Are you used to collaborating with private sector or government in trying innovations?		

Appendix I. Descriptive Statistics

Table I.1 Descriptive statistics of respondents from Sugihwaras (numeric variables)

No.	Variable description	Unit	Sample size[1)]	Min	Max	Mean	Standard deviation
1	Age of farmers	Years	59	22	79	48.29	12.22
2	Current size of household	People	59	2	10	5.37	1.76
3	Number of children < 15 years old	People	54	0	3	0.59	0.85
4	Number of children aged $\geq$ 15 years old	People	54	0	8	2.14	1.83
5	Farmers' years of schooling	Years	59	0	17	6.67	4.50
6	Spouse's years of schooling	Years	57	0	17	6.61	3.52
7	Number of family labour	People	59	1	5	1.53	0.82
8	Area of ricefield-pond owned by farmer	Hectares	59	0.1	12	1.32	1.83
9	Area of ricefield-pond rented by farmer	Hectares	59	0	3.25	0.25	0.57
10	Years of experience in paddy cultivation	Years	59	2	65	27.07	14.44
11	Years of experience in prawn cultivation	Years	59	1	20	7.41	4.40
12	Years of experience in milkfish cultivation	Years	59	2	31	20.92	9.11
13	% of self-provision capital	Percent	59	0	100	75.74	37.48
14	Number of agricultural machines used by farmer	Units	59	0	4	1.66	0.78
15	Average years of application of agricultural machines by farmer	Years	59	0	41.5	12.16	9.66
16	Farmers' average monthly gross income (May 2004-April 2005)	IDR (000)	59	288	16,346	2,251	3,012
18	Annual total production of paddy	Ton	59	0.2	47.44	7.53	8.85
18	Annual total production of prawn	Ton	59	0	3.15	0.30	0.53
19	Annual total production of milkfish	Ton	59	0	7	0.90	1.13
20	Annual total production of other fish	Ton	59	0	3.3	0.17	0.46
21	Annual cash received from sales of paddy	IDR (000)	59	300	56,926	8,936	10,624
22	Annual cash received from sales of prawn	IDR (000)	59	0	132,750	12,442	22,120
23	Annual cash received from sales of milkfish	IDR (000)	59	0	53,000	5,157	7,662
24	Annual cash received from sales of other fish	IDR (000)	59	0	14,529	691	2,021

[1)] Variable No. 3 & 4: five farmers do not have children. Variable No. 6: one respondent has not been married, and another one is a widow.

Appendix I (continued)

Table I.2 Descriptive statistics of respondents from Sugihwaras (categorical variables)

No.	Variable description	Unit	Sample size[1)]	Category[2)]	%
1	Average years of schooling of a farmer's children	0-5 score	54	10-12 years (4)	48.1
				7-9 years (3)	16.7
				no formal education (0)	14.8
				> 12 years (5)	9.3
				1-3 years (1)	5.6
				4-6 years (2)	5.6
2	Land ownership indicated by the land certificate	0-2 score	59	No land certificate (0)	55.9
				Have land certificate for all area (2)	39.0
				Only part of the land (1)	5.1
3	On-farm productive activities not in the ricefield-pond	0-2 score	59	None (0)	71.2
				Yes but not related to 'pandu' (1)	28.8
4	Off-farm productive activities	0-5 score	59	None (0)	49.2
				Construction & transportation (1)	16.9
				Agricultural related activities (5)	15.3
				Non agricultural trade & services (2)	11.9
				Government official (4)	5.1
				Education (3)	1.7
5	Farmers' objective(s) in farming	1-13 score	59	Higher income (4)	62.7
				Income & human capital improvement (8)	16.9
				Two goals related to better prosperity (12)	10.2
				Side activities (1)	1.7
				Income & local development goals (6)	1.7
				Side activities & income related goals (7)	1.7
				Higher income & production (9)	1.7
				Income+human capital+religious goals (10)	1.7
				Better income-production-human capital (11)	1.7
6	Farmers' cropping pattern between May 2004 and April 2005	1-4 score	59	Only intercropping (4)	50.8
				Mostly intercropping (3)	40.7
				Mostly monoculture (2)	6.8
				Only monoculture (1)	1.7
7	Whether or not farmers cultivate vegetables in 2004-2005	0-1 score	59	No (0)	76.3
				Yes (1)	23.7
8	Whether farmers have intercropped paddy-prawn prior to 'pandu'	0-1 score	59	No (0)	62.7
				Yes (1)	37.3
9	Farmers' perception on the intensity of problems affecting paddy and prawn intercropping	1-10 score	59	Pests and diseases:	
				- no problem (10)	27.1
				- becoming serious (4)	20.3
				- common (5)	16.9
				- serious (2)	11.9
				Water & irrigation:	
				- no problem (10)	50.8
				- serious (2)	20.3
				- common (5)	15.3
				Prawn sale price: no problem (10)	98.3
				Soil conditions: no problem (10)	96.6
				Prawn growth & mortality: no problem (10)	84.7

[1)] Variable No. 1: Five farmers do not have children.

[2)] Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.2 Descriptive statistics of respondents from Sugihwaras (categorical variables, continued)

No.	Variable description	Unit	Sample size[1)]	Category[2)]	%
9	Farmers' perception on the intensity of problems affecting paddy and prawn intercropping (continued)	1-10 score	59	Input availability & cost: no problem (10)	84.7
				Household financial condition: no problem (10)	83.1
				Household human capital no problem (10)	98.3
10	Farmers' perception on yearly production (paddy, prawn, milkfish)	0-5 score	59	Paddy:	
				- higher (4)	45.8
				- unchanged (0)	30.5
			55	Prawn:	
				- lower (2)	32.7
				- higher (4)	30.9
				- fluctuating (3)	27.3
			58	Milkfish:	
				- higher (4)	41.4
				- unchanged (0)	27.6
11	Farmers' perception on the average of yearly sale prices (paddy, prawn, fish)	0-5 score	59	Paddy:	
				- unchanged (0)	61.0
				- higher (4)	25.4
			55	Prawn:	
				- lower (2)	43.6
				- fluctuating (3)	25.5
				- unchanged (0)	21.8
			58	Milkfish:	
				- unchanged (0)	34.5
				- fluctuating (3)	25.9
				- lower (2)	24.1
12	Farmers' perception on the average of yearly input costs (pesticides, fertilizers, seeds)	0-5 score	40	Pesticides:	
				- higher (4)	62.5
				- unchanged (0)	27.5
			55	Fertilizers:	
				- higher (4)	61.0
				- unchanged (0)	15.3
				- far higher (5)	15.3
			58	Seeds:	
				- unchanged (0)	44.1
				- higher (4)	35.6
13	Farmers' perception on the average of annual income	0-5 score	59	- higher (4)	47.5
				- unchanged (0)	47.5
				- fluctuating (3)	11.9
				- lower (2)	10.2
14	Average method for marketing rice, prawn & milkfish	1-3 score	59	Indirect (1)	76.2
				Direct (3)	16.1
				Indirect & direct (2)	7.7
15	Average market destination of rice, prawn & milkfish	1-3 score	59	Local (1)	78.9
				Outside district (3)	13.3
				Local and outside district (2)	7.8

1) Variable No. 10-11: the size of sample varies because not all farmers cultivated prawn or milkfish. Variable No. 12: the size of sample varies because not all farmers applied pesticides and fertilizer, or bought seeds.

2) Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.2 Descriptive statistics of respondents from Sugihwaras (categorical variables, continued)

No.	Variable description	Unit	Sample size	Category[1)]	%[2)]
16	Farmers' means in keeping track of information about farm past performance	1-5 score	59	Memory (1)	72.9
				Farm record book (4)	11.9
				Written & unwritten records (5)	11.9
				Brief written calculation (3)	3.4
17	Information continuously recorded, maintained and/or remembered		59	Production	100.0
				Income	97.3
				Prices	94.9
				Cost and profit	78.0
18	Information sources commonly used by farmers related to paddy, prawn and fish production techniques (including the intensity of usage)	0-4 score	59	Family:	
				- always (4)	78.0
				- often (3)	15.3
				Neighbours:	
				- often (3)	57.6
				- always (4)	6.8
				Farmer group meeting:	
				- often (3)	5.1
				- always (4)	5.1
				Extension activities: rarely (1)	11.9
				Learning by doing: always (4)	11.9
19	Information sources commonly used by farmers related to loans (including the intensity of usage)	0-4 score	59	Neighbours: often (3)	8.5
				Farmer group meeting: often (3)	3.4
				Tv: rarely (1)	3.4
				Bank-BPR:	
				- often (3)	5.1
				- rarely (1)	3.4
				Cooperative:	
				- rarely (1)	18.6
				- often (3)	3.4
20	Information sources commonly used by farmers related to new inputs, including machinery (including the intensity of usage)	0-4 score	59	Neighbours:	
				- often (3)	69.5
				- sometimes (2)	3.4
				Village leader: often (3)	10.2
				Farmer group meeting: often (3)	11.9
				Input retailers: often (3)	11.9
				Extension officers	
				- often (3)	15.3
				- sometimes (2)	11.9
21	Information sources commonly used by farmers related to markets and prices (including the intensity of usage)	0-4 score	59	Family: often (3)	6.8
				Neighbours:	
				- often (3)	18.6
				- sometimes (2)	3.4
				Middlemen:	
				- often (3)	59.3
				- always (4)	18.6

1) Number in the bracket represents the score associated with each category (see also Appendix C).

2) The percentage in variables No. 17 represents the proportion of the respondents who mentioned the relevant categories of answers. In the analysis, some of these variables are quantified.

Appendix I (continued)

Table I.2 Descriptive statistics of respondents from Sugihwaras (categorical variables, continued)

No.	Variable description	Unit	Sample size[1]	Category[2]	%[3]
21	Information sources commonly used by farmers related to markets and prices (including the intensity of usage)	0-4 score	59	Extension officers: often (3)	3.4
				Buyers: often (3)	3.4
				Warehouse: often (3)	5.1
				Local market	
				- often (3)	11.9
				- always (4)	3.4
22	Whether or not farmers actively participate in farmer group	0-1 score	59	No (0)	57.6
				Yes (1)	42.4
23	Whether or not farmers have ever participated in extension activities	0-1 score	59	Yes (1)	72.9
				No (0)	27.1
24	Whether or not farmers participate in other organizations	0-1 score	59	No (0)	71.2
				Yes (1)	28.8
25	Farmers' perception on the benefits of farmer group		59	Agricultural service provider& extension	27.1
				Farm planning & problem solving	25.4
				Improve knowledge, skills & experience	13.6
				Increase production	3.4
				Not yet realized/no benefit	3.4
26	Farmers' main reason for not participating in farmer group		25	Not always stay in the village	40.0
				Farmer group is inactive	24.0
				Being excluded	16.0
				Only trust own practices & family's decision	8.0
				Have limited resources	4.0
				Shy	4.0
				New farmer	4.0
27	Types of extension activities that farmers have participated in		43	Group meeting	79.1
				Field training & demo plot	67.4
				Individual meeting	39.5
				Class training & workshop	20.9
				Comparative study	9.3
28	Farmers' main consideration(s) when evaluating the feasibility of a new technology		57	Observable results	64.9
				Significant others' opinion	43.9
				Financial & marketing aspects	29.8
				Specific feature of the technology	26.3
				Agro-climatic conditions	22.8
				Relevant extension services	14.0
				Skill & experience	8.8
				Supporting facilities	5.3
				Relevancy with current conditions & practices	5.3
				Personal motivation	3.5
				Fate	1.8
				Political aspects	1.8

[1] The sample size in variables No. 26 & 27 represents a group of (i) farmers who were not active and (ii) the ones who were active in the farmer group, respectively. Variable No. 28 has 2 unrecorded answers.

[2] The percentage in variables No. 27 and 28 represents the proportion of the respondents who mentioned the relevant categories of answers. In the analysis, some of these variables are quantified.

[3] Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.2 Descriptive statistics of respondents from Sugihwaras (categorical variables, continued)

No.	Variable description	Unit	Sample size[1)]	Category[2)]	%[3)]
29	Farmers' action(s) once receive information about a new technology		59	Directly apply	37.3
				Seek info, discuss, wait, observe, & decide	23.7
				Wait, observe & decide	15.3
				Seek info, discuss & decide	11.9
				Seek info, discuss, small trial & decide	10.2
				Ignore	1.7
30	The degree of farmers' interaction with their significant others	0-4 score	59	Spouse:	
				- always (4)	52.5
				- often (3)	16.9
				- never (0)	15.3
				Children:	
				- never (0)	66.1
				- often (3)	23.7
				- always (4)	6.8
				Parents:	
				- never (0)	76.3
				- always (4)	8.5
				- sometimes (2)	6.8
				Extended family members:	
				- never (0)	54.2
				- often (3)	28.8
				- sometimes (2)	8.5
				Head of farmer group:	
				- often (3)	39.0
				- never (0)	32.2
				- sometimes (2)	20.3
				Neighbouring farmers:	
				- often (3)	79.7
				- never (0)	8.5
				- sometimes (2)	8.5
				Village leaders:	
				- never (0)	59.3
				- often (3)	23.7
				- sometimes (2)	13.6
				Religious leaders:	
				- never (0)	89.8
				- often (3)	6.8
				Field extension officer:	
				- never (0)	35.6
				- sometimes (2)	32.2
				- often (3)	16.9
				Researcher:	
				- never (0)	96.6
				- always (4)	3.4
				Middlemen:	
				- never (0)	71.2
				- often (3)	22.0
				sometimes (2)	6.8

[1)] Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.2 Descriptive statistics of respondents from Sugihwaras (categorical variables, continued)

No.	Variable description	Unit	Sample size[1)]	Category[2)]	%[3)]
31	Farmers' reason(s) for discussing farming practices with only their significant others		55	Easy to meet & quick responses	47.3
				They are more experience/knowledgeable	32.7
				Helpful in planning & problem solving	27.3
				Have family relation	5.5
				Have leadership	1.8
				They own the land	1.8
32	Farmers' perception on the benefit(s) from the discussion with their significant others prior to decision making		59	Increase knowledge & experience	66.1
				Problem solving, progress& improvement	37.3
				Firmer decision	5.1
				Strengthen family relation	3.4
33	Farmers' way(s) of responding to different opinions during the discussion with their significant others		50	Join the debate & find mutual solution	54.0
				Just follow the majority	18.0
				Listen-screen-make own decision	14.0
				Join the debate but make own decision	10.0
				Ignore & use own opinion	4.0
34	Final decision makers when farmers discuss a new technology with their significant others		59	Myself	40.7
				Consensus with significant others	23.7
				Depend on situation	18.6
				Individual significant other	16.9

[1)] Variable No. 31 has 4 unrecorded answers. Variable No. 33 has 9 unrecorded answers.

[2)] Number in the bracket represents the score associated with each category (see also Appendix C).

[3)] The percentage in variables No. 31 & 32 represents the proportion of the respondents who mentioned the relevant categories of answers. In the analysis, some of these variables are quantified.

Appendix I (continued)

Table I.3 Descriptive statistics of respondents from Rejosari (numeric variables)

No.	Variable description	Unit	Sample size[1)]	Min	Max	Means	Standard deviation
1	Age of farmers	Years	71	27	69	48.52	10.63
2	Current size of household	People	71	2	11	5.00	1.59
3	Number of children < 15 years old	People	62	0	3	0.63	0.83
4	Number of children aged $\geq$ 15 years old	People	62	0	6	1.65	1.64
5	Farmers' years of schooling	Years	71	0	17	6.55	4.60
6	Spouse's years of schooling	Years	69	0	17	6.32	3.91
7	Number of family labour	People	71	0	4	1.34	0.72
8	Area of ricefield-pond owned by farmer	Hectares	71	0	4.5	0.83	0.60
9	Area of ricefield-pond rented by farmer	Hectares	71	0	4	0.15	0.52
10	Years of experience in paddy cultivation	Years	71	2	45	23.80	12.14
11	Years of experience in prawn cultivation	Years	71	0	15	3.15	2.97
12	Years of experience in milkfish cultivation	Years	71	2	40	22.18	9.86
13	% of self-provision capital	Percent	71	0	100	90.14	27.54
14	Number of agricultural machines used by farmer	Units	71	1	4	2.75	0.58
15	Average years of application of agricultural machines by farmer	Years	71	3	28.33	14.44	6.27
16	Farmers' average monthly gross income (2003-2004)	IDR (000)	71	393	10,558	1,871	1,510
18	Annual total production of paddy	Ton	71	0	28	5.70	5.60
18	Annual total production of prawn	Ton	71	0	0.95	0.03	0.12
19	Annual total production of milkfish	Ton	71	0.25	13.4	2.12	2.12
20	Annual total production of other fish	Ton	71	0	2.99	0.71	0.63
21	Annual cash received from sales of paddy	IDR (000)	71	0	40,623	7,758	7,845
22	Annual cash received from sales of prawn	IDR (000)	71	0	14,435	1,103	2,530
23	Annual cash received from sales of milkfish	IDR (000)	71	1,125	74,300	11,574	11,658
24	Annual cash received from sales of other fish	IDR (000)	71	0	13,200	2,431	2,389

[1)] Variable No. 3 & 4: nine farmers do not have children. Variable No. 6: two respondents have not been married.

Appendix I (continued)

Table I.4 Descriptive statistics of respondents from Rejosari (categorical variables)

No.	Variable description	Unit	Sample size[1)]	Category[2)]	%
1	Average years of schooling of a farmer's children	0-5 score	62	10-12 years (4)	44.6
				7-9 years (3)	26.2
				no formal education (0)	12.3
				1-3 years (1)	9.2
				4-6 years (2)	6.2
				>12 years (5)	1.5
2	Land ownership indicated by the land certificate	0-2 score	71	No land certificate (0)	53.5
				Have land certificate for all area (2)	45.1
				Only part of the land (1)	1.4
3	On-farm productive activities not in the ricefield-pond	0-2 score	71	Yes but not related to 'pandu' (1)	87.3
				None (0)	12.7
4	Off-farm productive activities	0-5 score	71	None(0)	62.0
				Non agricultural trade & services (2)	18.3
				Agricultural related activities (5)	9.9
				Construction & transportation (1)	5.6
				Government official (4)	4.2
5	Farmers' objective(s) in farming	1-13 score	71	Higher income (4)	78.9
				High yield (3)	8.5
				Two goals related to better prosperity (12)	4.2
				Human capital improvement (2)	2.8
				Human development & religious goals (5)	1.4
				Income & local development goals (6)	1.4
				Income & human capital improvement (8)	1.4
				Three goals related to better prosperity (13)	1.4
6	Farmers' cropping pattern between May 2004 and April 2005	1-4 score	71	Mostly intercropping (3)	78.9
				Only intercropping (4)	12.7
				Mostly monoculture (2)	8.5
7	Whether or not farmers cultivate vegetables in 2004-2005	0-1 score	71	Yes (1)	88.7
				No (0)	11.3
8	Whether farmers have incropped paddy-prawn prior to 'pandu' dissemination	0-1 score	71	No (0)	83.1
				Yes (1)	16.9
9	Farmers' perception on the intensity of problems affecting paddy and prawn intercropping	1-10 score	71	Pests and diseases:	
				- no problem	56.3
				- trivial	14.1
				- quite trivial	11.3
				Water & irrigation:	
				- no problem	42.3
				- quite serious	28.2
				Prawn sale price: no problem (10)	91.5
				Soil conditions: no problem (10)	93.0
				Prawn growth & mortality: no problem (10)	91.5
				Input availability & cost: no problem (10)	97.2
				Household financial condition: no problem (10)	95.8
				Household human capital no problem (10)	97.2

1) Variable No. 1: Nine farmers do not have children.

2) Number in the bracket represents the score of each category (see also Appendix C).

Appendix I (continued)

Table I.4 Descriptive statistics of respondents from Rejosari (categorical variables, continued)

No.	Variable description	Unit	Sample size[1)]	Category[2)]	%
10	Farmers' perception on yearly production (paddy, prawn, milkfish)	0-5 score	67	Paddy:	
				- higher (4)	79.1
				- unchanged (0)	14.9
			18	Prawn:	
				- lower (2)	33.3
				- fluctuating (3)	27.8
				- higher (4)	22.2
			71	Milkfish:	
				- higher (4)	73.2
				- unchanged (0)	12.7
				- fluctuating (3)	11.3
11	Farmers' perception on the average of yearly sale prices (paddy, prawn, fish)	0-5 score	67	Paddy:	
				- higher (4)	62.7
				- unchanged (0)	20.9
				- fluctuating (3)	10.4
			18	Prawn:	
				- lower (2)	38.9
				- fluctuating (3)	33.3
				- higher (4)	16.7
			71	Milkfish:	
				- higher (4)	42.3
				- fluctuating (3)	28.2
				- lower (2)	18.3
12	Farmers' perception on the average of yearly input costs (pesticides, fertilizers, seeds)	0-5 score	25	Pesticides:	
				- higher (4)	52.0
				- unchanged (0)	40.0
			71	Fertilizers:	
				- higher (4)	64.8
				- unchanged (0)	22.5
			70	Seeds:	
				- higher (4)	48.6
				- unchanged (0)	28.6
				- fluctuating (3)	21.4
13	Farmers' perception on the average of annual income	0-5 score	71	- higher (4)	83.1
				- fluctuating (3)	8.5
				- unchanged (0)	4.2
				- lower (2)	4.2
14	Average method for marketing rice, prawn & milkfish	1-3 score	71	Indirect (1)	63.5
				Direct (3)	36.0
				Indirect & direct (2)	0.5
15	Average market destination of rice, prawn & milkfish	1-3 score	71	Local (1)	89.2
				Outside district (3)	9.9
				Local and outside district (2)	0.9
16	Farmers' means in keeping track of information about farm past performance	1-5 score	71	Memory (1)	93.0
				Farm record book (4)	4.2
				Written & unwritten records (5)	2.8

1) Variable No. 10-11: the size of sample varies because not all farmers cultivated prawn or paddy. Variable No. 12: the size of sample varies because not all farmers applied pesticides or bought seeds.

2) Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.4 Descriptive statistics of respondents from Rejosari (categorical variables, continued)

No.	Variable description	Unit	Sample size	Category[1)]	%[2)]
17	Information continuously recorded, maintained and/or remembered		71	Production	83.1
				Income	81.7
				Prices	78.9
				Cost and profit	64.8
18	Information sources commonly used by farmers related to paddy, prawn and fish production techniques (including the intensity of usage)	0-4 score	71	Family: always (4)	80.3
				Neighbours:	
				- always (4)	52.1
				- often (3)	26.8
				Farmer group meeting:	
				- always (4)	22.5
				- often (3)	11.3
				Extension activities:	
				- rarely (1)	35.2
				- sometimes (2)	1.4
				- Learning by doing: always (4)	5.6
19	Information sources commonly used by farmers related to loans (including the intensity of usage)	0-4 score	71	Bank-BPR:	
				- rarely (1)	2.8
				- often (4)	1.4
				Cooperative:	
				- rarely (1)	49.3
				- often (4)	2.8
20	Information sources commonly used by farmers related to new inputs, including machinery (including the intensity of usage)	0-4 score	71	Family:	
				- always (4)	8.5
				- often (3)	1.4
				Neighbours:	
				- always (4)	38.0
				- often (3)	35.2
				Village leader: often (3)	4.2
				Farmer group meeting:	
				- always (4)	15.5
				- often (3)	14.1
				Input retailers:	
				- often (3)	9.9
				- always (4)	5.6
				Extension officers	
				- often (3)	23.9
				- rarely (1)	7.0
				- always (4)	5.6
				Tv: rarely (1)	8.5
21	Information sources commonly used by farmers related to markets and prices (including the intensity of usage)	0-4 score	71	Family: always (4)	2.8
				Neighbours: always (4)	2.8
				Middlemen:	
				- always (4)	63.4
				- often (3)	14.1

1) Number in the bracket represents the score associated with each category (see also Appendix C).

2) The percentage in variables No. 17 represents the proportion of the respondents who mentioned the relevant categories of answers. In the analysis, some of these variables are quantified.

Appendix I (continued)

Table I.4 Descriptive statistics of respondents from Rejosari (categorical variables, continued)

No.	Variable description	Unit	Sample size1)	Category2)	%3)
21	Information sources commonly used by farmers related to markets and prices (including the intensity of usage, continued)	0-4 score	71	Warehouse:	
				- always (4)	54.9
				- often (3)	7.0
				Local market	
				- always (4)	35.2
				- often (3)	7.0
22	Whether or not farmers actively participate in farmer group	0-1 score	71	Yes (1)	76.1
				No (0)	23.9
23	Whether or not farmers have ever participated in extension activities	0-1 score	71	Yes (1)	80.3
				No (0)	19.7
24	Whether or not farmers participate in other organizations	0-1 score	71	No (0)	76.1
				Yes (1)	23.9
25	Farmers' perception on the benefits of farmer group		71	Farm planning & problem solving	46.5
				Agricultural service provider& extension	23.9
				Improve knowledge, skills & experience	22.5
				Increase production	7.0
26	Farmers' main reason for not participating in farmer group		17	Not always stay in the village	58.8
				Farmer group is inactive	23.5
				Only trust own practices & family's decision	5.9
				Have limited resources	5.9
				New farmer	5.9
27	Types of extension activities that farmers have participated in		57	Group meeting	100.0
				Field training & demo plot	57.9
				Individual meeting	29.8
				Class training & workshop	8.8
				Comparative study	3.5
28	Farmers' main consideration(s) when evaluating the feasibility of a new technology		70	Observable results	84.3
				Significant others' opinion	54.3
				Financial & marketing aspects	25.7
				Specific feature of the technology	20.0
				Agro-climatic conditions	8.6
				Personal motivation	5.7
				Relevancy with current conditions & practices	5.7
				Relevant extension services	4.3
				Skill & experience	2.9
				Supporting facilities	1.4
29	Farmers' action(s) once receive information about a new technology		71	Directly apply	35.2
				Seek info, discuss, wait, observe, & decide	31.0
				Wait, observe & decide	16.9
				Seek info, discuss, small trial & decide	11.3
				Seek info, discuss & decide	4.2
				Run small-scale trial & decide	1.4

1) The sample size in variables No. 26 & 27 represents a group of (i) farmers who were not active and (ii) the ones who were active in the farmer group, respectively. Variable No. 28 has 1 unrecorded answer.

2) The percentage in variables No. 27 & 28 represents the proportion of the respondents who mentioned the relevant categories of answers. In the analysis, some of these variables are quantified.

3) Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.4 Descriptive statistics of respondents from Rejosari (categorical variables, continued)

No.	Variable description	Unit	Sample size	Category[1)]	%
30	The degree of farmers' interaction with their significant others	0-4 score	71	Spouse:	
				- always (4)	70.4
				- often (3)	18.3
				- never (0)	7.0
				Children:	
				- never (0)	69.0
				- often (3)	12.7
				- always (4)	8.5
				Parents:	
				- never (0)	62.0
				- always (4)	16.9
				- often (3)	14.1
				Extended family members:	
				- never (0)	50.7
				- often (3)	33.8
				- sometimes (2)	8.5
				Head of farmer group:	
				- often (3)	57.7
				- never (0)	16.9
				- sometimes (2)	16.9
				Neighbouring farmers:	
				- often (3)	54.9
				- always (4)	33.8
				- sometimes (2)	7.0
				Village leaders:	
				- often (3)	35.2
				- never (0)	31.0
				- rarely (1)	16.9
				Religious leaders:	
				- never (0)	97.2
				- rarely (1)	1.4
				- often (3)	1.4
				Field extension officer:	
				- never (0)	42.3
				- often (3)	21.1
				- rarely (1)	19.7
				Fellow farmers from other villages:	
				- never	95.8
				- always	2.8
				Middlemen:	
				- never (0)	93.0
				- rarely (1)	4.2
				Input retailers:	
				- never	95.8
				- often	4.2

1) Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.4 Descriptive statistics of respondents from Rejosari (categorical variables, continued)

No.	Variable description	Unit	Sample size[1)]	Category[2)]	%[3)]
31	Farmers' reason(s) of discussing farming practices only with their significant others		62	Easy to meet & quick responses	59.7
				Helpful in planning & problem solving	25.8
				They are more experience/knowledgeable	14.5
				Have family relation	4.8
				They own the land	3.2
32	Farmers' perception on the benefit(s) from the discussion with their significant others prior to decision making		70	Increase knowledge & experience	52.9
				Problem solving, progress& improvement	52.9
				Firmer decision	5.7
33	Farmers' way(s) of responding to different opinions during the discussion with their significant others		68	Join the debate & find mutual solution	89.7
				Just follow the majority	5.9
				Listen-screen-make own decision	2.9
				Ignore & use own opinion	1.5
34	Final decision makers when farmers discuss a new technology with their significant others		71	Myself	49.3
				Depend on situation	23.9
				Consensus with significant others	23.9
				Individual significant other	2.8

[1)] Variable No. 31 has 9 unrecorded answers. Variable No. 32 has 1 unrecorded answer. Variable No. 33 has 3 unrecorded answers.

[2)] The percentage in variables No. 31 & 32 represents the proportion of the respondents who mentioned the relevant categories of answers. In the analysis, some of these variables are quantified.

[3)] Number in the bracket represents the score associated with each category (see also Appendix C).

Appendix I (continued)

Table I.5 Normality test of background variables

No.	Variable**	N = 130 farmers			
		Skewness	Kurtosis	Kolmogorov-Smirnov *	
				Statistics	Sig.
1	Crop	-0.34	0.57	0.33	0.00
2	Veg	-0.38	-1.89	0.39	0.00
3	Inc	**4.22**	**21.43**	0.25	0.00
4	Obj	1.71	2.05	0.45	0.00
5	It2	-0.82	-0.97	0.34	0.00
6	New1	**2.96**	**7.14**	0.53	0.00
7	New3	**3.37**	**9.62**	0.53	0.00
8	FG	-0.48	-1.80	0.40	0.00
9	Jext	-1.29	-0.33	0.48	0.00
10	Tell	-0.22	-1.51	0.27	0.00
11	Know	0.95	1.94	0.08	0.04
12	DM	0.23	-1.04	0.28	0.00
13	Age	-0.01	-0.11	0.09	0.01
14	HH	0.83	1.03	0.19	0.00
15	FL	**2.15**	**5.63**	0.39	0.00
16	Edu	0.62	-0.30	0.21	0.00
17	EP	0.03	-0.46	0.09	0.01
18	EM	-0.53	-0.83	0.15	0.00
19	EPr	1.39	2.25	0.13	0.00
20	EPP	1.10	-0.81	0.46	0.00
21	Land	**5.79**	**40.94**	0.30	0.00
22	OC	-1.82	1.78	0.46	0.00
23	Off	1.23	0.09	0.32	0.00
24	Y2	**5.33**	**33.38**	0.35	0.00
25	Y3	**3.21**	**14.74**	0.20	0.00
26	S2	**5.84**	**39.66**	0.35	0.00
27	S3	**3.20**	**14.16**	0.20	0.00
28	Met	-0.18	-1.52	0.25	0.00
29	Tar	1.14	-0.02	0.39	0.00
30	Diss	0.38	-1.89	0.39	0.00

* There are no missing data; Kolmogorov-Smirnov statistics with significance value more than 0.5 indicate normal data distribution.

** See Appendix C and Appendix G for the variable definition.

Appendix I (continued)

Table I.6 Descriptive measure of the background variables and actual behaviour

No.	Variable*	Sample size	Missing sample	Mean	Standard deviation	Skewness	Kurtosis
1	Vil	130	0	1.546	0.500	-0.188	-1.996
2	Intr	130	0	0.892	0.673	0.130	-0.776
3	a045	130	0	0.192	0.467	2.451	5.447
4	Crop	130	0	3.208	0.606	-0.343	0.572
5	Obj	130	0	4.938	2.237	1.707	2.045
6	Jext	130	0	0.769	0.423	-1.293	-0.334
7	HH	130	0	5.169	1.671	0.831	1.032
8	FL	130	0	1.423	0.766	2.154	5.631
9	Edu	130	0	6.604	4.537	0.615	-0.304
10	EPP	130	0	0.262	0.441	1.098	-0.807
11	Land	130	0	1.056	1.324	5.786	40.938
12	OC	130	0	83.604	33.091	-1.817	1.783
13	Off	130	0	1.238	1.760	1.232	0.094
14	Mar	130	0	1.736	1.851	10.312	113.617
15	Tar	130	0	1.303	0.445	1.139	-0.019
16	Y3	130	0	1.567	1.837	3.209	14.737
17	Diss	130	0	0.408	0.493	0.380	-1.885
18	It2	130	0	2.523	1.561	-0.819	-0.965

* See Appendix C and Appendix G for the variable definition.

Table J.1. FOCUS results: element groups related to the attitudes towards "pandu"

Sugihwaras			Rejosari		
Element groups	Elicitation frequency	% of total elements elicited	Element groups	Elicitation frequency	% of total elements elicited
Comparison between prawn and fish production	24	16.90	Overall farming requirements	25	12.76
Overall farming requirements	20	14.08	Paddy and fish production	25	12.76
Knowledge, skills & experience	20	14.08	Knowledge, skills & experience	21	10.71
Income from multicropping	14	9.86	Agro-climatic problems	18	9.18
Risks of failure and consequences	9	6.34	Fish production	11	5.61
Input costs and availability	8	5.63	Comparison between prawn and fish production	11	5.61
Farming requirements and outputs	8	5.63	Vegetable production	11	5.61
Motivation to work and learn	8	5.63	Human and financial capital	10	5.10
Learning about "pandu"	7	4.93	Paddy cultivation	9	4.59
Side jobs	6	4.23	Workload on prawn cultivation	7	3.57
Income from paddy	4	2.82	On farm and off-farm jobs	6	3.06
Income from "pandu"	3	2.11	Motivation to work and learn	6	3.06
Human and financial capital	3	2.11	Family income security	6	3.06
Time allocation	2	1.41	Risks of failure and consequences	6	3.06
Household needs	1	0.70	Paddy and vegetable production	6	3.06
Agro-climatic problems	1	0.70	Time allocation	5	2.55
On-farm and off-farm income	1	0.70	Income from multicropping	5	2.55
Paddy production requirements	1	0.70	Family assets and capital	3	1.53
Soil and water requirements for fish production	1	0.70	Secondary sources of income	3	1.53
Vegetable production	1	0.70	Human capital and outputs of "pandu"	2	1.02

Appendix J (continued)

Table J.2 FOCUS results: construct groups related to the attitudes towards "pandu"

Sugihwaras			Rejosari		
Construct groups	**Elicitation frequency**	**% of total constructs elicited**	**Construct groups**	**Elicitation frequency**	**% of total constructs elicited**
(expenses-revenues)	14	8.38	(primary-secondary)	29	13.43
(managerial-financial)	13	7.78	(farming issues-family issues)	23	10.65
(input-output)	11	6.59	(learning-working)	14	6.48
(work in progress-completion)	11	6.59	(managerial-financial)	13	6.02
(primary-secondary)	10	5.99	(expenses-revenues)	12	5.56
(routine-occasionally)	10	5.99	(sufficient-deficient)	12	5.56
(the work-the results)	10	5.99	(input-output)	11	5.09
(sufficient-deficient)	8	4.79	(routine-occasionally)	11	5.09
(available-unavailable)	7	4.19	(certain-uncertain)	9	4.17
(certain-uncertain)	7	4.19	(the work-the results)	9	4.17
(own decision-consensus)	7	4.19	(depend on money-not depend on money)	7	3.24
(cheap-expensive)	6	3.59	(own decision-consensus)	7	3.24
(farming issues-family issues)	6	3.59	(own effort-need other's help)	7	3.24
(own effort-need others' help)	6	3.59	(paddy-vegetable)	7	3.24
(successful-unsuccessful)	6	3.59	(cheap-expensive)	5	2.31
(easy-difficult)	5	2.99	(easy-difficult)	5	2.31
(depend on money-not depend on money)	5	2.99	(sources-utilization)	5	2.31
(learning-working)	5	2.99	(successful-unsuccessful)	5	2.31
(fish-paddy)	3	1.80	(important-trivial)	4	1.85
(suitable-unsuitable)	3	1.80	(work in progress-completion)	4	1.85
(advanced farmer-traditional farmer)	2	1.20	(all-partial)	3	1.39
(break-even-bankrupt)	2	1.20	(working for myself-working for others)	3	1.39
(paddy problem-prawn problem)	2	1.20	(available-unavailable)	2	0.93
(sources-utilization)	2	1.20	(familiar-unfamiliar)	2	0.93
(stable-fluctuating)	2	1.20	(from family-from friends)	2	0.93
(all-partial)	1	0.60	(suitable-unsuitable)	2	0.93
(carefully endeavoured-up to fate)	1	0.60	(annually-seasonally)	1	0.46
(water-land)	1	0.60	(fish-paddy)	1	0.46
(work for living-work for other means)	1	0.60	(skills dependent-not depending on skills)	1	0.46

Appendix J (continued)

Table J.3 PrinCom results related to the attitudes towards "pandu"

Sugihwaras			Rejosari		
Main themes (combination of elements and constructs)	Elicitation frequency	% of total themes elicited	Main themes (combination of elements and constructs)	Elicitation frequency	% of total themes elicited
Expenses and revenues	10	18.52	Labour and knowledge requirements	10	18.52
Labour and knowledge requirements	8	14.81	Comparison between "pandu" & current practices	10	18.52
Farming input and expenses	8	14.81	Farming input and expenses	8	14.81
Income from multicropping ("pandu" & fish production)	8	14.81	Expenses and revenues	6	11.11
Soil and water requirements	6	11.11	Soil and water requirements	6	11.11
Risk of failure	4	7.41	Risk of failure	6	11.11
Limited time for working in the farm due to side jobs	3	5.56	Workload	6	11.11
Comparison between "pandu" & current practices	2	3.70	Human and financial requirements	5	9.26
Workload	2	3.70	Knowledge requirement and income for the family	4	7.41
Human and financial requirements	1	1.85	Preference on vegetable production	3	5.56
Price of prawn	1	1.85	Limited time for working in the farm due to side jobs	3	5.56
Knowledge requirement and income for the family	1	1.85	On-farm and off-farm income	3	5.56

Appendix J (continued)

Table J.4 FOCUS results: element groups related to perceived behavioural control

Sugihwaras			Rejosari		
Element groups	Elicitation frequency	% of total elements elicited	Element groups	Elicitation frequency	% of total elements elicited
Own and borrowed capital	20	25.32	Knowledge and capital requirements	17	23.29
Knowledge and capital requirements	13	16.46	Knowledge and experience in paddy-prawn intercropping	9	12.33
Knowledge and experience in paddy-prawn intercropping	9	11.39	Access to extension services	7	9.59
Access to extension services	6	7.59	Own and borrowed capital	7	9.59
Capital, water and pest problems	6	7.59	Family income and expenses	6	8.22
Farming expenses	5	6.33	Water supply and quality	5	6.85
Pest, disease and water problems	4	5.06	Vegetable production	4	5.48
Water supply and quality	4	5.06	Input and output price problems	3	4.11
External interactions	2	2.53	Knowledge, capital and marketing problems	3	4.11
Marketing problems	2	2.53	Marketing problems	2	2.74
Work motivation	2	2.53	Water and input requirements	2	2.74
Pest, disease and marketing problems	2	2.53	Pest, disease and water problems	2	2.74
Access to knowledge and market	2	2.53	Access to capital and extension services	2	2.74
Access to input and market information	1	1.27	Costs of transportation	1	1.37
Asset, sale price, pest & disease problems	1	1.27	Marketing and water problems	1	1.37
			Incentives from extension	1	1.37
			Pest, disease and marketing problems	1	1.37

Appendix J (continued)

Table J.5 FOCUS results: construct groups related to perceived behavioural control

Sugihwaras			Rejosari		
Construct groups	**Elicitation frequency**	**% of total constructs elicited**	**Construct groups**	**Elicitation frequency**	**% of total constructs elicited**
(technical issues-financial issues)	18	18.56	(technical issues-financial issues)	12	11.54
(family needs-farming needs)	10	10.31	(own capacity-others' help)	9	8.65
(easy-difficult)	10	10.31	(certain-uncertain)	8	7.69
(certain-uncertain)	6	6.19	(solutions-problems)	7	6.73
(own capacity-others' help)	6	6.19	(available-unavailable)	6	5.77
(sufficient-deficient)	6	6.19	(input-output)	6	5.77
(access to the source-utilization)	5	5.15	(routine-occasionally)	6	5.77
(important-trivial)	5	5.15	(important-trivial)	5	4.81
(solutions-problems)	5	5.15	(guidelines-application)	5	4.81
(learning-working)	4	4.12	(sufficient-deficient)	4	3.85
(production-marketing)	4	4.12	(beginning-end)	3	2.88
(available-unavailable)	3	3.09	(cheap-expensive)	3	2.88
(routine-occasionally)	3	3.09	(consensus-individual decision)	3	2.88
(existing practices-new practices)	2	2.06	(existing practices-new practices)	3	2.88
(from friends-from God)	2	2.06	(individual-group)	3	2.88
(open-monopolized)	2	2.06	(revenues-expenses)	3	2.88
(revenues-expenses)	2	2.06	(access to the source-utilization)	2	1.92
(beginning-end)	1	1.03	(depend on effort-depend on nature)	2	1.92
(from relatives-from friends)	1	1.03	(fair-unfair)	2	1.92
(like-dislike)	1	1.03	(family needs-farming needs)	2	1.92
(quality-quantity)	1	1.03	(few types-various types)	2	1.92
			(production-marketing)	2	1.92
			(sell-buy)	2	1.92
			(successful-unsuccessful)	2	1.92
			(easy-difficult)	1	0.96
			(stable-fluctuating)	1	0.96

Appendix J (continued)

Table J.6 PrinCom results related to perceived behavioural control on "pandu"

Sugihwaras			Rejosari		
Main themes (combination of elements and constructs)	Elicitation frequency	% of total themes elicited	Main themes (combination of elements and constructs)	Elicitation frequency	% of total themes elicited
Debt	7	18.42	Own capital and knowledge	5	12.82
Knowledge and effort to achieve high quality product	6	15.79	Decreasing access to extension services, capital and price	4	10.26
Own capital and knowledge	5	13.16	Uncertainties in sale price	4	10.26
Capital and water availability	4	10.53	Water availability	4	10.26
Capital, pest and disease problems	3	7.89	Knowledge and capital for dealing with pests and diseases	3	7.69
Household daily expenses and pest & disease problems	2	5.26	Efforts to deal with pest and disease problems	3	7.69
Financial incentives	1	2.63	Debt for farming and family needs	2	5.13
Water availability	1	2.63	Debt, income and skills	2	5.13
Capital, pest, disease and water problems	1	2.63	Own experience and skills	2	5.13
Off-farm activities and income	1	2.63	Water, pest and disease problems	2	5.13
Household daily expenses	1	2.63	Access to extension services	1	2.56
Profit	1	2.63	Capital, knowledge, sale price and water	1	2.56
Access to capital and price information	1	2.63	Capital, knowledge, working motivation and water	1	2.56
Access to information	1	2.63	Capital, pest and disease problems	1	2.56
Pest and disease problems	1	2.63	Capital, pest, disease and water problems	1	2.56
Dependent on external help and decision	1	2.63	Extension services and income from vegetable	1	2.56
Workload	1	2.63	Profit	1	2.56
			Off-farm work and experience in dealing with pests and diseases	1	2.56

Appendix J (continued)

Table J.7 FOCUS results: element groups related to the bargaining process

Sugihwaras			Rejosari		
Element groups	**Elicitation frequency**	**% of total elements elicited**	**Element groups**	**Elicitation frequency**	**% of total elements elicited**
Family	15	19.48	Family	26	22.22
Close people (family and non family)	11	14.29	Related to extension activities	20	17.09
Related to extension activities	9	11.69	Close people (family and non family)	17	14.53
Source of information and advice	8	10.39	Partners in working and discussing farming issues	9	7.69
Trade relationships	7	9.09	Farmer group members	8	6.84
Partners in working and discussing farming issues	4	5.20	Non family	8	6.84
Distant people	4	5.20	Source of information and advice	6	5.13
Non family	3	3.90	Trade relationships	6	5.13
Source of capital	3	3.90	Distant people	6	5.13
Farmer group members	3	3.90	Source of capital	3	2.56
Source of capital and information	2	2.60	Input providers	2	1.71
Respected people	2	2.60	Officers	2	1.71
Input providers	1	1.30	Villagers	1	0.85
Local institutions	1	1.30	People who ask for an advice	1	0.85
Partners in making financial decisions	1	1.30	Observers	1	0.85
Villagers	1	1.30	Witness for credit application	1	0.85
Unchanged roles	1	1.30			
Non farmer group members	1	1.30			

Appendix J (continued)

Table J.8 FOCUS results: construct groups related to the bargaining process

Sugihwaras			Rejosari		
Construct groups	**Elicitation frequency**	**% of total constructs elicited**	**Construct groups**	**Elicitation frequency**	**% of total constructs elicited**
(close people-distant people)	28	24.56	(close people-distant people)	38	23.03
(family-non family)	14	12.28	(family-non family)	29	17.58
(primary-secondary)	7	6.14	(farming issues-general issues)	18	10.91
(business relation-social relation)	6	5.26	(primary-secondary)	11	6.67
(farming issues-marketing issues)	6	5.26	(give advice-apply advice)	9	5.45
(partner in life-partner in farming)	6	5.26	(commoners-leaders)	7	4.24
(commoners-leaders)	5	4.39	(informal-formal)	5	3.03
(give advice-give consent)	4	3.51	(own decision-consensus)	5	3.03
(locals-outsiders)	4	3.51	(depend on money-not depend on money)	4	2.42
(source of advice-source of capital)	4	3.51	(family issues-community issues)	4	2.42
(cooperation-rivalry)	3	2.63	(give advice-give consent)	4	2.42
(give advice-apply advice)	3	2.63	(knowledgeable-inexperienced)	4	2.42
(religious issues-farming issues)	3	2.63	(business relation-social relation)	3	1.82
(advanced farmers-traditional farmers)	2	1.75	(partial-all)	3	1.82
(buyer-seller)	2	1.75	(farming issues-family issues)	3	1.82
(community issues-family issues)	2	1.75	(farming issues-marketing issues)	3	1.82
(consultation-research)	2	1.75	(source of advice-source of capital)	3	1.82
(expenses-revenues)	2	1.75	(cooperation-rivalry)	2	1.21
(farming issues-family issues)	2	1.75	(locals-outsiders)	2	1.21
(knowledgeable-inexperienced)	2	1.75	(social issues-governmental issues)	2	1.21
(own decision-consensus)	2	1.75	(solutions-problems)	2	1.21
(fair-unfair)	1	0.88	(expenses-revenues)	1	0.61
(farmer group member-non farmer group member)	1	0.88	(many-few)	1	0.61
(give attention to farmers-never give attention to farmers)	1	0.88	(people's role model-personal role model)	1	0.61
(one-way communication-two-way communication)	1	0.88	(source of information-source of innovation)	1	0.61
(same roles-changed roles)	1	0.88	(village leader-farmer leader)	1	0.61

Appendix J (continued)

Table J.9 PrinCom results related to bargaining process

Sugihwaras			Rejosari		
Main themes (combination of elements and constructs)	**Elicitation frequency**	**% of total themes elicited**	**Main themes (combination of elements and constructs)**	**Elicitation frequency**	**% of total themes elicited**
Closeness and frequency of interactions	9	20.93	Kinship	18	29.51
Kinship	9	20.93	Closeness and frequency of interactions	12	19.67
Main source of advice & assistance	4	9.30	Main source of advice & assistance	6	9.84
Local source of farming advice	3	6.98	Topic of discussion: farming, family or general issues	5	8.20
People under my responsibility	3	6.98	Local source of farming advice	4	6.56
Type of relationships: trading, advising or financing	3	6.98	Extension services	3	4.92
Level of knowledge in farming	2	4.65	Level of formality	3	4.92
Extension services	2	4.65	Type of relationships: trading, advising or financing	2	3.28
Final decision makers	2	4.65	Level of knowledge in farming	2	3.28
Similar vision in decision making	2	4.65	Partner in making decisions	2	3.28
Level of attention to farmers	1	2.33	Final decision makers	1	1.64
Contribution to own success	1	2.33	Partner in applying farming recommendations	1	1.64
Partner in making financial decisions	1	2.33	Respected people	1	1.64
Membership in farmer group	1	2.33	Commoners/villagers	1	1.64

Appendix K. Classification of Respondents Based on Their Adoption Attitudes

Adopter and non adopter groups	Sugihwaras		Rejosari	
	Eligible respondents	% of total respondents in the group	Eligible respondents	% of total respondents in the group
Would never adopt	SI022, SI027, SI034, SI043, SI045, SI051, SI052, SI057, SI058	81.82	RI065, RI067, RI069 RI071, RI072, RI075 RI076, RI081, RI090 RI091, RI093, RI095 RI096, RI099, RI100 RI101, RI102, RI103 RI106, RI107, RI108 RI111, RI112, RI120 RI127	96.15
Discontinued from full adoption	SI002	100.00	RI074, RI077, RI078 RI080, RI082, RI086 RI089, RI094, RI097 RI109, RI117, RI119 RI121, RI122, RI123	100.00
Discontinued from partial adoption	SI004, SI005, SI007, SI008, SI010, SI012 SI015, SI017, SI019, SI023, SI024, SI025 SI026, SI029, SI030, SI031, SI032, SI033 SI035, SI036, SI037, SI038, SI039, SI040 SI046, SI047, SI048, SI049, SI053, SI056	93.75	RI061, RI063, RI064 RI068, RI070, RI079 RI083, RI084, RI085 RI087, RI088, RI098 RI104, RI105, RI113 RI114, RI116, RI118 RI124, RI125, RI126 RI128, RI129, RI130	100.00
Decreasing trend of adoption	SI018	100.00	RI092, RI060, RI066	100.00
Continued partial adoption	SI001, SI003, SI011, SI014, SI016, SI020 SI028, SI044, SI054, SII059	90.91	RI062, RI115	100.00
Incremental adoption			RI073	100.00
Continued full adoption	SI006, SII013, SI021	100.00		

Appendix L. Farmers' Main Decision Criteria Regarding "Pandu"

Decision criteria	TPB	PCT (Repertory Grid)	EDTM
Objectives	✓		
Household size	✓		
Family labour			✓
Age/Strength			✓
Land ownership	✓	✓	✓
Suitability of location			✓
Own capital	✓	✓	✓
Current cropping pattern	✓	✓	
Neighbours' cropping system			✓
Farm labour system			✓
Access to external capital		✓	
Access to extension services		✓	
Paddy yield		✓	
Milkfish yield	✓	✓	
Income from paddy and fish		✓	✓
Income from fish		✓	
Prawn yield		✓	
Income from prawn		✓	
Vegetable production		✓	
Participation in the dissemination	✓	✓	✓
Effort to search more information			✓
Commitment to the "pandu" program			✓
Own motivation			✓
"Pandu's" financial incentives			✓
"Pandu's" technical assistance			✓
"Pandu" components' applicability			✓
A particular feature of "pandu" component			✓
"Pandu" yield		✓	
Income from "pandu"		✓	✓
Peer's performance			✓
Risk of failure		✓	
Relevant knowledge and skills		✓	✓
Relevant experience		✓	✓
Workload		✓	
Off-farm activities		✓	✓
Water and irrigation problems	✓	✓	✓
Soil problems		✓	✓
Pest and disease problems	✓	✓	✓
Problem related to prawn price	✓	✓	✓
Bargaining power in marketing		✓	
Labour costs		✓	
Farm expenses			✓
Household expenses			✓
Debt problem		✓	
Family consensus/consent requirement		✓	✓
The role of the farmers' spouse	✓	✓	
The role of the farmers' children	✓		
The role of neighbours		✓	✓
The role of farmer group		✓	
The role of the field extension officers	✓	✓	
The role of researchers		✓	
Final decision maker	✓		