Choice and uncertainty in a semi-subsistence economy

Promotor: ir. A. Franke, emeritus-hoogleraar in de ontwikkelingseconomie

Co-promotor: dr.ir. H.A. Luning, hoogleraar Survey Integration for Development aan het International Institute for Aerospace Survey and Earth Sciences (ITC)

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A. Huijsman

Choice and uncertainty in a semi-subsistence economy

A study of decision making in a Philippine village

Proefschrift

ter verkrijging van de graad van
doctor in de landbouwwetenschappen,
op gezag van de rector magnificus,
dr. C.C. Oosterlee,
in het openbaar te verdedigen
op vrijdag 16 mei 1986
des namiddags te vier uur in de aula
van de Landbouwhogeschool te Wageningen

Risk is like love. We have a good idea of what it is,
but we can't define it precisely.

Joseph Stiglitz

STELLINGEN

1. Dat armoede leidt tot het vermijden van risiko's is in z'n algemeenheid onjuist.

   (Dit proefschrift)

2. Het risiko-onderzoek kan weinig bijdragen aan een verdieping van het inzicht in het funktioneren van boerenhuishoudens zolang de mate van risiko-aversie van boeren centraal staat in plaats van de vraag in hoeverre boeren effektief kunnen inspelen op onzekerheden in de landbouw.

   (Dit proefschrift)

3. In het bestuderen van de reaktie van boeren op risiko's in de landbouw dient een nadrukkelijk onderscheid gemaakt te worden tussen enerzijds fysieke opbrengstrisiko's van de afzonderlijke landbouwaktiviteiten en anderszijds de financiële gevolgen van deze risiko's voor het huishouden.

   (Dit proefschrift)

4. Het opnemen van risiko-kriteria in de beoordeling van nieuwe technologie mag niet leiden tot het te snel terzijde schuiven van een winstgevende technologie, die op het eerste gezicht riskant lijkt.

   (Dit proefschrift)

5. If the degree of risk (of new production possibilities) is measured by the possibility of disaster, it is the relatively poor who carry most of the risks, and the relatively wealthy who gain most of the benefits.

   J. Weeks (1972), Uncertainty, Risk, and Wealth and Income Distribution in Peasant Agriculture. Journal of Development Studies, Vol. 7: 28-36.

6. In de toepassing en verdere ontwikkeling van ekonomische modellen betreffende besluitvorming onder onzekerheid dient men ervoor te waken dat het middel niet tot doel verheven wordt.

7. De levenscyclus van het boerenhuishouden is een onmisbare variabele in het bestuderen van de bedrijfsvoering en de adoptie van arbeidsintensieve of -besparende technologie.

   (Dit proefschrift)

8. Het uitgaan van hypothesen, geformuleerd vóór het onderzoek, roept, althans bij de maatschappij-wetenschappen, het gevaar op dat alleen feiten passend bij de uitgangshypothesen worden opgemerkt. Juist niet-passende feiten kunnen een nieuw licht werpen op de onderzoeksvraag.

9. Het experimenteren met en ontwikkelen van nieuwe produktiemogelijkheden is niet voorbehouden aan rijke boeren.

   (Dit proefschrift)

10. De mate waarin boeren zelf bijdragen aan de ontwikkeling van technologie wordt vaak aanzienlijk ondergewaardeerd. Essentiële aanpassingen van nieuwe technologie aangebracht door boeren worden vaak niet opgemerkt. Bovendien wordt technologie, ontwikkeld op basis van ideeën van boeren, soms door onderzoekers c.q. onderzoeksinstellingen geclaimed als resultaat van eigen onderzoek.

11. Een praktische kennis van de uitoefening van de landbouw is voor een onderzoeker in de maatschappij-wetenschappen van groter belang dan een wetenschappelijke kennis van de plantenteelt.

12. De effektiviteit van voorlichtingsdiensten in ontwikkelingslanden kan aanzienlijk verhoogd worden indien voorlichters een aktieve rol zouden spelen in het stimuleren en begeleiden van boeren bij het uitvoeren van eenvoudige proeven op het eigen bedrijf.

13. Het gezegde 'een gegeven paard mag men niet in de bek kijken' gaat niet op voor hulp verstrekt in het kader van de ontwikkelingssamenwerking.

14. Ook de anti-bont beweging in Nederland kan het te bont maken.

A. Huijsman
Choice and uncertainty in a semi-subsistence economy.
A study of decision making in a Philippine village.
Wageningen, 16 mei 1986

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PREFACE AND ACKNOWLEDGEMENTS

For most countries in Southeast Asia, agricultural growth is a prerequisite for overall economic development. Apart from providing the main source of employment and livelihood of the majority of rural households, the agricultural sector is expected to produce sufficient surplus to feed the growing urban population, to save foreign exchange by reducing the need for food imports as well as to earn foreign exchange by exporting agricultural products.

For the Philippines, Luning (1981) indicates that until 1960, agricultural growth was primarily based on extending the land frontier with little change in cropping intensity, change in technology and total factor productivity. Thereafter, a shift has occurred to land use intensification in response to an increasing population pressure against constraining land resources. Land use intensification may occur without changes in the basic crop production technology through improvements in existing agricultural practices or from the introduction of additional crops on the same piece of land. It may also involve basic changes in crop technology introduced from outside the farming community such as new seed technology or irrigation. Apart from increasing physical agricultural output, households may increase <u>their</u> returns from land through a more effective use of household resources, thus limiting payments to non-family owned factors of production.

In the past decade, much attention was paid to increasing agricultural production through the introduction of new crop production technology consisting of packages of improved seeds, artificial fertilizers, and crop protection inputs such as pesticides and herbicides as well as improved crop husbandry practices. In particular during the initial stage of the so-called 'Green Revolution', the adoption of the 'seed-fertilizer' technology was slow and highly skewed towards irrigated areas and supposedly to the richer segment of the farmer community. Among the most cited reasons causing this adoption pattern are the high investment costs associated with the technology as well as the much higher risks involved compared to the existing production technology. Because of their limited risk taking capability, poor households were considered not to be in a position to take advantage of the institutional credit facilities that were usually offered to overcome budget constraints. Also, a more general conservative attitude of farmers towards risk taking was considered to impede the technology adoption process.

Against the above background of land use intensification, this study attempts to assess the impact of environmental uncertainty and associated risks on choices of small farm-households that depend on rainfed rice production as their main source of income. In particular, the issue will be addressed whether resource-induced risk aversion hampers the intensification of rice crop production in rainfed agriculture, thus worsening the relative - and possibly absolute - income position of poor households.

Apart from considering the risk issue in agricultural development, attention will be paid to the theory and methodology of risk analysis. Risk analysis for small-scale agriculture is still highly theoretical and has not yet been adequately tested for its practical usefulness. Consequently, the character of this study is explorative. In developing techniques and models of risk analysis, agricultural economists have primarily concentrated on risk in terms of outcome variability of production activities and on ways to incorporate such additional choice criterion in the convential framework of economic optimization, thus without altering the basic structure or design of the decision model. Because of the biased research attention towards the construction and testing of rather abstract models of choice under uncertainty, insufficient consideration has been given to how farmers themselves approach and perceive risk, and how they incorporate risk considerations in farm-household management strategies. Much less attention is focused on the inherent more complex issue as to how learning (e.g. through experimentation or information gathering) affects choices and choice procedures. Most economic studies cast their analyses of risk in an essentially static environment where changes in technology or institutions are (implicitly) not taking place.

In carrying out this study and writing the thesis I relied on the support and help of various persons whom I would like to thank here. Foremost, I want to express my gratitude to all people of the study village who for a period of two years generously offered hospitality to my wife and me, and were most considerate in taking time to respond to our numerous questions. In particular, without the outspoken and sustained contribution of the case-study households this study would not have been possible. Further, I wish to thank Manang Ason and Miss Ofelia Alingalan on whose unselfish help in coming to grasp with daily life in the village we could always rely. Also the excellent support of Miss O. Alingalan together with Mr. M. Genesila in the collection and processing of field data is gratefully acknowledged.

Sincere thanks are expressed to Prof. Ir. A. Franke and Prof. Dr. H.A. Luning, who have guided and supervised this thesis. Prof. Franke taught me that understanding farmers' choice behaviour can only come from careful observation and an open mind, and thinking twice before knowing better than farmers.
Prof. Luning, with his enthusiasm and genuine interest in research concerning the economics of small-scale agriculture, induced and further stimulated me to undertake this study. I also wish to thank my wife Lyda Res, who as a colleague and fellow researcher critically followed this study and provided me with valuable insights in matters concerning farm-household decision making, particularly with respect to the role of women and children.

At the International Rice Research Institute, a number of people have contributed to this study. In particular, I wish to thank Dr. E.C. Price, who has guided and supervised this study in the Philippines. Dr. H.G. Zandstra and Dr. F.R. Bolton allowed me to use their water balance simulation model and contributed to the development of this model into a cropping pattern simulation model. They further made valuable comments on observations concerning rice agronomy reported in this thesis. Also Dr. R.A. Morris and Dr. D.P. Garrity made valuable comments in these fields. With Dr. M. Kikuchi I had intensive discussions regarding the structure of the village economy and benefited from his experience in carrying out village studies in irrigated areas. The development of an econometric risk assessment model benefited considerably from the stimulating criticism of Dr. K. Kalirajan. Finally, Dr. S. Jayasuriya and Dr. G.E. Goodell stimulated me with their viewpoints and challenging criticisms on economic and anthropological aspects of the study.

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SUMMARY

This study deals with the response of Philippine rice farmers to uncertainties and associated risks in the production environment. Farmers' risk behaviour is analyzed within the context of land use intensification through the adoption and utilization of the so-called 'modern seed-fertilizer' technology. This technology has been criticized for its capital intensity and high riskiness compared to existing technology. Among others, farmers' aversion to take risks has been suggested as a possible factor explaining slow adoption rates of poor farmers. In order to investigate the impact of risk on decision making, a distinction should be made between (1) farmers' attitudes towards risk taking, i.e., the possibility that they are unwilling to take risks and to invest in risky but profitable technology causing an overall underinvestment in agricultural inputs and misallocation of resources and/or; (2) the farmers' inability to invest in risky technology because of a limited risk taking capacity leading to an unequal distribution of benefits derived from new technology among the rich and poor strata of the rural economy.

Conceptual issues and practical problems in analyzing the influence of risk and uncertainty on farm-household decision making are discussed in Chapter 3. A critical review is presented of various theories concerning risky decision making. The general conclusion is that none of these theories have yet been tested to the extent that they can be used as an adequate framework for examining the occurrence of farmers' risk aversion and assessing the impact of risk on decisions.

Chapter 4 describes the historical process of land use intensification in relation to population growth. It shows that the introduction of the 'modern' IRRI-released rice varieties (IR-varieties) and double rice cropping is just a new phase in a continuous process of land use intensification that started in the mid 1940s with the closing of the land frontier in the rice lowland area. Compared to their predecessor BE-3 - now considered a traditional rice variety - the adoption of IR-varieties has been relatively quick. However, adoption at an appreciable scale did not take place until farmers themselves - through various cultural adaptations - had augmented the attractiveness of growing IR-varieties under rainfed conditions.

The new rice technology allowed a more effective use of family labour resources, and augmented the income of individual farm-households. However, due to changes in the labour utilization pattern induced by this technology and the introduction of labour saving technology (rice threshers), job opportunities in the village did not increase, whereas income sharing between the poor and somewhat wealthier households declined and the economic position of women deteriorated. In the process of land use intensification, the overall risk that farm-households face has

increased. The present land utilization pattern is characterized by intensive cropping systems on relatively small farm areas that have become strongly dependent on external inputs. The capacity of risk spreading between agricultural activities has become limited, whereas the overall financial risk of crop production has increased.

The majority of development programmes imposed upon the village community during the 1970s, did not contribute much to farmers' efforts to intensify rice crop production. Instead, they created an atmosphere of uncertainty and were counterproductive to the needs and economic development of households.

In order to investigate the effect of risk on the household's ability to take advantage of the new crop technology, farm-households were classified according to their sensitivity to income risks (Chapter 5). Two classification variables were employed: (1) the subsistence coverage factor indicating the household's capacity to generate a surplus income above basic subsistence requirements through crop activities, and (2) the family life cycle stage which among others determines family labour availability and the capacity to timely control crop production risks.

Patterns of farm resource utilization, household income formation and consumption expenditures are analyzed in Chapter 6. Household categories differ substantially with respect to their ability to improve upon living conditions and risk taking capacity. In sharp contrast with surplus households, for non-surplus households there is hardly any room to cut back on household expenditures or create reserves. Forced by short-term subsistence pressures during the lean month period, young non-surplus households have to employ their scarce family labour resources on activities that provide immediate income affecting labour investments in self-employed agriculture. With a higher worker to consumer ratio, middle-aged non-surplus households are able to devote much more family labour to self-employed agricultural activities while at the same time providing for short-term income requirements through wage labour activities. In fact, these households face serious problems in finding remunerative employment for all their family labour resources. The possibility of increasing labour input in individual rice crops is economically marginal, whereas off-farm employment opportunities are limited.

Compared to surplus households, non-surplus households show low productivities per labour hour mainly due to a lower level of cash input investments. The necessity to use credit to sustain subsistence and education expenses affects the capacity of non-surplus households to invest in productive activities and induces them to credit rationing. Interest payments on loans acquired in poor production years usurp a substantial part of the income above basic subsistence needs realized in good production years. The middle-aged non-surplus households have to use income for the education of children in order to safeguard long-term security.

In Chapter 7 the relationship between the household's risk sensitivity and the adoption of double rice cropping is investigated. Households differ with respect to the perceived risks of double rice cropping due to differences in risk control capacity resulting from differences in family labour availability and financial position. They also differ with respect to the need to intensify rice crop production. The importance of the family life cycle - a variable commonly lacking in adoption studies - on adoption behaviour is indicated. This factor may cause cyclical dynamics in technology utilization patterns, i.e., households may gradually change management orientation and pattern when moving from one life cycle to another. The adoption process shows that experimentation is a major tool of farmers to reduce uncertainty and that - in contrast with a commonly held belief - experimentation with new crop technology is not a prerogative of wealthy farmers.

Farmers' decisions with respect to the use of fertilizer in rice crop production are discussed in Chapter 8. An attempt is made to quantitatively assess the relative importance of resource-induced risk aversion as opposed to the farmers' risk taking willingness, and farmers' fertilizer response perceptions as opposed to risk aversion. Difficulties encountered in quantifying the various parameters playing a role in such an analysis are discussed. Fertilizer response under farmers' conditions are estimated and the risk of fertilizer application is empirically assessed. The farmer's perception of fertilizer response turns out to be strikingly similar to empirical estimates. In contrast with response perception and risk taking willingness, resource-induced risk aversion appears to be an important variable explaining differences in fertilizer application levels among household categories. However, perceptions and risk taking willingness are important in explaining differences between individual households.

A summary of the salient features of the farmer's choice processes and a synthesis of major findings concerning farmers' risk behaviour is presented in Chapter 9. The study arrives at the overall conclusion that it is dangerous to base risk analyses on superficial observations and generalize about small farmers' risk behaviour. First, many farmers' production strategies and practices - often erroneously identified as resulting from risk averse behaviour - serve the dual purpose of reducing risk and attaining best economic results. Such strategies result from (1) cautious optimization over a certain period of time based on adaptation to changes in internal household conditions and external circumstances, search for improvements, and experimentation and; (2) sequential choice procedures and risk control within years based on adaptation to chance constraints and opportunities as they evolve in the course of a production cycle. They allow for an optimum use of environmental resources and are thus sound economic practice.

Second, risk is not a well defined concept. It describes various types of uncertainty (e.g. yield vs. financial risk), whereas the degree of riskiness of activities depends on the risk taking capacity of households, comprising both the ability to timely control crop production risks through labour investments and the capacity to bear financial risks. Hence, crop production risks are not the same for different types of households, whereas financial risk is likely to differ between time periods. Within an apparently homogeneous group of small farm-households, differences in financial risk taking capacity and resource composition are such that households perceive different production risks as well as financial risks to similar activities, and thus show a different response to risks in agricultural production. Moreover, for the same household there may exist a conflict of interest between risk reduction in the short and medium term and in the medium and long term. Thus, without specifying the type of risk as well as the period and conditions under which decisions are made, it cannot be evaluated whether risk deters investments in inputs or adoption of technology more for one category of households than another. From a production point of view, farmers simply cannot be classified as risk seekers or risk averters. In fact, the same farmer may fit both categories.

Farm-households are used to risk taking in agriculture. They are generally not much interested in stabilizing agricultural output if such implies an even moderate reduction in perceived income. It is not so much the perceived production risks in agricultural that influence choice behaviour of poor households, it is the need to opt for particular income earning activities that secure immediate subsistence needs and limit the impact of financial risks on subsistence security. In order to keep financial risk at a manageable level, households have to ration credit use and limit financial investments in agriculture. When risk-induced underinvestment occurs, it is caused by the limited capacity of poor households to take financial risks rather than by their risk averse attitudes. Given the continuous indebtedness of non-surplus households, perceived financial risk may constitute a serious cause for underinvestment in agriculture and widening income disparities between poor and wealthy households.

1 INTRODUCTION

Since the early 1960s, choice behaviour of small (semi-subsistence) farmers - traditionally considered the domain of mainly anthropologists and rural sociologists - was increasingly paid attention to by agricultural economists studying agrarian change processes in developing countries. This followed from the recognition that small farmers constituted a major segment of the agricultural producers and thus would determine, in part, the pace of agricultural development. It led to increased efforts of economists to study the specific character of (semi-) subsistence agriculture in order to identify possible ways of integrating this sector into the mainstream of overall economic development (Wharton, 1969). In 1965, during a major conference on subsistence agriculture, Mosher (1969) unequivocally summarized the then current opinion concerning the basic requirement for such change process to occur:

> For agricultural development to take place, it is essential, among several other necessities, that farms become less and less subsistence and more and more commercial, producing increasingly for the market. (Hence), it is essential that we learn more about what motivates subsistence farmers at the present time and what new influences can be brought to bear to help them move toward greater commercialization of their farming. (Further), the faster those now engaged in subsistence agriculture increase their productivity and move more and more into commercial operation of their farms, the greater the demand for industrial goods will be and the faster the total economy can grow.

Initially, it was assumed that an increase in production from the small-scale farm sector could be attained through a more efficient use of existing resources and technology. This policy orientation logically followed from the then widely held view that small farmers were technologically backward, had deficient entrepreneurial ability, and limited aspirations (Rogers, 1969). This image of small farmers is best summarized in the once colonial stereotype of 'those lazy natives who refuse to work for an income beyond what they require for their subsistence'. The idea of an economically inert small farmer population was, however, seriously challenged by Schultz (1964) in his pathbreaking essay 'Transforming Traditional Agriculture'. He and Jones (1960) were the early spokesmen for those who argued that farmers in traditional agriculture act economically rational within the context of their available resources and given the existing technology. Schultz arrived at the conclusion that underdeveloped agricultural communities - not just individual farmers - are <u>economically efficient but poor</u>. He derived his belief from the long constancy of traditional agricultural environments.

Although Schultz may have somewhat overstated the economic rationality thesis, i.e., that farmers allocate resources in a manner consistent with the neo-classical model of the firm, his work gave impetus to serious efforts in the specification of the technical and economic conditions under which farmers have to operate and the quantification of small farm production relationships. As indicated by Lipton (1968): 'Economists started to realize that the small farmer is no fool. A non-fool in a static environment learns to live efficiently: to optimize, given his values and constraints and to teach his children to do the same'.

The issue whether farmers were economically efficient producers had critical policy implications on agricultural development (Mellor, 1969):

> If there are significant disequilibria within the existing agriculture then presumably the total production from the existing set of resources can be increased through production economics studies and educational programmes. If, however, farmers are 'poor but efficient', a more substantial effort is needed. The burden of development is shifted to policies for changing the decision making environment. In addition to farmers, governments and institutions must be moved.

A large number of studies were undertaken to test Schultz's 'allocative efficiency' hypothesis usually consisting of cross-section production function analysis (Chennareddy, 1967; Massell and Johnson, 1968; Welsch, 1965; Yotopoulos, 1968). By and large, these studies concluded that within their technological and institutional constraints farmers were behaving like profit maximizers. However, much of this 'evidence' was later criticized on methodological grounds. On the basis of these findings, there was a growing consensus among agricultural economists that increased agricultural growth and poverty alleviation required basic changes in the agricultural production technology employed by farmers and/or a redistribution of resources (e.g. land) in rural areas.

At the start of the 1960s a number of international agricultural research institutes were established (e.g. the International Maize and Wheat Improvement Centre in Mexico (CYMMIT) and the International Rice Research Institute in the Philippines (IRRI)) with the specific aim of undertaking fundamental research (e.g. genetic research) into some of the world's major food crops such as maize, wheat and rice. At IRRI, established in 1962, a number of short-straw rice varieties were developed that were fertilizer responsive and showed - under good management practices and water supply conditions - a considerable higher yield level compared to the existing rice varieties used by farmers. By the end of the 1960s this technology was considered to be sufficiently developed and tested to be disseminated among farmers. In order to transfer this relatively cash-intensive technology to the large number of small farmers, massive government concerted extension and credit programmes were undertaken in many countries in the early 1970s.

1.1 The risk issue in agricultural development

The evaluation of the impact of these programmes on agricultural development has led to a substantial controversy among scholars and development planners which is well documented in the extensive literature on the so-called 'Green Revolution'. In particular, the argument evolves around the question whether the 'seed-fertilizer' technology has caused increased income disparities within and between rural areas. For various reasons, farmers' attitudes towards the risks associated with this technology has increasingly become a central issue in this debate.

First, because of its vulnerability to adverse climatic and biological conditions, the 'seed-fertilizer' technology has been particularly criticized for its high risk level compared to the existing technology employed by farmers. Under less favourable production regimes, the potential high production levels are often not realized rendering the required investment in cash or capital inputs such as fertilizer and machinery a risky undertaking. Thus, it is argued that especially resource-poor farmers - due to their limited risk-taking capability - are not likely to benefit from these new production possibilities. The idea that risk considerations may cause careful behaviour of poor farmers has led to the hypothesis that the profitable, but risky 'seed-fertilizer' technology may have increased income disparities between poor and rich strata of farm-households (Griffin, 1979, Weeks, 1970, Cancian, 1972).

Second, the increased commercialization of the rural economy partly following the increased use of cash inputs in crop production has been held reponsible for a rapid deterioration of local welfare institutions (Scott, 1976). It is argued that the process of commercialization allows individual farmers to increase their economic welfare without regarding the social consequences within the village: inequality with respect to social prestige, the characteristic of the original village structure, is replaced by inequality in economic position (Grijpstra et al, 1976). This process of 'individualization' causes a weakening of traditional welfare cushions and levelling mechanisms. This implies that resource-poor farmers face an increasing risk of food shortages in poor production years.

Third, it has also been argued that the rapid succession of new types of 'improved technology', coupled with the inherent tendency to become more complex with every new development, has led to an increasing lack of comprehension and control over new technology on the part of the farmer (Goodell, 1982). In particular, farmers with limited access to extension services or other sources of information are likely withheld from using such technology due to high perceived risk levels.

The recognition that farmers' aversion to risk may potentially impede agricultural development and cause increased income disparities in rural areas, has led to a growing interest in research on the influence of risk on farmers' decision making. In fact, the topic of farmers' risk aversion became quite fashionable in the last decade. To some extent, risk aversion has become a new variant in reconciling the differences between researchers' findings and farmers' practices:

> Before the work of Schultz (1964) it was common to conclude that when observed behaviour conflicted with recommendations generated from normative models, the discrepancy was the farmers' fault, i.e., that the farmer was either ignorant, stupid, lazy or irrational ...... Now that it has become the accepted practice to regard farmers as rational, it has become more popular to explain discrepancies by an appeal to risk aversion (Roumasset, 1976).

A tremendous body of literature has been accumulated in the field of risk research both at the theoretical and applied level. Despite these efforts, research progress in this area has been slow as indicated by recent review papers of Young (1979) and Robison (1982). The main difficulties stem from the lack of a satisfactory theoretical and analytical framework (Chapter 3), the development of which is seriously hampered by a lack of data that would allow empirical analysis of risk associated with agricultural production activities. There is no concensus on how risk as a concept should be defined to adequately represent farmers' feelings with respect to outcome uncertainty. Given the lack of knowledge in the field of risk perception, it is obvious that knowledge with respect to farmers' response to risk is equally limited. A part of the literature simply takes the existence of risk aversion for granted. Based on superficial analyses, it is common to observe in many kinds of traditional agricultural practices and institutions measures through which farmers attempt to reduce risk.

In contrast to the large research effort directed towards the measurement of farmers' risk preferences, economists have generally neglected research on risk perceptions. Risk attitudes are often (incorrectly) associated with permanence and thus are considered of analytical interest from a policy point of view, whereas perceptions of activity risks are specific to particular alternatives, location, and time. Although, a micro-economic theory including aspects of perception of prospects and processing of information is rapidly emerging, it is not nearly as well developed as theories concerning risk attitudes (Walker, 1981). In much of the literature, empirical outcome distributions are employed to represent the riskiness of options assuming that decision makers have similar perceptions.

Although a substantial effort has been made to measure the extent of farmers' risk aversion, these findings should be treated cautiously. The methods to elicit farmers' risk preferences are, to a large extent, unreliable, while the cause of risk aversion may easily be confounded. In this respect, Binswanger (1978) points to the difference between 'attitudinal risk aversion' and 'resource-induced risk aversion'. The former concerns the individual's <u>willingness</u> to take risks and is determined by the psychological make-up of the individual, whereas the latter concerns the <u>ability</u> to take risk and is determined by resource availability and access to additional means of production and consumption. This distinction is of critical importance to the design of agricultural policy measures. The underlying question is whether farmers are poor because they are less willing to take risks or whether they are more limited in their risk taking behaviour because they are poor.

If differences in behaviour are due to differences in attitudes, it may be argued that one should seek (a) to change attitudes or (b) to channel incentives and resources to those farmers whose attitudes are favourable to the desired changes. However, influencing attitudes of people, for example through educational programmes, is a difficult - if not impossible - task which at least requires some time to yield results. The second type of measures may result in increasing income disparities in rural areas. In the past, this type of policy orientation was often justified on the grounds that it maximizes returns to scarce resources in the short run, thus enlarging the total output available for further investment or income redistribution later on (Berry, 1980).

If, on the other hand, underinvestment in agriculture is caused by risk averse behaviour stemming from the farmer's inability to take risks, this would provide a distinct opportunity to design measures that will not only increase total output from agriculture but also directly improve the lot of poor farmers. In order to break through the perpetual cycle of poverty caused by resource-induced risk aversion, one would require measures from outside the community that increase the risk taking capacity of farm-households. This may involve channelling productive resources to poor households or measures that reduce the negative effect of risk taking such as insurance programmes, special credit programmes, or relief measures.

1.2 <u>Research approach and objectives</u>

From the above it may have become clear that it was difficult to arrive at well-formulated, testable hypotheses on which to base a research approach. Consequently, the study had a strong explorative character. It was hoped that through careful monitoring of household behaviour, new insights could be obtained in the course of the research project that would allow subsequent testing on the basis of empirical data.

In the design of the study we have attempted to do justice to the complexity of farm-household decision making. As much as possible, risk was treated as just one variable in the decision making of farmers. The analysis focused on the extent to which different categories of small rural households in a rainfed rice production area in the Philippines were able to adapt to conditions of a worsening man/land ratio through the adoption of new crop and crop input technology.

Within this context, research objectives specifically related to the role of risk in agricultural decision making are:

- How do individual households, in addition to other decision variables, respond to the risks associated with agricultural production as well as maintaining an acceptable level of living;
- To what extent do risk considerations of farmers affect the economic efficiency of agricultural production;
- Does risk taking behaviour differ between households with different resource endowments;
- How do demographic and agrarian change processes affect the level of agricultural risk and the risk taking capability of households.

It was expected that, on the basis of results derived from the above analysis, it could be assessed whether the importance of risk warrants the considerable research resources required to carry out proper risk research. And if so, whether the impact of risk can be sufficiently pinpointed to specific decision fields and/or types of farm-households to allow the formulation of policy measures to alleviate the effect of risk. Hence, derived research objectives concerned the following questions:

- What is the scope for risk analysis within the context of small- scale agriculture;
- To what extent can risk specific policy measures be expected to diminish possible negative effects of risk on agricultural development.

1.3 Thesis outline

The outline of the thesis is as follows. Chapter 2 deals with the design of the field study and the methods of data collection used. Chapter 3 contains a review of literature and an assessment of the present 'state of the art' concerning choice theory and risk analysis related to small-scale agriculture.

Chapters 4 to 8 deal with a village-level case-study concerning decision making of rural households operating rice-based farming systems under rainfed conditions. Chapter 4 provides a brief historical description of the relationship between land use intensification and population growth. Chapter 5 deals with the structure and organization of the farm-household system. The various activity fields covering the different aspects of household management related to both consumption and production activities will be discussed. This will be followed by a detailed description of household resources and income earning opportunities. This chapter is concluded with a classification of farm households according to their sensitivity to income risks. In Chapter 6 differences between categories of households with respect to the utilization of scarce resources are analyzed. On the basis of an in-depth analysis of income and expense flows, an attempt is made to delineate short- and long-term risk management strategies of households. Special attention will be paid to the allocation of resources between productive and consumptive uses.

Chapter 7 and 8 are concerned with two case-studies of specific aspects of household decision making, both related to agricultural production. Chapter 7 deals with decisions regarding the choice of rice production activities. It starts with an assessment of farmers' risk control in rice crop management. Within the context of the introduction of double rice cropping, it will be analyzed how different categories of farmers respond to innovation risk. Chapter 8 concerns farmers' decisions with respect to the use of fertilizer in rice crop production. Here we will specifically deal with the difficulties in quantifying the various parameters that play a role in the analysis of risk in decision making. An attempt is made to estimate the risk attached to fertilizer use. Problems encountered in quantifying subjective decision parameters such as risk attitudes and perceptions are discussed.

Chapter 9 contains a synthesis of major findings and reviews implications for agricultural research and policy.

2 RESEARCH METHOD AND STUDY DESIGN

Investigating the role of risk in farmers' decision making means primarily dealing with the following two issues:

- how farmers tend to perceive the risks associated with income earning activities (both agricultural and non-agricultural) and household income management strategies;
- how they weigh the importance of these risks against the importance of other attributes of choice options or strategies.

Both questions are closely interlocked with the more general issue of how farmers approach decision problems. These research issues are inherently difficult to analyze because they relate to the inner feelings of people, and as such do not allow for a relatively straightforward research strategy based on direct questioning procedures.

2.1 Research approach

In the economic literature, two ways of investigating the rationale behind individual decision making are suggested. The first approach starts from hypotheses based on the economic rationality of individual decision making. It tests their validity by comparing the predictive power of alternative choice models based on such hypotheses. As indicated by Gladwin (1979), this approach determines how closely the behaviour studied conforms to researchers' hypotheses about farmers' decision rules. The advantage of this approach is that it gives a clear direction to research. However, in case a theoretical framework is lacking on the basis of which hypotheses can be formulated, this approach may at best provide a time-consuming, iterative research methodology. In the worst case, it may identify erroneous causal relations due to a wrong or incomplete specification of the model.

The second approach reverses this process. Instead of hypothesizing decision procedures that allow optimization and test whether predicted results conform to actual behaviour patterns, this approach focuses on the issue of how farmers actually do arrive at decisions. This behavioural approach to decision making explicitly recognizes man's limited ability to process information and solve complex problems. Through close observation of farmers' decision making processes, it attempts to identify what type of choice criteria farmers employ in what kind of situations, and whether the importance attached to certain choice criteria differ for different types of households. It is the premise of this approach, that, on the basis of such understanding, a more general theory of choice can be developed. As major advocates of this approach, both Simon (1979) and Day (1979) argue that such research strategy will not only lead to a better descriptive theory of choice, but may also improve our ability to identify and prescribe better solutions to choice problems farmers are actually facing in the real world.

In this study, we opted for the latter approach because of lack of a satisfactory theoretical framework on which to base relevant hypotheses concerning choice behaviour of rural households near the subsistence level of living. In fact, it appears that due to the predominant use of the first approach, the development of such theory has been impeded rather than stimulated.

The behavioural approach to the analysis of decision making is somewhat alien to the agricultural economist. However, it has been extensively used by economic anthropologists. As indicated by Barlett (1980), it involves a sequence of the following steps:

- Careful description of current household strategies to attain a livelihood and the diversity within those strategies between individual household units;
- Determination of the variables and conditions creating and reinforcing those diverse strategies;
- Clarification, if possible, of the weight of some variables over others;
- Prediction of the future directions and the long-term implications of those choices as they affect both current and long-term processes of agricultural change.

Applied to the present research problem, this approach was employed to reveal decision criteria and management principles through: (a) identifying contrasts in behaviour patterns between individual households and to relate such contrasts to differences in household characteristics; (b) for individual households, analyzing changes in behaviour over time - within and between years - as well as deviations between planned and actual behaviour, and to relate them to changes in the decision making environment.

Once such relations are identified it may be possible to derive more general behavioural principles related to such aspects as resource availability, life cycle stage, differential access to information or development institutions, etc. The obvious weakness of this approach is that it only allows for the identification of differences in household behaviour patterns. Since we are also interested in determining the economic costs associated with the strategies followed by households, economic optimum solutions to choice problems were, in as far as possible, also determined. As will be indicated in subsequent chapters, except for relatively simple choice problems such as fertilizer application (Chapter 8), determination of economic optima is generally difficult, particularly for dynamic choice situations.

Thus, the farm-household unit was chosen as the basic unit of analysis and the actual behaviour pattern and underlying decision making process of these units were taken as starting points of the study. Apart from essential information on how to model the choice process in order to test the risk aversion hypothesis, it was expected that through such an approach the time-consuming, quantitative analysis of activity risks could be more adequately directed towards those decision problems where it mattered most. A description of the structure and organization of the farm-household system will be provided in Chapter 5.

To cover as much as possible the different fields of household decision making, the study focused on the following decision making areas:

- crop choice and resource allocation within the farm;
- crop management and cash input level choice in rice crop production;
- labour allocation between own farm activities and employment as a wage labourer;
- allocation of resources between productive investments and consumptive expenditures.

Although there are clear analytical disadvantages in following a case-study approach involving a limited number of farmers (e.g., sampling errors, problems with statistical inference), it was decided, for the following reasons, to study a small group of farm-households within one village during a sequence of years. First, an adequate analysis of decision making as a process necessitates close monitoring of choice behaviour and in-depth interviewing of farmers with respect to the reasoning process behind decisions. Second, to evaluate adoption decisions and to properly assess the consistency of choice patterns in uncertain choice environments several years of observations are required. Third, to understand behaviour of individual households as part of the wider community setting, an in-depth analysis of the social and economic environment directly affecting choice is needed.

Although, as will be indicated below, in the selection of the village and case-study households, serious attention was paid to whether they were representative for other villages in the area and typical categories of households, care should be taken to extrapolate results to the larger population. It should be realized, however, that the main focus of the study is to understand general features of farmers' risk behaviour and assess whether research methodology in this field is adequate. Within this context, observation errors are more serious than sampling errors.

2.2 Selection of the study location

A study location was selected in close proximity to a research site of the 'Multiple Cropping Programme' of IRRI located in Iloilo Province. This province is one of the major rice growing areas in the Philippines most of which is grown under rainfed conditions (Luning, 1981). At the IRRI-site a number of profound changes were taking place in the existing rice crop production system. In particular, the availability of short-maturing rice varieties developed at IRRI (henceforward named IR-varieties) made it technically feasible to fit two sequential rice crops in the rainfall pattern of the area. However, the risks associated with this cropping pattern were thought to be substantial, both for the first rice crop that required dry-seeding (viz., drought stress during the seedling stage) and the second crop (viz., drought stress during the reproductive growth stage). Despite these risks, it appeared that, to some extent, adoption of double rice cropping was taking place.

Further, at the time this study started, a research project was in progress concerning the simulation of crop growth - water balance relationships of rice crops based on data collected at the IRRI-site. This simulation model showed a promising potential to be employed as a means to assess production risks of rainfed rice crops which was considered important in view of the general lack of data on which to base an adequate risk assessment.

It was, however, decided not to select a study location within the IRRI research-site itself because of the extended period (4 years) farmers in this area were exposed to researchers and on-farm experimentation which could have biased their responses to interviews. Moreover, it could have induced an a-typical pattern of agricultural development. The selection of the study village was based on the following criteria:

. Rainfall-dependent rice production had to be the major economic activity of the selected location which had to be representative for other rainfed rice growing in the Province. Close proximity to an irrigated area or the existence of small (partially) irrigated parts in the study site were considered beneficial from a research point of view as it would provide the opportunity to compare rainfed rice production conditions with irrigated conditions.

. The rainfall pattern and physical production conditions (soils and topography) had to be similar to the IRRI research-site to facilitate the use of the above mentioned simulation model. Further, close proximity to this site would facilitate logistic support. On the other hand, the distance between this site and the selected study area had to be great enough to guarantee no technology transfer.

. In order to investigate adoption decisions and the importance of innovation risks, the aim was to find a location where, to some extent, changes to new rice production technology were taking place and/or where government development programmes were (or had been) initiated.

. The village had to be of medium size and have an access position to town markets and urban centres similar to the majority of villages in the province.

In a first reconnaissance survey, five potential study locations were visited four of which in Iloilo Province and one in the neighbouring province of Antique. A second visit was paid to three of these sites together with members of the research staff of the IRRI outreach-site and local extension officers on the basis of which the present research location was selected.

The selected village is a predominantly agricultural community located 24 km northwest of Iloilo City. It is one of the 43 villages (barrios) of the municipality of Alimodian. It is situated along a 7 km unpaved municipal road which connects two rural market towns (Map 1). At both ends, the road is intersected by a river which frequently overflows during the rainy season, temporarily cutting off the village main connection with the outside world. Twice a day, regular transportation to Iloilo City is provided by a small local truck (jeepney). No other means of transportation are available and commuting to the nearby towns is on foot. The village comprises 125 households most of which are engaged in self-employed agriculture or a combination of self-employed agriculture and wage (mainly agricultural) labour. Only a small number of households is landless.

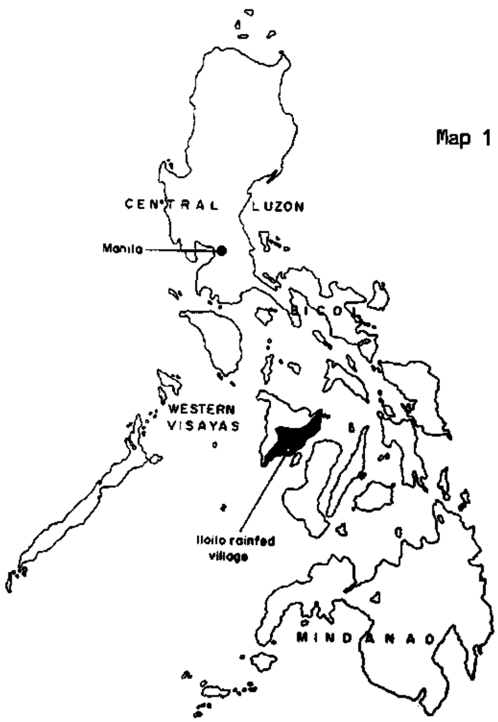
This community is close to the IRRI research-site but has no direct contact with it. It is a strictly rainfed area with a small portion irrigated by natural wells. At the start of the study, a few farmers were experimenting with double rice cropping using IR-varieties. Further, it can be considered representative for an extensive belt of rainfed rice area which lies in-between the marine plain located in the southwest part of Iloilo Province and a mountain range which extends from the south to the north on the west side of Panay-island. This area is characterized by foothills and miniplains allowing the cultivation of both upland crops and rice.

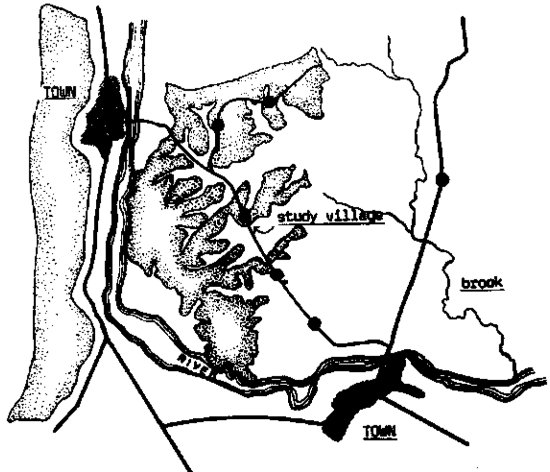
2.3 Selection of case-study households

On the basis of a village census, held in March 1979, 25 farm-households were selected. This census included questions on household composition; the number, location, and estimated size of fields cultivated and/or owned as well as their landscape position and tenure status; for each field the main cropping pattern and crop yields (or cash returns); and an inventory concerning farm and household assets.

Selection of households was carried out through stratified sampling. The sample frame was sub-divided into six groups on the basis of a wealth status index and stage in the family life cycle. Both these household characteristics were expected to have a major influence on household decision making and farm management strategies. The wealth status can be expected to determine, to a large extent, the risk taking capacity of households. The life cycle stage determines the farmer's experience with agriculture and is likely to influence family labour availability and

Map 1 Location of study village





scale 1:70,000

expenditure patterns. Excluded from the sample frame were: landless households, older households not active in farming, and households primarily dependent on non-farm sources of income. Sampling of households was not fully random because not all sampled farmers were willing to participate in the time-consuming daily recording of crop input-output data.

On the basis of the data collected through the village census, it was difficult to arrive at a stratification of households according to a relative wealth status index. The main determinant of potential wealth - area cultivated and/or owned - was based on farmers' estimates and as such to some extent unreliable. Apart from this problem, area size was possibly a poor indicator of production potential given the substantial variation in land quality. Further, it turned out to be difficult to get reliable estimates on additional income derived from livestock production and non-farm sources. Hence, only a rough classification into high and low income households could be made on the basis of land area and gross crop production per capita. A consistency check was made with other wealth indicators such as the quality of the house, the presence of productive assets (rice mill, rice threshers, draught animals) and consumer durables (radio, television, furniture), and the amount of rice in stock. Moreover, after households were classified, a further consistency check was made with a classification compiled by one of the research assistants - who is a resident of the village - which was based on a subjective ranking of households from high to low wealth status. At a later stage in the study, a more precise measure of wealth was determined on the basis of accurate field measurement and including differences in land productivity (Chapter 5).

The definition of a life cycle stage index did not pose any specific problems. Three phases in the developmental cycle of a household were distinguished on the basis of the age of children and their potential participation in the labour process (Chapter 5). Apart from this discrete classification, a continuous ranking index was developed which - apart from the above criteria - included as additional criteria (a) the duration a household was within one of the above defined life cycle stages and (b) the number of years of marriage.

2.4 Data collection

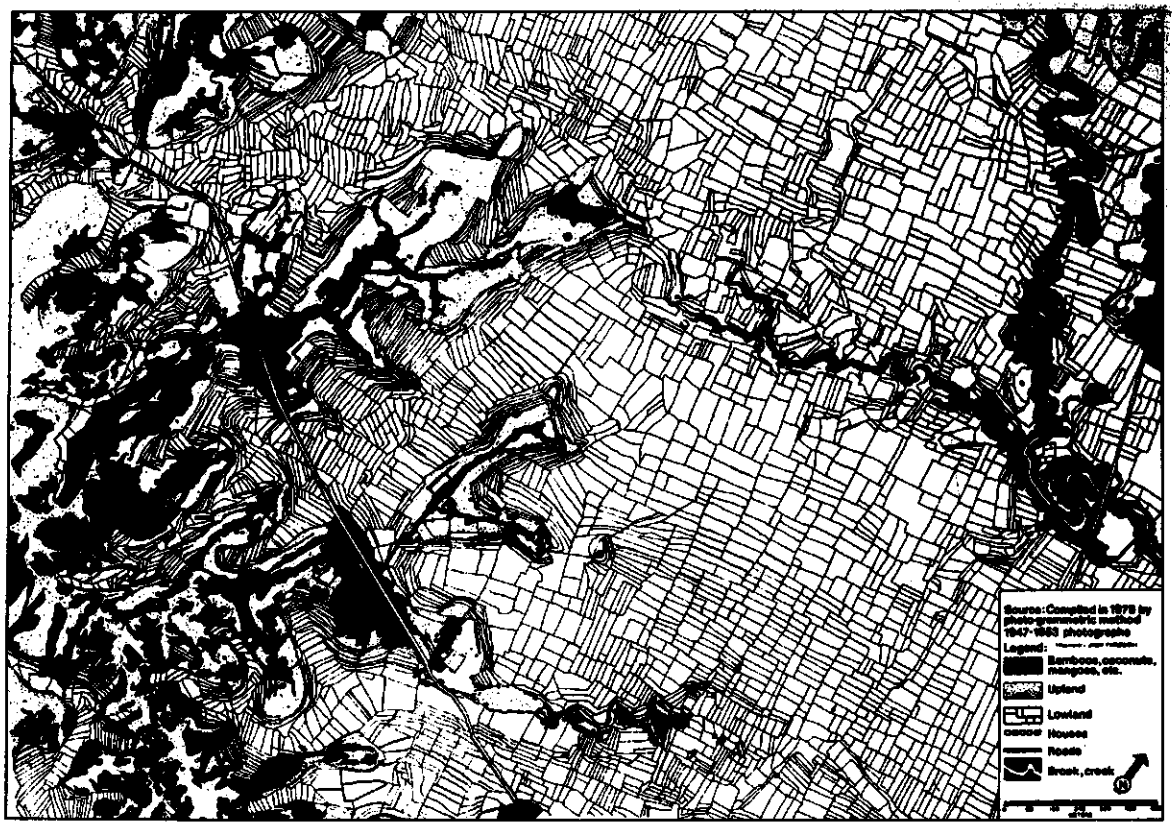
Directly following the selection of the 25 case-study households, an in-depth benchmark survey was held concerning farm management in the previous crop season of 1978-79. For individual crops, data were collected on planting and harvesting date(s); labour use by operation broken down into family, hired, and exchange labour; type and amount of other crop inputs used such as fertilizer and pesticides; type of harvesting arrangement and amounts harvested; and farmers' opinion about the yield as well as main factors causing low yields.

At the same time, a rough sketch of the farm was made indicating the approximate location of all individual parcels (continuous areas of similar land quality and tenure status), their distance from the homestead, as well as the shape of both the parcel and the individual boxes (small plots surrounded by bunds) within each parcel. Further, the tenure status of parcels was recorded, the type of soil, the landscape position, the number of years cultivated, as well as specific problems related to the cultivation of each parcel. Soils and landscape positions were classified according to the local nomenclature. After the benchmark survey was completed, parcels were measured up to the individual box sizes by an experienced research assistant from the IRRI research-site. At a later stage, the location of parcels could be exactly determined on a detailed area map compiled from aerial photographs (Map 2).

After the benchmark survey, the group of 25 case-study households was intensively monitored during a period of three years, from April 1979 until March 1982. A daily recording system was designed to monitor farm management activities and record crop input-output data. For the first year, farmers were given a daily record form each week (stated in the local dialect) on which: management operations could be indicated for each crop together with the time spent on every operation specified for different types of manual labour (husband, wife, children, hired, exchange) as well as draught animal and machine use; cost of hired labour; type, amount and cost of other inputs applied; and the amounts harvested and output prices received. Initially, all farmers were assisted in filling out these forms, but gradually most of them were able to do so by themselves.

In order to check the accuracy of the recordings, data from the daily record sheets were directly transferred to crop budget forms on which calculations were made on a per hectare basis. They were checked against standard time budgets for the various crop operations (high and low requirements specified by crop and soil type) based on a group-concensus of a number of farmers. In case recordings deviated too much from the standard operation time, the recording was re-checked with the farmer.

After the first year of monitoring, the format of the daily record form was changed to a more structured design. For each parcel, farmers were given a separate sheet consisting of a matrix with the columns representing the days of the month and the rows representing the boxes of a parcel. Farmers were requested to mark every operation on the specific day and box such operation was carried out by using pre-coded abbreviations of the local word for the various operations. The bottom rows were reserved for the usual information on the time and cash spent on labour and other crop inputs as well as crop output recordings. This format allowed an easier check on whether the usual crop care operations were included in the form and also facilitated an easier and more timely transfer of data to the crop budget sheets.



Map 2 Land utilization map

Each year, before the start of the crop season, farmers were asked for their farm plans for the coming season. For each parcel, questions were asked about the planned cropping patterns, including planting and harvesting dates; fall-back strategies in case of a late onset and/or early decline of the rainfall season; and planned input levels. In the course of the crop season, actual farm operations were plotted on a cropping system chart indicating crop areas, and date and type of operations for all parcels. Unexpected deviations from the farm plan were discussed with farmers, and biweekly yield expectations of farmers were used to keep in touch with their feelings regarding the status of their crops.

A less intensive survey method was used to record household income and expenditure data. The first year involved a back-recording survey carried out in February 1980. Monitoring of income and expenses did not start earlier because of problems that were expected when asking such sensitive questions at an early stage of the research project. However, the back-recording did not pose any specific problem due to the availability of data on crop income and expenses and wage labour income derived from the daily recording sheets; loan acquisition and repayment data collected through a special study held in February 1980; and rice stocks as of March 1979 obtained during the initial benchmark survey. For the other two years, income and expense data were recorded monthly. Special attention was paid to rice stock and credit management. Each month, calculated rice and cash balances were checked for consistency against the actual rice inventory and cash savings.

On the basis of above indicated data, in-depth, open-ended interviews were held with each farmer concerning last year's farm and household management and crop production planning for the coming season at the end of the first and second year of monitoring. Throughout the field work period, short surveys were conducted concerning issues not directly dealt with in the above monitoring activities. Among others, these surveys included topics such as the influence of rural development programmes, the functioning of the local credit system, a study on farmers' risk attitudes and perception of fertilizer response. These studies will be discussed in more detail in the relevant chapters. Furthermore, considerable effort was made in the reconstruction of the village history with respect to demographic as well as agricultural development, the results of which are presented in Chapter 4. The main sources of information used were family and farm land histories as well as interviews with old persons.

The above survey activities were supported by interviews with key informants and own observations. During the initial two years of the study, a permanent stay in the village facilitated my wife and me to have close and frequent contacts with farmers and their wives. These individual contacts as well as formal and (more often) informal group meetings with village people were very valuable in coming to grasp with the way of life in the community. Without this information it would have been impossible to adequately carry out this study.

2.5 Presentation of data

In the presentation of data local measures are as much as possible converted into standard metric quantities. There is a well-defined and elaborate system of local volume-based measures (particularly for grain products), probably resulting from the widespread occurrence of product sharing arrangements in the village. The standard measure for grains is the _paniga_ which is a wooden chest of exact measurements reinforced with steel mountings. Measurement of grains always occurs after grains have been thoroughly sun-dried. For IR-varietes, one _paniga_ roughly equals 14 kg of unmilled rice (_palay_) and 15 kg of the local BE-3 rice variety. Three _panigas_ make up one _cavan_ which is roughly the size of a fertilizer bag, whereas two _cavans_ equal one _bolto_, a measure commonly used in trading rice or corn. A _cavan_ is also equal to 25 _gantas_, which usually is a basket used for the measurement of products like mungbeans or cowpea and also for the application rates of fertilizer and seeds. The smallest measure is a _salmon_ named after the salmon tin that is used for this purpose. Finally, a _caltex_ or _mobil_ equals one litre, also named after the oil cans used for this measure.

Monetary data will be presented in terms of US dollars ($). At the start of the study period (1979), the official exchange rate of the Philippine Pesos was Pesos 7.415 to the dollar. For subsequent years, monetary values were corrected for the price increase of _palay_ that occurred during the study period. This increase in rice prices was quite similar to the increase in rural wages (Section 5.2.5). Thus, the Village Palay Price Index (VPP-index with 1979-80 = 100) is used as a deflator for the seasons of 1978-79 (= 95), 1980-81 (= 116), and 1981-82 (= 126). This implies that the real value of the employed monetary unit ($) is constant between years in terms of the amount of _palay_ it can buy at the local market, i.e., $1 equals 6.8 kg _palay_.

3 DECISION THEORY AND RISK ANALYSIS FOR SMALL FARM AGRICULTURE: CONCEPTUAL ISSUES AND PRACTICAL PROBLEMS

The purpose of this chapter is to elucidate some of the conceptual issues and practical problems in analyzing the influence of risk and uncertainty on farm-household decision making. This chapter does not pretend to provide a comprehensive review of the massive amount of literature concerning decision making and risk taking. To keep this review within manageable proportions, the focus will be on the economic literature related to decision making concerning the material well-being of small rural households in developing countries, and in particular how risk and uncertainty may influence choices of farm-households. Other issues related to decision making of farm-households will receive due attention in the relevant chapters.

3.1 The family labour farm

Households are faced with multiple choices in many areas regarding production and consumption. For agricultural production, they have to decide on what techniques of production to use and how to allocate their resources of land, labour and capital among the alternatives open to them. Consequences of production decisions may be realized in the short term, not exceeding one growing season, or may extend far into the future in case of investment and loan taking decisions. Households also have to decide on marketing strategies. They must decide not only what to produce, but how much, when and where to sell it. Apart from production and marketing decisions, the household has to make a large number of decisions in such fields as food consumption, purchase of consumer durables, housing, saving, education of children, etc.

Household decisions are influenced by household needs and goals as well as by the resources available to the household and constraints imposed by the environment. Household needs determine short term decision making targets and cover such aspects as basic food requirements, cash to purchase other necessary consumer goods, shelter, health care etc. Goals and aspirations give direction to behaviour patterns and choices with a focus on the future realization of wants. Resources do not only include land, water, labour, capital, etc., but also social resources such as information about agricultural methods, security ties with well-to-do families, social influence, and links to the government bureaucracy facilitating the participation in government support programmes. Finally, the environment will impose certain restrictions on the choice options open to households. They may be of a technical nature (e.g. land and water, pest and diseases), in the sphere of economic constraints (e.g. crop input and market prices), institutional and infrastructural limitations, social restrictions, etc.

In many economic studies dealing with decision making of rural households in developing countries, it has been popular to use the standard micro-economic theory as employed for the analysis of commercial firms operating in western countries. Such studies (implicitly) assume that production and consumption decisions can be analyzed separately; that all inputs and outputs in the production process should be valued against market prices; that perfect knowledge exists regarding production possibilities and outcomes of activities; as well as that the aim of a single decision maker is to maximize one or another utility value.

As an early source, Chanyanov (1925) argued that the semi-subsistence farm-household would not behave in the same way as a profit maximizing commercial farming enterprise. Chayanov conceptualized the 'family farm' as both an enterprise and a domestic group, with all decisions serving the requirements of business and of the family (Chayanov, 1925). Mellor (1963) and Nakajima (1969) demonstrated the apparent similarity between the theory of the family farm and that of consumer choice. The assumption on which this analogy is based is that the farm-household is regarded as a 'closed economy' in terms of labour, and thus its relationship to the labour market is not considered (Hart, 1978).

Chayanov proposes the labour-consumer balance as a tool to understand family farm decisions, and specifies the criterion of <u>returns to family labour</u> as the appropriate methodology to understand agricultural decisions. Chayanov asserts that farm-households make decisions based on the gross product of activities minus paid-out costs. Thus, the goal of the family farm in allocative decisions is the highest return to family labour. The household weighs its subsistence requirements together with the drudgery of family labour required to attain these requirements. The family's needs are determined by the size and composition of the family, whereas the drudgery required is determined by the specific farm conditions. Thus, for conditions of ample availability of land, the intensity of family labour use and the size of the farm holding are primarily determined by the demographic structure of the household, in particular the ratio workers/non-workers, and results in what Chayanov calls 'the degree of self-exploitation'.

For conditions of high man/land ratios and imperfect land markets (applicable to the present study village), Mellor emphasized land holding size as the major determining factor of household differences in the intensity of family labour input:

> Families that control only small amounts of land are forced by subsistence pressures to move well out on the labour input function, gradually raising average product per worker in the family labour force closer to the subsistence level. In contrast, a family with control of a substantial amount of land per worker will be able to operate well back on the labour input

schedule and still provide sufficient product to achieve a culturally acceptable standard of living (Mellor, 1963).

Nakajima (1969) showed the similarities between the analysis of Chayanov and Mellor by showing that, in the absence of a labour market, the marginal productivity of labour in 'subjective equilibrium' will vary according to differences in both physical assets and household size /composition. He showed that in a pure subsistence situation without trade in goods and labour, application of the 'closed-economy' model leads to a farm-household equilibrium in which the levels of production, leisure, and consumption are all simultaneously determined.

However, farm-households are seldom (if ever) isolated from all trading possibilities in goods and labour. To the extent that households specialize in the production of certain goods, and trade surplus goods and labour for goods that provide greater utility, consumption and production decisions become less interdependent. With perfectly competitive markets for labour and goods, the simultaneity between consumption, leisure, and production decisions breaks down. Under these conditions, the farm-household equilibrium may be derived through a two-stage process employing the standard economic theory of the capitalistic firm. First, the farm production problem is solved through profit maximization, assuming no consideration for risk and provided that all labour is valued at the market wage rate. Second, given income and the market wage rate, the household's consumption of goods and leisure is determined. This formulation of farm-household behaviour is popular as it allows the estimation of an indirect utility function derived in terms of prices and income independently of the farm's production function. To estimate such utility functions, recent advances have been made with the use of the linear (logarithmic) expenditure system (Hart, 1978; Lau et al, 1981).

Thus, given the existence of a perfect labour market, all households - irrespective of their landholding size or family labour resources - can allocate their family labour resources in such a way as to attain a similar marginal productivity of total labour (i.e., family plus hired labour), i.e. the market wage rate. Under perfect labour market conditions, the farm-household may be regarded as an economic unit which in the first place behaves as a 'firm maximizing profit' and, in the second place, as a 'labourer's household maximizing utility' (Nakajima, 1969). This implies a certain demand for total labour but does not imply any particular level of family labour input. When the family devotes more time to work, the household enjoys a gain in income that can be used to increase the amounts of marketed goods or household production consumed. In conformity with the theory of the marginal utility of leisure (or alternatively, the dis-utility of work, a concept which is similar to Chayanov's 'drudgery of labour'), it is argued that, if the family attempts to maximize satisfaction, time would be allocated so that the satisfaction lost through the last unit of leisure sacrificed would be just offset by the satisfaction gained from the use of the added income derived from the additional work (Barnum and Squire, 1979). Hence, also under perfect labour market conditions, households with different resource structures are likely to differ with respect to the intensity of family labour use as well as the returns to family labour. However, the marginal return to family labour will not fall below the market wage rate. Family labour input in self-employed agricultural activities on small farms would be less than predicted by Mellor's 'closed economy' model, whereas on large farms it is greater (Hart, 1978). Participation in off-farm labour enables the smaller households to attain a higher level of welfare than would be the case if it spends all its time on self-employed agricultural activities.

Apart from the fact that in most rural economies of developing countries markets are notoriously imperfect, if risk considerations are introduced in the farm-household decision model, the separation between production and consumption decisions does not necessarily hold. In the absence of or restrictions to alternative income earning opportunities, for households with limited land resources family labour presents itself as an overhead rather than as a variable cost. To the extent that labour cannot be remuneratively employed, it is a liability in terms of subsistence cost rather than a productive asset. As the household cannot risk to fall below a subsistence level of income, there will be no trade-off between the marginal utility of leisure and income until subsistence is 'guaranteed'. Under such conditions, Mellor's idea of families moving well out on the labour input schedule due to subsistence pressures is again valid. Farmers' concern with subsistence risk may affect production decisions if no sufficient measures outside the sphere of production are available to ensure subsistence in poor production years. Moreover, due to imperfect capital markets and the possible necessity to lend money to finance subsistence, resource poor households may saturate labour with less complementary inputs and therefore may operate on an agricultural production possibility curve which lies substantially below that of richer households. This implies that for similar labour input levels resource poor households will generally receive lower returns to labour.

For both reasons, it seems mandatory to analyze production employment

decisions within the context of the farm-household taking into account the interrelationship between production and consumption decisions. In case market demand for labour is limited and employment opportunities for labour in activities outside self-employed agricultural activities are restricted, poor households can be expected to exploit their family labour resources in agriculture to a fuller extent against lower returns compared to richer households.

Above we have alternatively used the term 'farmer' and 'farm-household' as denoting the same entity. It is realized, however, that the assumption that one single decision maker acts on behalf of the household has been seriously challenged. From the increasing number of women studies that specifically deal with the division of decision making tasks within the household, it has become increasingly apparent that there may be possible conflicts of interest between household members (Jones, 1983). Who actually decides is culture-specific, depends on household composition (life cycle stage) and personal characteristics of household members, and may vary according to the type or field of decision concerned (Chapter 5). For an explicit analysis of the role of women in farm-household decision making and their participation in income earning activities we refer to the complementary study by Res (1983).

3.2 The risk factor in agricultural decision making

The introduction of uncertainty into the above framework of farm-household decision making substantially complicates normative economic analysis, even when one concentrates on the production side of farm-household management. This is primarily due to the fact that single determinate outcomes of activities are replaced by arrays of possible outcomes, i.e., known outcomes are replaced by expectations due to the variable influence of exogenous, non-controllable factors on the outcome of activities.

Uncertainty in farm-household decision making basically stems from two broad types of influences. The first set of influences is composed of so-called stochastic environmental factors. Such influences ('States of Nature') may consist of physical and market price related factors. Uncertain physical influences can be divided into climatic and biological factors. Market price uncertainty is composed of variability of input and product prices, but excludes price variations due to regular price fluctuation patterns. By nature, the behaviour of these factors cannot be influenced by the individual decision maker. In contrast with industrial production, agricultural production processes are usually strongly dependent upon these environmental influences the effect of which cannot or only in part be controlled by farmers. The degree of control will depend on the type of agriculture and the level of employed technology.

A second distinct source of uncertainty is the behaviour of other decision makers and organizations. This type of uncertainty is important if the feasibility or outcome of activities is dependent upon decisions made by other decision makers. As mentioned by Berry (1980), part of the reason for the inadequacy of decision making analysis as a guide to explaining and supporting economic change is that it considers individuals (or households) in isolation. However, both opportunities and constraints to which individuals respond are often the result of interactions among individuals and groups. This type of uncertainty is present in situations where farm-households acquire land from landlords, are dependent upon poor-functioning input and output markets and agricultural extension institutions, restricted credit markets, etc. It is also present in situtions where behaviour patterns are new and not yet accepted by a community. In contrast with the behaviour of climatic, biological, and market related factors, uncertainty arising from this source may be partly subject to control by the individual decision maker who may attempt to actively influence the behaviour of other individuals and organizations. On the other hand, uncertainties of this kind are much less predictable compared to the stochastic environmental factors implying that often such influence cannot be exercised.

With uncertainty subjective elements are introduced into decision normative analysis which prevent the determination of a single optimum solution to choice problems. Decision making under uncertainty involves personal or subjective judgements about (a) the chances associated with the various outcomes that might arise from any particular action (risk perceptions), and (b) the desirability of each action in terms of arrays of possible outcomes (risk preferences). Because of these subjective elements, the best operating conditions that would be appropriate for one person may be quite different for another (Dillon, 1977). Prior to considering farmers' risk perceptions (Section 3.3.1) and preferences (Section 3.3.2), the various types of risks that may result from uncertain physical, institutional, and human influences will be discussed.

In the literature, one encounters a large variety of risk concepts. Distinctions in types of risk are based on factors such as:

- the type of activity involved (e.g. crop production risk vs. livestock production risk (Section 3.2.1));
- the underlying factor causing risk (e.g. climatic risk vs. market risk (Section 3.2.2));
- the type of output considered (e.g. physical yield risk vs. monetary return risk (Section 3.2.3));
- the level of aggregation at which risk is estimated (e.g. crop input risk vs. farm risk (Section 3.2.4));
- the type of consequences of risk taking (e.g. economic risk vs. social status risk (Section 3.2.6)).

Further distinctions are made on the basis of whether risks pertain purely to production or also involve financial considerations (business vs. financial risk (Section 3.2.5)), and whether empirical or subjective data are used in risk assessment (objective vs. subjective risk (Section 3.3.1)).

Below, these various types of risk will be dealt with from the 'bottom-up', starting with individual input risks in the crop production process and concluding with risk concepts at the farm-household level. The type of factors that should be accounted for in assessing such risks either empirically or subjectively based on farmers' information will be indicated. In Chapter 8, the various methods to estimate production risks will be discussed, particularly with respect to response risk of individual crop inputs.

3.2.1 Physical crop production risk

In assessing crop production risks it should be clear from the onset that observed variability in physical output of crop production activities may result from various factors influencing the crop production process. A broad distinction can be made between three types of factors (Anderson et al, 1977):

- decision factors: factors of production that are under the control of farmers such as land preparation, weeding, fertilizer and pesticide inputs;
- fixed exogenous factors: production factors that are beyond the control of producers but have known values, e.g., soil type, natural fertility, etc.;
- uncertain exogenous factors: production factors not controlled by farmers that may have known or unknown values at the time decisions are made about the controlled inputs, i.e., the earlier discussed 'States of Nature' caused by uncertain environmental influences.

Apart from these factors, observed variability in output is also caused by differences in management. This input factor accounts for differences in the ability of farmers to effectively use inputs under their control and reduce the effect of adverse environmental factors on crop growth.

In assessing physical crop production risk, the aim is to determine the contribution of the uncertain exogenous factors (risk factors for short) to output variability. The contribution of other factors should be accounted for as much as possible. The influence of risk factors on agricultural production can be analyzed at different levels of aggregation. At the lowest level of aggregation, risk factors may influence the effectivity of individual crop inputs and, thus, decisions related to the level of applied inputs.

To establish whether input use is risky, it should be determined whether yield variability increases with an increasing use of a particular input and whether the magnitude (in absolute terms) is such that it is visible to farmers. Although the output of crop production activities may be variable, such condition is not sufficient to conclude that input use is risky. To the extent that yield variability is independent of the amount of input applied, input risk as such does not exist. Thus, a distinction should be made between yield risk and input response risk. The former represents the variability in yield due to the influence of all environmental factors taken together, whereas the latter specifically pertains to the relative riskiness of the use of particular inputs.

The extent to which risk factors will cause input response risk will depend on:

- The type and degree of interaction between input factors and risk factors. In this respect a distinction can be made between protective and non-protective farm inputs;
- The extent to which risk situations occur prior to the time input decisions have to be made (timing of input application);
- The ability of farmers to protect their crops from the influence of these latter risk factors through adequate crop management practices (risk control).

Protective and non-protective inputs

In assessing the risk of input use, it is useful to look at the specific purpose of the input. On the basis of whether inputs are meant to control environmental risk or not, a distinction can be made between protective and non-protective inputs (Binswanger, 1979).

Protective inputs are aimed at reducing the likelihood of low production outcomes without necessarily increasing the potential yield of an activity, i.e., the yield under best management practices without being adversely affected by the environment. However, protective inputs often have the dual effect of increasing both the expected gross yield and reducing the probability of low yields. They may include labour inputs (weeding, erosion/water control, traditional pest control methods), cash inputs (insecticides, herbicides), and capital investments (irrigation, anti-erosion works). A further distinction in protective inputs can be made between profilactic and corrective inputs. The former type of inputs is applied irrespective of the occurrence of adverse conditions such as the pre-emergence applications of herbicides and early season sprayings of insecticides, whereas the latter are applied when a crop stress condition has developed and has passed a certain threshold. To the extent that negative influences on crop growth cannot be controlled through the use of protective inputs, farmers still have the option of remedying the effects of adverse crop conditions once they have occurred. Such methods will be particularly important for crop systems where direct environmental control is low.

Non-protective inputs are primarily meant to increase the potential yield without necessarily reducing the probability of low returns. Fertilizer is a typical example of a non-protective input, although, to some extent, it may also reduce yield risk. For instance, fertilizer may facilitate a better root system development providing the crop with a higher drought resistance.

Timing of input application

Agricultural production processes are typically sequential in nature and necessarily involve the effluxion of time. Environmental conditions, choices, and consequences will probably face the decision maker in overlapping sequences in the course of the production cycle and farmers are likely to make use of this information when deciding to apply inputs or to carry out certain operations.

Time may influence crop input decision making in two ways. On the one hand, with the progression of time better decisions with respect to input use can be made as more information becomes available concerning the status of environmental conditions. On the other hand, the effectivity of applied inputs may decline the later they are applied in the crop cycle. Timing of input applications will thus become a factor in the risk taking process. A possible decline in the response to inputs should be weighed against a possible increase in the efficiency (including risk reduction) with which decisions can be made. Hence, apart from directly controlling environmental influences through the use of protective inputs, farmers may postpone certain decisions until critical risk periods have passed and/or adjust input levels to actual crop conditions once a crop stress situation has developed.

The applicability and effectivity of the latter two control methods to reduce response risk to non-protective inputs will depend on the distribution of risk factors over the growth cycle of the crop relative to the time inputs have to be applied as well as their relative importance in terms of likelihood of occurrence and the damage they may cause to crop growth. To the extent that adverse conditions develop before a particular input is applied, farmers may adjust the application level on the basis of such conditions and the risk of input use will be reduced. However, in case inputs have to be applied before certain risk periods have passed, risk may affect decisions.

Farmers' control over risk factors

Given the possibility that the risk associated with input use may be actively influenced by farmers implies that such input risks may not be neutral with respect to the resource endowments of the farmer. In this respect it is useful to distinguish between environmental influences that are potentially fully under the control of the decision maker (e.g. weed infestation), partly controlled (e.g. pest incidence), or not controlled (e.g. drought stress in the absence of supplemental irrigation). To the extent that effective risk control depends on the resources available to the decision maker, input response risk and farmers' perception of such risk may be influenced by perceived cash or labour constraints.

3.2.2 Market related risks

Market related risks are caused by uncertainties in product and input markets. A major cause for market risk are varying prices for products and crop inputs. Apart from price risk, a number of other risk factors result from market dependence. Among others, they may be caused by poor transport facilities and road infrastructure; poor marketing channels (e.g. timely lack of buyers, postponed payments); and a poor input supply system (non-availability of inputs).

The importance of price risk in agricultural decision making of individual farm-households generally depends upon the extent to which:

- the farm-household is integrated into a market of monetary exchange relations;
- products can be stored;
- prices of products and inputs fluctuate;
- price movements are predictable;
- price fluctuations are correlated with fluctuations in production.

Obviously, in assessing the importance of price risks account should be taken of the extent to which households market their products, buy crop inputs on the market, and depend on the market for consumption goods. Generally speaking, the more the household is incorporated in commercial markets, the more it is vulnerable to price fluctuations.

To assess price risk of production activities, a distinction should be made between various types of price movements:

- long term price trends caused by changes in such factors as population, income, taste, and production techniques;

- seasonal price fluctuations resulting from the seasonal character of agricultural production or consumer preferences for certain products during certain parts of the year. Price fluctuations of storable crops (e.g. grains) will generally be less than non-storable perishable products such as vegetables;

- long term price cycli of perennial crops and livestock products caused by supply reactions of farmers;

- irregular price movements caused by such factors as drought, storm damage, or heavy pest infestations.

Perceived price risks will depend upon the extent to which farmers are aware of patterns in the above price movements on the basis of which input and production price predictions can be made. If so, decisions can be geared to reduce the effect of price fluctuations on production incomes as much as possible. Only fluctuations around known price movements form an element of risk. The effect of known price movements can be reduced by hedging, diversified and staggered planting of crops.

3.2.3 Net return risk

The combined effect of yield risk and price risk finally determine the monetary return risk of crop activities. In agriculture, due to the usual low price elasticities of demand for agricultural products, crop prices and aggregated output levels are often found to be negatively correlated. This negative price-output correlation tends to have a stabilizing effect on the monetary returns of crop production activities. Thus, to the extent that crops are marketed, monetary return risk of crop activities will generally be lower compared to yield risk valued against constant prices. Hence, it is often argued that stabilizing agricultural output prices through government market intervention increases variability in monetary returns and consequently increases instead of reduces household income risk. However, for households operating near a subsistence level of living, this may not necessarily be true. In years of low production such households face the market as consumers and have to pay high prices for purchased food, whereas in good production years they face the market as sellers of products and get low prices. In effect, poor households cannot take advantage of the high product prices in poor production years, and thus the stabilizing effect of a negative price-output correlation on their incomes will be minor. Moreover, although such correlation may occur at the regional or national market level, it is much less likely that it also works for the individual farm or village level.

A second risk aspect of monetary returns to crop production activities is <u>net return risk</u>. This type of risk considers the variability in returns to crop activities when all production costs are subtracted. Subtracting costs from the gross return level will have the effect of shifting the activity outcome distribution to the left, thus lowering the mean value of the distribution and increasing the probability of loss. The calculation of net return risk will therefore depend on how the various input factors are costed. For example, net return risk will vary substantially if labour costs are based on an imputed wage rate or if they are considered to have no opportunity value.

For the same reason, one cannot simply state that protective inputs reduce crop production risks. Although they are meant to reduce yield risk, this does not necessarily imply that they also reduce the <u>net return</u> risk of an activity since such inputs usually require cash or labour outlays. This will generally depend on the size of the outlay in relation to the effectivity of the input to reduce the probability of low returns. The latter will depend on the importance of the specific risk factor to be controlled. Hence, the idea that risk averse farmers should overinvest in protective inputs (Binswanger, 1979) does not necessarily hold. Due to the shift of the yield distribution both the expected return may be lower and the probability of net loss may be higher. However, at relatively low levels of protective input use such a situation is not likely to occur, especially not when corrective inputs are applied in reaction to actual adverse environmental conditions. In such situations, non-control will certainly result in a net return loss.

3.2.4 Aggregation of production risks

The above discussed risk factors concern individual crop enterprises. However, farming systems are typically composed of a number of different crop production enterprises, often grown on different types of land and at different times of the year. Apart from crop activities, livestock and off-farm employment activities are often also included. The influence of risk factors on these activities may differ and farmers are likely to make use of these differences to reduce overall risk. Hence, the question should be addressed at what level of activity aggregation risk should be assessed.

For example, at the cropping pattern level account could be taken of the combined risk of crops grown sequentially on the same piece of land as the planting date of the first crop may influence the planting date of the second crop. Given a monomodal rainfall pattern, postponement of the first crop planting may reduce the yield risk of this crop but increase the yield risk of the second crop. At the crop production system level, crop enterprises may react differently to environmental circumstances. Drought resistant crops may do reasonably well during poor rainfall years, but may not yield as high as other crops in favourable years, whereas the opposite applies to non-drought resistant crops. Also, covariance in price risk for different crops should be considered. Thus, by choosing a diversified crop portfolio and/or staggered plantings of crops, farmers may not only substantially reduce the risk of the total cropping system's physical output, but also the monetary returns. Further, the temporal interdependencies between individual crop activities both with respect to output and (unforeseen) conflicting resource requirements may be considered.

At the farming system level, differences in the timing of the income streams of crop and livestock activities are often employed by farmers to stabilize income flows. A well-known safety measure is the keeping of animals as a reserve for times of poor crop production. Finally, at the farm-household level, the risks associated with own-farm production income should be combined with the risk associated with income derived from off-farm employment activities such as activities in the sphere of home industries and wage labour. Although income derived from such activities may effectively balance a shortfall in income derived from farm production, in poor production years income earning opportunities are often scarce. For example, wage labour opportunities in agriculture will be limited at exactly those times that small farm-households need them, i.e., in poor production years.

3.2.5 Financial risk

Apart from the risks attached to production activities, another type of risk is associated with financing these production activities. In this context, it is useful to distinguish between business risk and financial risk. Business risk is defined as the inherent uncertainty of the firm's output independent of the way it is financed (Weston and Brigham, 1978). The major sources of business risk are the earlier mentioned variation in physical output and market related risks. Financial risk is defined as the added variability to household income that results from obligations in cash or in kind associated with debt financing. In contrast with business risk, which is incurred during one production cycle, financial risk considers the carry-over effect of business risk between production periods. Financial risk depends on the farm-household's ability to diffuse the consequences of risk taking in individual production years over an extended period of time. Even for years with normal production circumstances, financially over-extended households may face a severe subsistence risk.

3.2.6 Social risk taking

The outcomes of activities often also depend on what other people are doing. The extent of such interaction will depend on the form and quality of the social relationships in a community (Berry, 1980). Social risk taking ~~will be particularly important~~ in situations where individuals attempt to deviate from established behaviour patterns. This matter has been widely discussed in the literature on innovation behaviour. For example, with the theory of the 'Image of the Limited Good', stating the folks' belief that the personal improvement in living conditions can only come at the expense of others, Foster (1965) indicated the existence of such social risk factor for innovating households. Also in the sphere of patron-client and other reciprocal relations social risk taking occurs in case one of the two parties acts in conflict with the other party.

3.2.7 Background risks

Finally, a group of risks should be considered that extends beyond the sphere of household production and consumption. These 'background risks' (Lipton, 1979) are, to a large extent, unpredictable and may have a major impact on the viability of the household unit. They may range from sickness of household members, withdrawing labour from income earning activities and requiring extra outlays for medicine or hospital bills; death of parents or children requiring large cash and food outlays for funerals; unexpected weddings of children; to the burning down of the homestead or theft. These risks are essentially those against which households in western countries are commonly insured. The involved indemnities are too large to be carried by the household budget. In non-western economies, to cover such risks households are usually dependent on village level social insurance institutions such as mutual-help, gift giving during funerals and weddings, etc. To the extent that they are inadequate, individual households may keep relatively large reserves in stored produce, livestock or savings to meet such calamities, thus blocking potential funds for investement in income earning opportunities and livelihood improvement of the household. The inability to cover background risks may be an important factor explaining the impoverishment of households.

3.3 Modelling farmers' risk behaviour

Obviously, analyzing how farmers take into account the above described complexity of risk factors is difficult. From the discussion below, it will become clear that risk, and consequently risk aversion, are not well-defined concepts that can be readily employed in analytical models. In fact, despite the increasing research attention to risk in agricultural decision making during the last two decades there is no concensus whatsoever how risk can best be incorporated in decision models to be relevant to farmers' choice problems. It is therefore not surprising that attempts to incorporate risk in decision models have been confined to rather academic exercises.

The economic literature on agricultural decision making is strongly dominated by normative decision theories. Such theories prescribe how individuals ought to behave when they rationally follow pre-defined behaviour rules. They usually start from the assumption that decision makers maximize one or another utility value (e.g. profits, returns to family factors). To allow maximization, decision makers are portrayed as cool calculating, rational persons with sophisticated computational ability. Such persons are faced with a finite number of possible actions or strategies the outcomes of which depend on a finite number of environmental influences ('States of Nature'). In the conventional economic model, the decision maker is assumed to have perfect knowledge regarding the status of the various environmental factors, i.e., he knows what 'State'' is true, each activity has a determinate outcome, and maximization simply involves selecting the activity with the highest utility value.

For the whole-farm planning problem, known in decision theory as portfolio selection, agricultural economists have long since developed and refined a number of mathematical (linear) programming models that are commonly used to determine the optimum allocation of farm resources. The standard linear programming model assumes perfect knowledge: prices paid and received by farmers, resource requirements and constraints, and yields of crops and livestock activities are all assumed to be known with certainty. Given values for these model parameters, the linear programming model under certainty yields a unique solution to the resource allocation problem. It maximizes income subject to resource constraints and possibly other considerations such as rotation requirements and timeliness of output (cash/kind flow).

For situations where the outcomes of activities are uncertain, i.e., where the decision maker does not know what 'State of Nature' is true due to the influence of some of the earlier indicated risk factors (most decision situations), certain single outcomes of activities are replaced by uncertain arrays of possible outcomes. Decision theories that focus on choice under conditions of uncertainty have to deal with the decision maker's ability:

- to forecast uncertain events. Individuals must have some idea of the likelihood of occurrence of the various 'States of Nature' relevant to their choices or at least must be able to rank them according to some relative (heuristic) frequency of occurrence;
- to predict the various consequences of each course of action assuming that 'Nature' is in each of its possible states;
- to order alternative actions according to some preference measure, taking into account arrays of outcomes (consequences).

3.3.1 The farmers' ability to forecast uncertain events

Most studies cited in the literature that attempt to assess the farmers' ability to forecast uncertain events are still largely exploratory and limited to perceptions of yield variability of single crop activities. The problem in assessing farmers' feelings of outcome uncertainty directly relates to the - inherently difficult to analyze - issue how individuals process information and how they perceive choice problems. Studies by Ortiz (1980) and Gladwin (1979, 1980) are some of the few serious attempts investigating the manner in which farmers themselves conceptualize choice problems and perceive uncertainties in the decision making environment.

The mainstream of economic literature, however, simply sidesteps this problem by assuming that individuals choose between activities as if they are able to (subconsciously) compare risky options in terms of subjective probabilities. The concept of subjective probability stems from the early work of Savage (1954) who showed that, under uncertainty, the best way to achieve the maximum is to use whatever you do know to make your best guess about probabilities. That is, he indicated that even the smallest bit of information on the likelihood of outcomes is better than no information at all in reaching the goal of maximization. In this way, Savage effectively expelled the noncalculable part of uncertainty (e.g. due to knowledge constraints or actions by other decision makers) and paved the way for decision analysts and model builders to mathematically include outcome uncertainty in decision models and cast away the distinction between risk and uncertainty as being irrelevant.

Richardson et al (1976) eloquently summarize this view:

> In this context risk is taken to mean uncertain events to which probabilities are attached and it is argued that all probabilities are subjective, reflecting the degree of belief the decision-maker holds in the occurrence of relevant uncertain events (de Finetti, 1972). Objective data bearing on the uncertainty, such as relative frequencies of past events, are seen merely as aids in formulating probability judgements. In this view, the classical distinction between risk, where probabilities are 'known' and uncertainty, when they are not, is invalid and all cases of uncertainty for which possible events can be enumerated are categorized as (subjective) risk.

In line with this - among economic decision theorists - widely accepted view, uncertainty is merely referred to as a state of mind in which the individual perceives a number of possible outcomes to a particular action, whereas risk has to do with the degree of uncertainty in a given situation. That is, uncertainty regarding the outcomes of choice options can always be expressed in terms of subjective likelihood indicators.

As one of the few opponents to this view, Cancian (1972) states:

> Knight's classic distinction between risk and uncertainty seems to be overwhelmed by the demand of the micro-economic model to characterize decision making into calculable terms: economists seem to translate uncertainty into terms that make it comparable with risk ... In many recent discussions of agricultural development, 'risk and uncertainty' appear as a single term, not as a conjunction of concepts denoting differential phenomena.

We agree with Cancian's objection to an identical treatment of (a) situations where farmers know what kind of risks they take when opting for existing practices and (b) situations where they are faced with the uncertainties of new technologies or when they have to adjust to other changes in the environment. With the adoption of new technology, no information is available about the way in which the technology will perform under local conditions, i.e., there is no experience on which to base an assessment of the response of the technology to local inputs and production circumstances. Thus, farmers may be highly uncertain about the risks involved in new production opportunities. They may neither know the odds against which they are gambling nor the outcomes.

In such situations decisions are made under conditions of ignorance. By nature, ignorance cannot be incorporated in formal decision models. Given the emphasis on formal maximizing models in the literature, it is not surprising that this dimension of decision making under uncertainty has received minor attention. However, decision situations of this type are likely to occur at the early stage of adoption processes. They are referred to by Cancian as decision situations where pure uncertainty and not risk considerations prevail. Ignorance may explain conservative behaviour in case new prospects are simply not taken into account as viable options. Uncertainty of this type can be reduced by gathering information on the new prospect or by own experimentation. As indicated by Petit (1976) to take into account learning aspects, decision models must focus on the adaptive nature of decision making and incorporate mechanisms for feedback that allow modification of choices in the light of new information.

Choice situations under pure uncertainty should be distinguished from choice situations where the consequences are known but not the odds. This latter situation is referred to in the literature as ambiguity which measures the degree of confidence one has in a probability estimate (Ellsberg, 1961; Bernard, 1974). Clearly, in pure probability calculus such phenomenon does not occur: a probability about a probability is again a probability. Hence, most decision theorists employing subjective probability concepts argue strongly against taking up this additional dimension of uncertainty in decision models (e.g. Raiffa, 1961).

Studies that attempt to analyze how individuals arrive at probability judgements are mainly limited to psychological laboratory research. There has been a growing appreciation of the limitation of individuals in processing probabilistic information and judging uncertainty. Slovic, Kunreuther and White (1974) summarize laboratory and field research illustrating the inability of decision makers to think in probabilistic terms and to bring relevant information to bear on their judgements. This finding would seem to invalidate many of the proposed decision theories and risk definitions that are commonly based on the assumption that individuals tend to behave as if they think in probabilistic terms.

Tversky and Kahneman (1974) describe two heuristics commonly employed by persons in making judgements on the occurrence of events that appear to be relevant to the present study. The first heuristic, availability of instances or scenarios, is employed when people are asked to assess the frequency of a class or the plausibility of a particular development. For example, a person, when assigning a subjective probability, may put too much weight on recent information and results, as they are more easily available to him. This may lead to a bias if recent experiences or information are not representative. If experience with a certain technique or event is lacking (e.g. newly introduced technology), persons may use existing instances to evaluate outcomes.

The second heuristic, adjustment from an anchor, is usually employed in numerical predictions when a relevant value is available (e.g. the most likely yield estimate). For example, when eliciting a probability distribution of yields, if the modal value strikes first in the mind of the farmer, he may not truly express the values at the tails of the distribution. To some extent one can try to overcome this problem by encouraging the farmer also to think of the tail values of the distribution.

Another type of heuristic specifically pertains to the manner in which persons may assess the relative riskiness of alternative prospects. Instead of separately taking into account the returns and riskiness of opportunities, persons may very well directly discount for risk through a more conservative assessment of returns of high risk prospects compared to less risky propects. Such a simple heuristic does not only have an intuitive appeal, but may also be hypothesized on the basis of what is known in behavioural theory as 'cognitive dissonance'. In case a person has the choice between a high risk - high return and a low risk - low return prospect, he may reduce cognitive dissonance by adjusting the returns of the high risk venture downwards in order to avoid feelings of regret that would be associated with not choosing an opportunity with a potential high pay-off. Such bias may in part be dependent on the risk attitude of persons, i.e., the more risk averse a person is the more conservative his perception will be. The resource position of individuals may have a similar effect on perceptions. Based on the earlier developed notion that effective and timely risk control is influenced by the resource position of the farmer, poor farmers may show a tendency to have more conservation perceptions than resource rich farmers.

Apart from the above cognitive biases, other discrepancies between responses to elicitation procedures and what persons actually perceive may occur due to motivational bias (i.e., careless responses of the subject in the course of - the often - tedious questioning procedure) and interview bias which may arise from elicitation methods that involve concepts with which subjects are not familiar or have meanings which differ from those held by the researcher.

Still, in studying farmers' perceptions, one should be careful to simply agree with Estes (1976) that individuals are unlikely to have enough information and information processing ability to think about the future in probabilistic terms. For example, heuristic probability concepts such as most unlikely, probable, very likely, almost certain may well replace mathematical probabilities in decison making and essentially lead to similar decisions. Others (e.g. Binswanger, 1979) have indicated that farmers are quite capable of expressing feelings about the likelihood of occurrence of certain events in terms of 'so many out of (say) ten', which is a well defined probability concept.

Such probability concepts may be applied to certain discrete events such as early onset of rainfall, typhoon incidence, heavy pest infestation. It is, however, much less likely that farmers are able to assign probability concepts to continuous variables such as yields or prices.

Until recently, limited attention was paid to the analysis of the influence of farmers' perceptions on decision making. Most efforts have been made in the area of measurement of risk preferences. Only during the last five years, a number of studies that have attempted to elicit farmers' yield risk perceptions were reported. Some of the most noteworthy were by Bessler (1980), Grisley and Kellog (1983), Herath et al (1982), and Walker (1981). These studies support the view that perceptions are as important as attitudes in explaining farmers' behaviour.

Apart from the question how farmers perceive outcome uncertainty, a much broader issue concerns the question at what level of activity aggregation farmers perceive risk. Do farmers consider the risks attached to particular actions such as fertilizer application; do they evaluate risk at the crop activity level; or are they concerned with overall farm income or household income risk. It is, for instance, quite possible that once very basic subsistence requirements are assured at the aggregate household level, farmers engage in remunerative activities the outcomes of which are highly uncertain. It is also likely that perceived risk is influenced by the scale at which the activity is undertaken.

3.3.2 Defining risk and measuring farmers' risk preferences

Given the lack of knowledge regarding farmers' outcome perceptions, it will be clear that knowledge about the way in which farmers compare choice options with variable outcomes (prospects) is equally limited. Although there are a considerable number of hypotheses regarding risk-based decision criteria, none of these hypotheses have been adequately tested as providing a good description of farmers' risk perception and risk taking behaviour. Emphasis has been put on models that consider decision making in a whole-farm context leading to a substantial number of different risk programming models. Less attention has been focused on decision models related to input use. Very few attempts have been made to include risk in models that link production with consumption decisions at the household level.

Risk considerations can be incorporated into mathematical programming models in two ways. Either in the form of ad hoc manipulations of the programming matrix or by explicitly altering the programming algorithm by way of taking into account the farmers' risk considerations in the objective or constraint function. Examples of ad hoc manipulations of the programming matrix are the exclusion of high risk activities from the set of activities in the matrix or limiting the size of these activities by using a maximum constraint. Alternatively, low risk activities may be forced into the solution by using a minimum constraint. One may also use conservative estimates of resource levels or of gross margins and resource requirements for high risk activities. In a more systematic way, such procedures may be carried out through sensitivity analysis.

On the basis of the decision criteria and risk definitions employed, three approaches that explicitly take into account risk considerations in the model structure can be distinguished :

I. 'Safety First' approaches as proposed by Roy (1952) and Day, Aigner and Smith (1971) which pay explicit attention to minimum income goals;

II. Expected income & dispersion of income analysis, first employed by Markowitz (1952, 1959), Tobin (1958), and Freund (1956), based on (subjective) expected utility theory allowing a utility trade-off between risk and expected income;

III. Approaches derived from game theory orginating with Von Neumann and Morgenstern (1953).

These approaches differ mainly in two respects. First, the manner in which risk considerations of decision makers are taken into account in the model structure: in a compensatory way as a trade-off between income and risk which allows optimization (II) or as a boundary condition to the feasible choice set (I and III). Second, the manner in which risk factors are represented in the model: employing subjective probabilities (I and II) or not (III).

Risk programming models further differ on the basis of whether risk is recognized only in the activity return coefficients and those where it is also recognized in the resource constraints and/or technical input coefficients. The latter type programming models are far more complex than the former. Hence, risk programming studies are usually confined to cases where only activity gross margins are stochastic. Below, the various approaches to include risk attitudes and choice criteria in formal decision models are briefly described. A more detailed discussion is provided in Appendix I.

Safety-First

The simplest way to compare options with more than one possible outcome is to compute the expected value, i.e., the probability weighed sum of the array of outcomes. In this way, the profit maximization criterion under certainty is replaced by an expected profit maximization criterion under conditions of uncertainty. This criterion implies profit maximization over a period of several growing seasons, some of which may be prosperous, others may be disastrous. By acting as if he uses the calculus of expected values, an optimizing farmer may find a long-run maximizing strategy. Obviously, this criterion does not distinguish between options with different types of outcome arrays but similar expected values. For example, options with outcome arrays including negative outcome possibilities are considered identical to options with outcome arrays with only positive values, if the expected value is the same for both options.

As early sources, both Wharton (1968) and Lipton (1968) indicated that specifically in regions where farms are small and production conditions highly uncertain, long-run expected profit maximization could imply severe production shortages in the short-run, exposing the farm family to the danger of starvation. This will be particularly true if institutions for spreading risks are poorly developed (Griffin, 1979). In such circumstances, it is argued that farmers are not preoccupied with maximizing expected profits but with maximizing their chances of survival (Lipton, 1968). Instead of focusing on long-run objectives, farmers are concerned with short-run goals and constraints. For example, resource poor farmers may prefer prospects which combine lower than maximum profits with a security that a certain level of profits will always (or with a certain chance) be attained to prospects that maximize profits where such security is not guaranteed.

Under the general name of 'Safety First' various decision rules have been proposed that incorporate such <u>security motive</u> in decision models. The principal feature of these models is that risk acts as a constraint to the feasible choice set, i.e., an increase in risk (e.g. a higher chance that income falls below subsistence requirements) cannot be compensated by an increase in expected income. This implies that if the risk constraint is binding, expected profit maximization will not occur. In contrast with the expected utility maximization theory discussed below, decision criteria derived from these approaches do not allow for a complete ordering of choice alternatives allowing maximization, but merely provide rules-of-thumb that ensure a certain level of security. Hence, in decision models these rules are generally incorporated into a framework of so-called lexicographic ordering of preferences. For example, alternatives are first screened for meeting a certain safety margin, and, as a second step, an expected profit maximizing alternative is selected. The rules-of-thumb suggested in the literature are, to a large extent, arbitrary and most of the employed parameters (especially the employed probability bounds) are difficult to elicit from decision makers. On the other hand, disaster levels and safety margins can be directly related to the decision maker's ability to take risks.

<u>Utility maximization</u>
Although the early interest in the influence of risk on decision making was primarily directed to the resource-poor farmers' <u>inability to take risk</u>, with the increasing interest in modelling risky choice processes a more general formulation of risk taking behaviour emerged in the literature focusing on the farmers' <u>willingness to take risk</u>. Such attitude towards risk is considered to be in part determined by the psychological make-up of the farmer and not induced by a limited risk taking capability. It is

an analogy to Friedman's (1963) theory concerning western type firms that attributes differences in the profitability and success between firms partially to differences in their willingness to take risks. Adventurous enterpreneurs are rewarded for undertaking activities for which the pay-offs are high but unsure. In contrast with formulating risk as a constraint to feasible choices, with the introduction of attitudinal risk aversion (i.e., risk preferences of a continuous nature) it is possible to include risk considerations in the objective function to be maximized.

Approaches in this category find their origin in the expected utility maximization theory. This is the most fully developed normative theory of choice behaviour under uncertainty based on the so-called Von Neumann-Morgenstern axioms of rational choice (1). It allows for a judgement concerning both expected income and risk associated with income to be formulated in a single utility value so that it can be consistently and coherently applied in an optimization framework. A comprehensive review of the expected utility theory is provided by Anderson et al (1977).

The assumption is that decision makers are willing to trade-off risk against income for all levels of income. Choice options are assigned expected utility values that combine the utilities of the various outcomes of each option and their likelihood of occurrence. Utility values are considered to reflect the individual's diminishing marginal utility of money. For the risk averse individual, the expected utility of a guaranteed sum of $100 is preferred to a 50:50 chance of $200 or nothing because the satisfaction or utility to be gained from an extra $200 is less than twice to be gained from an extra $100. Thus, it can be shown that the necessary and sufficient condition for risk aversion is that the first derivative of the individual's utility function for income (or wealth), i.e. his marginal utility, is positive and strictly decreasing (Arrow, 1971). Similar to expected profit maximization, this theory assumes a long-run optimization algorithm. As is indicated in Appendix I, this model encounters serious problems and shortcomings in actual application. It is essentially a theoretical construct without much support from either psychological studies investigating how individuals process information or economic studies that attempt to prove the theory as providing a decision model according to which people tend to behave.

The main difficulties in using the method of maximizing expected utility relate to the empirical estimation of utility functions (and subjective probabilities), and to the computation of expected utilities for continuous probability distributions. For simple choice problems that involve few options with discrete outcomes, assigning utilities to all individual outcome possibilities may not pose a particular problem. However, for the more common case of a substantial number of options with continuous outcome distributions (e.g. yield distributions) such a procedure becomes tedious. For such cases, it is common to assess utility in terms of the probability distribution of income itself and assume that such utility values can be encoded in a risk preference function. In such an approach, expected utility is expressed as a weighed sum of a series of moments of a probability distribution. Although, in principle, it is possible to assess probability distributions with an infinite series of moments, in practical applications it has been popular to take into account only the first two moments of the distribution, i.e., the mean and variance or any other variance related measure. In the expected utility theory, risk is thus usually defined in terms of the variance or standard deviation of outcome distributions.

Measuring farmers' risk preferences

To determine the risk preferences of farmers, encoded in utility functions that can be applied to the above utility maximization models, two approaches can be distinguished:

- approaches based on direct elicitation of risk preferences;
- approaches that infer risk preferences from observed behaviour.

In the direct elicitation approaches utility preferences are usually elicited for simple, hypothetical prospects to be subsequently used to indicate consistent choices for real farm planning problems. Elicitation procedures may either involve the estimation of a risk preference (utility) function or the determination of partial risk aversion coefficients derived from specific gambles. Preference functions are derived through various interview procedures designed to determine points of indifference between certain incomes and options involving high and low incomes. The usual method starts the interview procedure with a choice between options of which the expected pay-offs are identical, i.e., the expected income from the risky option is equal to the assured income option. In case the respondent prefers the assured income option (as will be the case for a risk averse individual), the assured income is lowered until the respondent is indifferent to the two options. The resulting certain income level is known as the certainty equivalent of the risky option. The difference between the certainty equivalent and the expected value of the risky option is the risk premium, i.e. the amount the respondent is willing to pay to avoid participating in the risky prospect. After a series of indifference points has been identified in the interview, a utility function can be fitted to the points by regression analysis.

The direct elicitation methods involving hypothetical gambles have been criticized for quite some time (Thornton, 1963). Since it forces decision makers to respond to hypothetical questions which may neither reflect nor bear a relation to the real risky prospects they perceive to face in their input or activity choices, it is questionable whether attitudes towards risk taking as implied by the results of these elicitation methods are consistent with, or can otherwise explain, the choices decision makers actually make (Roe, 1982). Even in case hypothetical prospects are related and tuned to the pertinent decision making situation in which farmers operate, the type of procedure has serious shortcomings, as Young (1979) points out:

> Does a utility function elicited in a short interview around a farmers' living room table reflect his attitude toward risk in real world decisions? In the latter case, unlike the former, he has much more time to consider a decision, can and often does solicit advice from family members and friends, and is fully aware that he must live with the consequences of his decision.

Also, the direct elicitation methods have been criticized as subject to a number of biases arising from misconceptions of the notion of probabilities, preferences for specific probabilities, negative preferences toward gambling, confounding from extraneous variables, and differences in interviewers.

A second direct elicitation method suggested by Binswanger (1980) which involves real pay-offs and preference assessment for sets of risky options may overcome some of these problems. The respondent is asked to make a single selection among a specified set of options, all involving 50:50 gambles with high and low incomes. Binswanger used real pay-offs (respondents are given the money to gamble with) and employed a procedure in which he gradually increased the amounts at stake, resulting in a number of partial risk aversion coefficients. However, as indicated by Knowles (1980), changing the wealth position of individuals (by giving them money with which to play the game) and, more importantly, the use of games in which participants average out as gainers rather than losers (in fact they never lose because the money they play with is not their own), will probably lead to different responses compared to individuals gambling with their own money. Although Binswanger made efforts to avoid the effect of these problems, the actual choices are observed under what Eidman (1983) calls 'somewhat artificial and contrived circumstances'.

Alternatives to the direct elicitation procedures are approaches that attempt to infer preferences from actual decisions made by farmers. In these approaches, observed economic behaviour with respect to factor demand and output supply is compared with results derived from theoretical models that incorporate risk. Risk preferences are imputed by choosing a risk aversion parameter that leads to the closest fit between the actual and predicted choice. The derived risk aversion coefficients can subsequently be incorporated into models that determine optimum choices for problems including new choice alternatives. Moscardi and deJanvry (1977) used this method in an expected utility framework with farmers in the Pueblo Project in Mexico. Brink and McCarl (1978) derived estimates of risk aversion coefficients of Corn Belt farmers employing a MOTAD-type programming model. The procedure followed is to compare actual crop activity or input choices of farmers with those selected by the model with the risk aversion coefficient varied parametrically. The value of the risk aversion coefficient that minimizes the difference between the actual and the predicted choice is considered to represent the farmer's risk preference.

Although this approach may escape the criticism that the directly elicitated preferences may not be relevant to real world decisions, the obvious weakness of this approach is that it is vulnerable to serious errors of inference. Because risk preferences are assessed on the basis of the difference between actual factor use or output supply levels and the levels derived from risk neutral (expected profit maximization) solutions, the approach attributes the entire difference to risk aversion. In actual fact, many other factors may explain such difference such as an inaccurate specification of the model, differences in resource endowments, capital constraints, different objective functions, and differences in perceived risk.

The problems associated with eliciting risk preferences and the general non-applicability of mean-variance analysis or related approaches, has led to the development of an alternative risk efficiency approach. It can be more generally applied as it allows the evaluation of entire profit distributions instead of certain parameters of such distributions as in mean-variance analysis. This approach is also based on the expected utility maximization framework, and is known as <u>stochastic dominancy</u>. It can be applied to situations in which little is known about the decision makers' preferences, i.e., it does not require complete specification of the utility function but only assumption about the general shape of the function.

<u>Game theory</u>

Game theory has provided a third set of choice criteria on which to base decisions under uncertainty. Game theory is originally developed to analyze situations where a conflict of interest exists between two or more decision makers. Applied to agricultural choice situations, nature is conceptualized as one of decision makers. Nature can play alternative 'states' under which the returns or pay-offs to the person playing against Nature (i.e. the farmer) vary. Game theory avoids explicit assumptions about the probability of occurrence of different 'states', except in one case where 'states' are assumed to be equally likely. Game theory models have been criticized on the grounds that the derived decision criteria imply that nature is malevolent. This is probably the main reason why after an initial interest in game theory, recent applications of this approach for agricultural decisions have been minor. In fact, as will be discussed lateron, based on their experience, farmers are more likely to make an optimum use of the opportunities nature gives them.

3.3.3 <u>Satisficing vs. optimizing behaviour</u>

Apart from the question of how to represent choice criteria of farmers that include risk considerations, an even more pervasive problem confronting economic maximizing models under uncertainty relates to how such problems should be structured to allow optimum choices. With the explicit incorporation of risk in decision models, the complexity of farm production processes and associated decision problems should also be recognized. Uncertain influences from the environment may not only affect the outcomes of activities, but may also profoundly affect the structure of the choice problem itself. In fact, as will be discussed later, one of the chief problems in investigating the impact of uncertainty on decision making is the intrusion of the time factor. With the passing of time, more information becomes available on which to base predictions of outcomes and feasibility of choice options, and thus better decisions can be made. On the other hand, at a certain time decisions have to be made as further postponement may imply reduction of income or an opportunity foregone. Hence, the time factor introduces a sequential element in decision making and the possibility to adapt to environmental influences in the course of the choice process (Section 3.2.1).

Sequential solutions to decision problems are differentiated from one-period solutions by the information utilized by the decision maker. The information pertains to three features of sequential solutions (Antle, 1983):

- <u>sequential dependence of decisions</u>: decisions made earlier may affect those made later, so that the optimal choice of an input may be a function of an earlier applied input. If the farmer takes this into account, then his optimal input choice in period 1 may depend on how it affects optimal inputs in period 2;
- <u>information feedback</u>: information that becomes available during earlier stages may be utilized in subsequent decisions. The farmer may use knowledge on actual crop development rather than initial estimates of production to determine optimal input levels at later stages in the production cycle;
- <u>anticipated revision</u>: decisions made earlier may be revised later as new information becomes available. The farmer's initial decisions may be different if he knows that he can revise these decisions at later stages rather than having to rely on initial expectations.

Sequential choice problems are generally not amenable to solutions by mathematical programming methods or by any other optimizing method. The problem why sequential decision problems are not easy to handle stems from the fact that at least one of the sequentially related decisions, say the (k)th, cannot be fully specified until one or more of the random parameters in the system has been observed. For the decision variable x(k) to be optimal, it must be based on an analysis of the problem including the realized values of the random variables. This means that, ex-ante, the optimal value of the x(k) variable will not simply be a number, but will be a strategy specified as a function of one or more of the random variables observed before decision (k) is taken (Anderson et al, 1977). Consequently, if the choice problem under consideration is even moderately complex, the size of the programming matrix quickly expands to unmanageable proportions. This explains the very few studies that explicitly take into account the sequential nature of decision problems.

To deal with such choice situations inevitably means an analytical simplification of the problem the solution is sought for. Simon (1979) indicates that there are essentially two ways of simplifying choice problems:

> The first is to retain optimization, but to simplify sufficiently so that the optimum (in the simplified world!) is computable. The second is to construct satisficing models that provide good enough decisions with reasonable cost of computation. By giving up optimization, a richer set of properties of the real world can be retained in models. Stated otherwise, decision makers can satisfice either by finding optimum solutions for a simplified world, or by finding satisfactory solutions for a more realistic world.

Simon indicates that the commonly employed dichotomy between optimizing and satisficing solutions is, to a large extent, arbitrary. In fact, there is practically no way of determining what decision procedure will lead to economically best results. There is, however, a clear difference in focus: optimization implies emphasis on the objective function to be maximized (i.e., the choice algorithm), whereas satisficing primarily concentrates on the feasibility and constraint side of decisions, including lack or insufficient information. The economist's tradition is to adhere strongly to optimization and to sacrifice problem representation to optimizing algorithms. The focus is on the act of choice rather than on the design and structure of the choice problem. In fact, emphasis on choice criteria and maximization has resulted in the above discussed hypothetical decision models that have, in the words of Besusan-But (1980):

> the peculiar quality of being, simultaneously, elaborate beyond the powers of any normal imagination and simplified beyond recognition. ... (they are) designed to deal with the affairs of the moment rather than a period of time and ... embody a wild exaggeration of the rationality of the indvidual at that moment.

In other words, it has become common usage among economists to employ highly sophisticated choice algorithms for relatively simplistic representations of the problem situation. It is questionable whether such models do yield results that are relevant to real-life choice problems, i.e., do they solve the choice problems farmers are actually facing.

A different class of decision theories departs from the assumption of maximizing behaviour and takes explicitly into account man's limited ability to process information. This so-called behavioural approach to decision making has a long standing history (e.g. Simon, 1957; Cyert and March, 1963; Forrester, 1961), but until recently was largely neglected. The idea of this approach is to observe how people behave, systematize and formalize their rules of behaviour, and study the dynamics of models based on these rules, using system analysis and computer simulation.

An example of a decision theory based on the behavioural approach is the '<u>elimination by aspects</u>' theory of Tversky (1972). This choice theory involves a screening procedure of alternatives in a number of stages. Each alternative is considered to be composed of a set of characteristics or aspects. An aspect is an attribute or feature of an alternative, 'an aspect can represent values along some fixed quantitative or qualitative dimensions (e.g. price, quality, comfort) or they can be arbitrary features of the alternatives that do not fit into any simple dimensional structure' (Tversky, 1972). For example, the aspects of a crop alternative could be output level, timing of output, cash input requirements, dietary value, the extent of the farmer's knowledge about the crop, etc. The theory assumes that all aspects are perceived by decision makers as discrete. When decision makers use a continuous quantitative dimension or aspect, they discretize it or categorize it into a small number of values (Gladwin, 1980).

Prospects are compared on the basis of one aspect at a time and those that do not satisfy some predetermined standard are eliminated. The process continues by considering progressively less discriminating aspects until only one alternative remains. Similar to lexicographic orderings, the approach does not allow for a trade-off among dimensions. Further it does not ensure that retained prospects are indeed superior to those eliminated.

Gladwin (1980) developed a choice procedure based on the elimination by aspects theory of Tversky. It is essentially a two stage procedure. As the first step in the procedure, decision makers narrow the set of alternatives to a feasible subset that satisfies certain minimal conditions. That is, they screen and eliminate some of the alternatives on the basis of some obvious negative aspects or constraints (e.g. land not suitable for a specific crop, too high investment requirements, no experience with alternatives, etc.). This initial screening and elimination of alternatives occurs unconsiously or 'pre-attentively' (Gladwin and Murtaugh, 1980). After elimination of irrelevant aspects, the decision maker picks one important aspect to order, partially or fully, the alternatives on. Then, the decision maker considers the constraints that are imposed on the alternatives from the environment, and passes the ordered alternatives through the (unordered) constraints. If the alternative ordered first does not pass all the constraints, the alternative ordered second is screened, and so on. If none of the alternatives passes all the constraints, the choice set is empty, and another choice strategy is required. Stage 2 of the theory is thus an algebraic version of maximization subject to constraints, and may be represented by an algorithm, decision tree, or set of decision rules (Gladwin, 1980).

3.4 Assessing the importance of risk in agricultural decision making

From the foregoing, it will be clear that a potentially large number of variables need assessment before one can arrive at some answer regarding the importance of risk in decision making and how risk may be incorporated in relevant choice models. Similar to testing the hypothesis of maximizing behaviour of farmers, testing the existence and importance of risk aversion is difficult as it concerns a general behaviour orientation that pervades decision making at all levels. In particular, determining the degree of attitudinal risk aversion and its influence on decision making will be difficult as it concerns an idiosyncratic factor that cannot be evaluated against an objective measure. In principle, it should be less difficult to prove the occurrence of resource-induced risk aversion as the underlying variables are structurally determined and more easily observed.

A part of the literature simply takes the existence of risk aversion for granted. In all kinds of traditional agricultural practices and institutions, it observes measures through which farmers attempt to reduce risk. Upon closer scrutiny, however, these measures can often be explained by other factors such as ill-fitted recommendations, real costs faced by farmers, or the non-existence of a market for agricultural products. Moreover, existing agricultural practices often turn out to be optimal both from an income and an income stability point of view.

A typical example of the apparent importance of risk in determining agricultural practices relates to West-Africa, where for some time it was assumed that sole cropping was more productive than mixed cropping, and the persistence of the latter was considered the result of the farmers' wish to reduce risk. However, careful research revealed that, apart from stabilizing yields, mixed croppings also yielded higher than sole stands because this technique makes an optimum use of environmental inputs, reduces adverse conditions in the ecosystem, and physically protects the soil (Norman, 1974). Hence, the observation that farmers attempt to stabilize income from production activities does not necessarily imply that such behaviour also results in a sacrifice in economic returns, i.e., it does not imply that farmers are risk averse in a strict economic sense.

In this respect, it is important to note that 'fluctuation aversion' does not necessarily imply 'risk aversion' (Lipton, 1979). The former concerns the psychological disposition of individuals to avoid unsteady outcomes. Such behaviour orientation may well prove to be economically efficient in the long-run given the occurrence of storage losses as well as interest and trading costs (differences in buying and selling prices, marketing costs) that are normally associated with large between-year fluctuations in agricultural output. Risk aversion, on the other hand, should be reserved for those situations, where decision makers consciously select alternatives that either have lower risk levels compared to other alternatives but are similar to the attainment of other objectives, or, alternatively, have similar risk levels but are less efficient in attaining other objectives. Defined in this way, risk aversion implies the existence of a conflict between a security motive and other objectives, i.e., it always has a cost in terms of foregone benefits.

The usual approach to assess the impact of risk on agricultural decision making is to examine the validity of a particular choice theory and underlying behavioural assumptions. Such studies compare the decision maker's actual choice with a prediction derived from the theory under consideration. For example, to test the validity of the expected utility maximizing model it is common to derive a farmer's utility function from an artificial choice set and then to apply such function to an 'actual modelled choice situation' from which a prediction is obtained which is compared with the decision makers' actual choice.

In order for such comparison to constitute a test for a specific theory and an assessment of the importance of farmers' risk aversion, the model must be accurately specified in the sense that it represents the choice situation of the farmer in a meaningful way, the variables in the model should have been measured accurately, and all elements that are considered relevant by the farmer should be included. Except for relatively simple choice situations, such conditions are probably difficult to meet. Moreover, if other theories predict equally well, no conclusive evidence from such tests can be obtained.

Thus, it is not surprising that few attempts have been made to put one theory against the other employing the above framework. Lin *et al*'s (1974) research on six commercial farmers in California is one of the few rigorous tests of the validity of the expected utility maximization theory as compared to expected profit maximization. Dillon (1979) mentions a number of other studies that have attempted to test this theory as positive and behavioural (Officer and Halter, 1968; Wolgin, 1975). As one of the major advocates of the utility maximization model, he arrives at the conclusion that none of the evidence is absolutely convincing and that there is a variety of evidence supporting or at least not disapproving other behavioural theories such as Safety First.

Boussard (1979) indicates that the majority of the models discussed in Section 3.3.2 (excluding some of the game theoretic models), whatever their theoretical support, yield about the same results when applied to actual farm problems. 'This fact suggests the practical uselessness of theoretical quarrels. But it is even more striking to observe how easily one of these models can be expressed as an approximiation of another one' (Boussard, 1979). Dillon (1979) concludes that 'the literature gives the impression that starting with a reasonable positive theory, it is not difficult to find reasonable support for it through either mind experiments or revealed choices'. As risk tends to have a conservative effect on choice, any theory which recognizes this marginal effect may, on average, approximate farmers' choice more adequately compared to expected profit maximization.

A substantial effort has also been spent on measuring farmers' risk preferences employing direct elicitation procedures as described in Section 3.3.2. Young (1979) summarizes the results of these studies. He arrives at the general conclusion that farmers in developing countries are, by and large, risk averse. However, Young also indicates that a considerable heterogeneity exists in risk preferences among individual farmers with superficially common business and personal characteristics. This may either indicate the existence of risk aversion as a pure idiosyncratic phenomenon or show the unproven reliability of the methods to assess risk aversion. We have earlier discussed the substantial problems in proving the validity of the employed risk preference concepts and elicitation methods. Hence, these findings should be treated cautiously. It is, for instance, not quite clear what kind of risk aversion is actually measured. It appears that 'attitudinal risk preferences' and 'resource induced risk aversion' may easily be confounded.

Underlying the difficulty in assessing the validity of the various choice theories and thus of the implied risk definitions, is the more general problem of isolating the effect on choice due to risk considerations from other variables influencing decisions.

First, risk models contain a number of 'working parts' which tend to obscure what actually drives the model into making predicted choices (Walker, 1981). For example, similar results may be obtained from models that predict choices using expected utility maximization and expected profit maximization models if the latter type models take into account a sufficiently high opportunity cost of capital. Further, few studies have simultaneously analyzed the contribution of both perceptions and attitudes in explaining choices for one decision situation. If farmers employ simple discounting measures to account for risk in activity returns, return perception would be sufficient to explain conservative choices. O'Mara (1971) and Walker (1981) represent two of the few efforts to formally establish the relative significance of risk perceptions as opposed to risk attitudes as determinants of adoption.

Second, the structure of the choice problem employed in most studies is essentially similar to the classical static (linear programming) model in a riskless environment. Except for the objective function, the basic choice structure remains unchanged. These models largely ignore any consideration for the timing of events by (paradoxially) assuming that except for the activity returns, all other parameters are fixed and not subject to the influence of uncertain environmental factors. For most agricultural decision situations such assumption is untenable. In practice, risk is seldom if ever confined to those coefficients. Both technical coefficients and resource stocks may be stochastic. For example, on a crop farm the rate of cultivation, sowing, or harvesting, and the time available for these tasks can vary widely from year to year. Further, few studies take into account the sequential nature of most farm planning problems.

The above inadequacies in model specification severely restrict the usefulness of results of approaches that compare predicted input levels or farm plans derived from one-period decision models with actual input levels or areas of crops planted that are decided upon by farmers in the course of the production process. Such approach may only be valid in case the production process does not allow for temporal adjustments to be made by farmers in the course of the production process. However, as will be indicated later, farmers are often able and do adjust input levels and planned crop areas in case such is necessary. In such a situation, the only valid approach when using one-period decision models, would be to compare predicted input levels with levels that are planned by farmers at the start of the production period.

Third, the majority of studies attempts to test the validity of one all-encompassing decision rule or procedure (usually single attribute or a lexicographic ordering of decision rules) which is assumed to apply to all types of economic decision problems of farmers irrespective of the circumstances under which decisions are taken. It is, however, quite possible that different decision criteria and procedures are used for different choice problems or for the same type of choice problem under different circumstances. For example, risk averting behaviour may change to risk seeking behaviour if a period of poor production years is followed by a number of good years. It appears that in constructing an adequate model of economic behaviour, it will be necessary to allow for different modes of behaviour which might be combined in one single individual.

The general conclusion that can be derived from this review is that none of the proposed theories have yet been tested to the extent that it can be used as a framework for examining the existence of risk aversion and assessing the importance of risk. At least not for small farmers in developing countries. Generally, it appears that it will be more fruitful to initially test the various behavioural assumptions underlying these theories than testing the theory itself. It should, in principle, be easier to provide knowledge about how people behave than how they should best decide (Day, 1979). For example, before testing the inherently more complex hypothesis that decision makers are actually making decisions as if they were expected utility maximizers, it seems appropriate to initially test the proposition that farmers in fact do maximize or optimize. In the context of factor input supply, if farmers behave as maximizers, a necessary condition should be that they perceive diminishing returns to an increasing level of applied inputs.

The main reason, however, why efforts so far have been rather unsuccessful is the poor representation of the choice problems facing farmers in the real world and the fact that in economic studies hardly any account is taken of how farmers themselves perceive choice problems and simplify choice procedures. Associated with these shortcomings is the limited knowledge concerning other aspects of farmers' decision making, i.e., how farmers perceive cost of production; how they value output; how conflicts in financing consumption and investments are resolved; what the effect is of 'leisure' preferences on labour investments; etc. As indicated by Weeks (1983), the tendency among economists is to concentrate more powerful modelling techniques on more specialized aspects of farming and farm operator decision making rather than on the integrative analysis actually needed.

The following aspects of choice under uncertainty should be accounted for when assessing the importance of risk and risk aversion on household behaviour:

- the extent to which environmental uncertain factors have a negative influence on the outcome of income generating activities;
- the degree of control farmers have over these environmental factors to mitigate their negative effect on the outcomes of income generating activities;
- the relative magnitude of differences in perceived riskiness and profitability of the various income earning opportunities;
- the size of these risks relative to the total household income;
- the extent to which farm-households are able to take risks, taking into account the need to cover basic subsistence requirements as well as the household's access to non-household means to spread or diffuse the consequences of risk taking;
- the extent to which farmers are willing to take risks.

In analyzing the above aspects of decision making under uncertainty, this study starts from the assumption that in most cases, the majority of people, including small farmers, tend to behave rationally in the sense that they exhibit choice patterns that are subject to rules that can be understood, i.e., behaviour is not a random event. Without such premise, explanation and prediction of behaviour are impossible because all real world events would then be the result of chance. Defined in this way, rational decisions encompass all purposeful choices that are consistent with an individual's expectations, level of information and behavioural strategy which exist at the time and place a decision is made. Such rationality should be understood in the wider context of the economy and social system within which decision making takes place. Of course, the above concept of rationality does not imply that emotional, impulsive, habitual or immitative types of decisions do not occur.

Rationality of household behaviour should be understood within the context of the economic and social system in which households act. Thus, logically prior to the analysis of decision making of individual households is a description and analysis of the environment within which households have to operate. If one accepts the notion that behaviour is adapted to environmental constraints, understanding present household behaviour also requires knowledge about the way in which households adapted to changes in the environment in the past. From such perspective, decision making is analyzed in terms of people's responses to dynamic environmental circumstances that impinge on the constraints, cost, and returns of alternative income earning opportunities. Such an approach deviates from the often employed approach of analyzing decisions from an 'innovation-adoption perspective'. Such framework tends to imply that the pre-innovation state is static or tradition-bound rather than a reasonable response to circumstances.

> Until recently, development planners and a majority of scholars concerned with development assumed that the agricultural practices of low-income rural people are governed by tradition, change only slowly, and are often poorly adapted to local conditions. Moreover, it was assumed that traditional rural societies were more or less static, and that their institutions must be broken down or greatly modified because they were constraints on more rational development (Hoben, 1980).

Associated with this belief is the idea that small rural households are averse to risk taking, a factor considered to be important in explaining slow adoption rates of new and improved technologies.

This chapter shows that this particular village has had a long history of changes in the decision making environment. During the period 1920 to 1980, the number of households more than quadrupled, from around 25 in 1920 to 119 in 1980. At the same time, the average size of landholdings declined from an estimated 3.5 ha of riceland around 1930 to roughly 1.5 ha of farmland (including 0.2 ha upland) in 1980. Accompanying this increasing man/land ratio, was a gradual change in crop production technology. The initial single rice crop monoculture was transformed into a complex, multiple cropping system including both rice and upland crops. The introduction of IR-varieties and double rice cropping is a new phase in this land use intensification process. Despite the widespread use of 'modern' rice production technology, recent demographic developments seem to indicate that - given present technology and availability of off-farm employment opportunities - the village economy is reaching a saturation point with regard to the absorption of farm-households. The average farm holding size of households that started to farm after 1970 further declined to 1.2 ha. Moreover, during the latter half of the 1970s the growth rate of the number of farm households also continued to decrease: 1.5% per annum for the period of 1975-80 compared to an average post-war level of 2.4% until 1975.

This chapter starts with a brief introductory description of the natural environment of the village (Section 4.1), a further elaboration of which is given in Section 5.1.1. Section 4.2 deals with the interrelationship between demographic development and the manner in which farm-households exploit their natural resources. In the recent village history, four distinct economic development stages are distinguished. The last stage - intensification of rice crop production - will be dealt with in more detail in Section 4.3. The extent to which government-initiated development programmes during the 1970s supported farmers' attempts to intensify crop production is discussed in Appendix II.

4.1 The natural environment

The study village is located on the north-eastern fringe of the Iloilo plain. Foothills of the Western Cordillera mountain range dominate the north-western part of the area. These hills are penetrated by narrow valleys (suok-suok) which run out to the eastern part of the area in a bowl-shaped mini-plain. This foot-valley complex forms a considerable catchment area for rainfall. Excessive cutting of firewood in the past (1) denuded most of its wood cover and severely reduced its water retention capacity. Consequently, heavy rainfall during the wet season results in a sudden heavy run-off. In some valleys, waterflows are partly channelled through drain ditches along the foot of the hills, but their capacity is limited and they easily overflow. More commonly, water drains from one field into another following the 'staircase' topography of the area. Towards the plain portion of the area, water flows become channelled through tracks of low-lying fields (waterways). They finally drain into a brook intersecting the plain area. The brook discharges into a river which encloses the study site to the western and southern sites. During periods of continuous heavy rainfall, the drainage capacity of the brook is substantially reduced by the high water level in the river, occasionally causing short periods of sustained flooding to depths of 1 to 1.5 meters. In addition to rainfall, in some valleys springs provide sufficient water to irrigate small areas of rice during dry spells in the wet season and sustain crop growth 1 to 1.5 months into the dry season.

Due to the topography of the area, there are considerable differences in land quality. On the basis of their geomorphic location, in total seven landscape positions and three water management classes were identified (Section 5.1.1). The soils in the area belong to the Pellic Vertisols or low humic gley soils. The main soil series represented is a recent alluvial deposit of fine soil material from surrounding uplands. It has a high clay fraction; it is plastic and soft when wet, but shrinks and cracks, and becomes very hard when dry. Soil differences in the area generally follow the catena or toposequence (i.e., the topographical sequence of a sloping area), with soil types becoming heavier towards the lower landscape positions.

Agriculture is influenced by a distinct wet and dry season. The rainfall pattern is unimodal and consists of 5 to 6 consecutive months of over 200 mm and between 3 to 4 months of 100 to 200 mm. The wet season gradually starts in May-June, with ponding of water in rice fields usually occurring in June-July. The dry season covers a period of 4 months and starts in January. The major determinant of rainfall is an inter-tropical convergence zone, a perennial band of clouds oscillating between the Philippines and the Indonesian archipelago. Originating in the mid-Pacific, tropical cyclones (typhoons) usually pass through the north-east quadrant of the Philippines in a matter of days - normally intensifying the south-east monsoon in the process - before recurving towards China and Japan. Tropical cyclones, of which there are usually about 20 every year in the Philippines, are responsible for about half of the wet season rainfall. Consequently, wet season rainfall is often clustered into short periods of heavy rainfall (Bolton, 1980). Late season rainfall is usually discontinuous, whereas early season rainfall - April and May - is principally convectional and very erratic. Mid-season rainfall is mainly cyclonic and more dependable. The destructive winds usually associated with cyclones, rarely cause crop lodging in Iloilo Province. In the last 32 years, only 14 typhoons passed through the area.

4.2 Agricultural and demographic development until 1970

Village settlement

The origin of the village can be traced back to four families who stayed in the village area around the mid-19th century. The descendants of three of these families still form the major part of the village population today. At the turn of the century, growth rate of the provincial population was low - about 0.5% annually from 1870 to 1903 - probably due to high infant and child mortality as well as high adult death rates caused by the occurrence of epidemic diseases. Around 1900, a large cholera epidemic decimated the population in the province. The same period showed an outflow of most villagers to the nearby town. The political turmoil, caused by the 'Iloilo-Uprising' against the Spanish occupants in 1898 and the American-Filipino war (1899-1901), apparently created such an insecure situation in the rural areas that families sought the safe sanctuary of the nearby town to protect themselves from armed attacks by robbers. During this period few families stayed in the village permanently and farming was mainly carried out on a commuter basis. Between 1910 and 1920, the settlement became more permanent again. Until after the Second World War, the village was a sitio (neighbourhood) of another village. In 1948, it was officially recognized as a separate

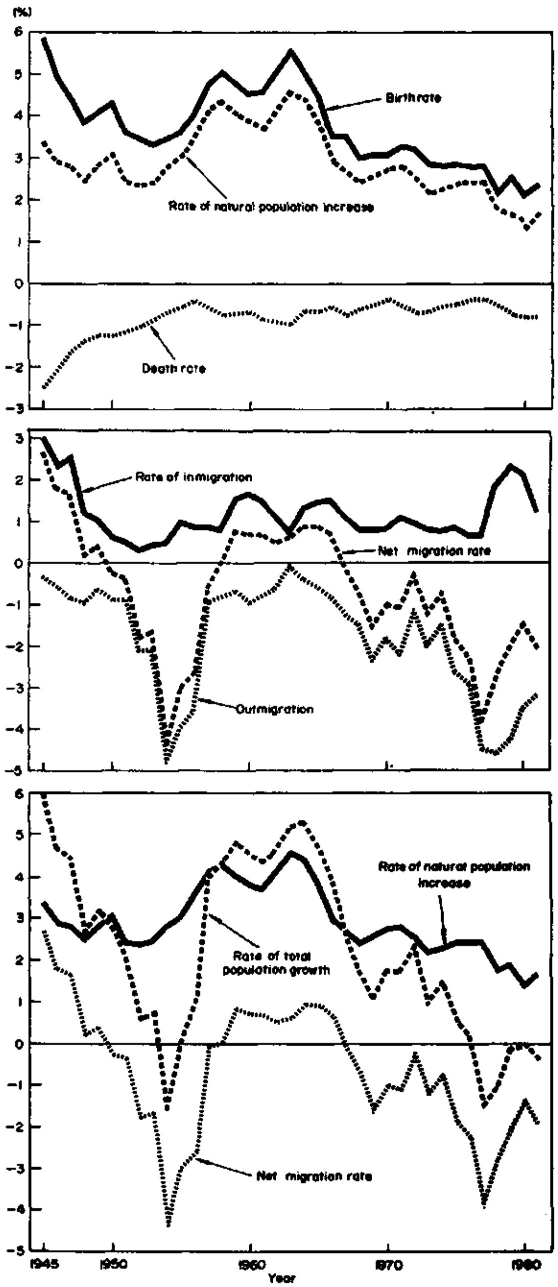


Fig. 4.1 Pattern of demographic development study village; three-year moving averages (1945-82)

administrative unit.

Village population growth and changes in farm technology and employment

On average total population growth over the period 1920 to 1980 was 2.7% annually. During this period, population growth rates experienced strong fluctuations (Figure 4.1). The major determinant of these fluctuations was the cyclical movement of the net migration rate. Associated with this demographic development were major changes in agricultural production technology and employment. In this process, four distinct development stages can be distinguished.

I. 1920-1940: A closing land frontier and the emergence of a tenant class of farmers.

During this period, the population increased from about 125 to 195 persons, with an average yearly growth rate of 2.2% (Table 4.1). The number of households nearly doubled, whereas the type and intensity of crop production remained largely the same. One crop of rice per year was grown after which the land was left fallow. Before transplanting rice, fields were usually ploughed once using a wooden plough with a steel end. Handweeding was not common practice. Harrowing of standing rice crops was practised as a method of weed control. Harvesting was mainly done with a finger-blade harvesting knife (kayog).

Table 4.1 Changes in population and number of households for the period 1920-80

Year	Population 1)	Number of households		
		total	farmers	landless
1920	125	25	-	-
1940	195	39	-	-
1945	278	53	-	-
1950	337	58	-	-
1960	403	67	-	-
1965	511	86	-	-
1970	586	95	75 (79) 2)	9 (9)
1975	629	109	89 (82)	8 (8)
1980	616	119	96 (81)	11 (9)
Annual compound growth rate (%)				
1920-50	3.4	2.8	-	-
1950-60	1.8	1.5	-	-
1960-70	3.8	3.6	-	-
1970-80	0.5	2.3	2.5	2.0
1975-80	-0.4	1.8	1.5	6.5

1) For 1920 and 1940, the population is estimated on the basis of the number of households, assuming an average household size of five persons.

2) Figures in parentheses are percentages of the total number of households.

Apart from rice cultivation, carabao raising provided an important additional source of livelihood. Upland areas, hardly used for crop cultivation, offered sufficient grazing areas for the cattle herds. Marginal lowland areas were left uncultivated and year-to-year rotation of rice land was still practised. A traditional home-based weaving industry provided regular employment for most women and was a main source of cash income for the household.

Absorption of households was possible without a substantial decline in farm sizes and income levels, partly due to an open land frontier, and partly due to a process of transfer of cultivation rights from the (well-educated) children of the relatively larger, town-based landowners - who apparently preferred city jobs to an agricultural occupation - to the children of the resident families. This process, coupled with a rapid fragmentation of inherited, owned land as well as loss of owned land due to sales or mortgaging, resulted in a rapid decline of the number of owner-operators. Share-tenants and part-owners emerged as the predominant class of farmers in the community. At the end of this period, it gradually became more difficult to acquire land. Most vacant lowland areas and land previously farmed by the larger landowners were brought into cultivation by village farmers.

II. 1940-1960: Increasing population pressure on land and worsening tenure conditions

A large inmigration flow during the early stages of the Second World War caused a sharp increase in the total population: 7.3% during the period of 1940-45. Most of these families became permanent residents after the war, bringing the total population to 278 persons in 1945. This trend of inflow continued during the first few years after the war, consisting of migrant families from neighbouring, economically depressed upland areas. The period of 1945-50 showed very high birth rates as well as death rates, which both declined gradually towards the end of the 1940s resulting in a more or less constant annual rate of natural population growth of around 3%. Consequently, total population growth that had been very high just after the war declined rapidly.

After the war, farmers gradually started cultivating the vacant upland areas, probably following the example of the immigrant upland farmers. These areas were no longer used as grazing areas for cattle since the war had decimated the number of carabaos. Crops grown on the upland areas included corn, mungbeans (*Phaseolus aureus*), and taro (*Colocasia esculenta* spp. dasheen), locally known as *dagmay*. Rice cultivation became more intensive with improved land preparation associated with the gradual introduction of the steel plough. Seasonal migration of groups of young women to rice areas in the northern province of Panay (Capiz), where they found employment as harvesters, increased. A home-based sewing industry on a piece-work contract basis rapidly became an important cash-earning activity for women. It replaced the existing weaving industry which had disappeared during the war. The large influx of new households caused a sharp increase in the demand for land. As a consequence, the landlord's share for newly acquired land tenure contracts started to increase from a one-third share to a two-fifth level. This change in share rent levels was the beginning of a period of worsening tenure conditions which lasted until the declaration of land reform in 1973.

During the mid-1950s, poor economic conditions induced a relatively large number of families to migrate to Mindanao. More than 10% of the village households migrated to the new frontier areas in Mindanao, an island located some 500 km from the village. They were participants in a government organized resettlement programme which involved the allotment of a 5 ha farm to every household. This outflow included young couples as well as families with older children who found future farming opportunities in the village too limited. For instance, the latter group included one household with five sons that owned (and sold) 3 ha of good riceland. The migration inflow during this phase was insignificant and consisted mainly of young people who came to the village to marry. The natural population growth increased sharply at the end of the 1950s when the children of war and post-war in-migrants reached their reproductive age and the death rate had stabilized around a level of 0.5%. Total population growth during the period 1945-1960 reached a comparatively low annual level of 1.65%, mainly because of the outmigration of families to Mindanao.

III. <u>1960-1970: Land use intensification under a rapid decline of farm sizes</u>

This period recorded a net population inflow. The rate of inmigration fluctuated between the 1% and 2% level mainly due to two waves of return-migrants from Mindanao, whereas the rate of outmigration declined to a level of about 0.5%. On the other hand, the high rate of natural population increase continued to be high throughout this period mainly due to the relatively large number of young married couples stemming from post-war inmigrants and possibly postponement of marriages during the war. Consequently, the total population growth rate was very high, fluctuating around an annual level of 4.5%.

As a result of the increasing number of households, farm sizes started to decline rapidly. This occurred in spite of the fact that the area farmed by village farmers continuously but slowly increased through the renting in of land from small town-based commuter farmers moving out of agriculture. Both rice and upland crop cultivation became substantially intensified through the introduction of improved seeds, better agricultural practices and multiple cropping. A number of improved rice varieties - released by the Philippine Seedboard - entered the area in the latter half of the 1950s, of which the BE-3 variety became most popular occupying most of the rice area by the end of the 1960s. This photo-sensitive variety was relatively short-statured and had a somewhat shorter growth duration compared to the existing <u>Macan</u>

varieties such as Arabon. Compared to Arabon, it was much more responsive to fertilizer in terms of grain yield. As farmers recall, a fertilized Arabon crop could grow over two meters high causing substantial problems with harvesting. It took a long period (roughly estimated, a period of ten years) before the BE-3 variety was adopted on an appreciable scale. The reason attributed by farmers to the slow rate of adoption was the inferior grain quality compared to existing varieties. Although the yield of the BE-3 was higher, the nutritional value of the variety was found to be substantially lower, due to a lower oil content. Farmers assert that with a good breakfast of Arabon they could work until after noon, whereas with the BE-3 meal they already became hungry at 11 o'clock in the morning. According to farmers, after some period, the grain quality of the BE-3 improved due to cross-fertilization with the Macan varieties.

Together with these new rice varieties, fertilizer and pesticides were introduced, and land preparation and crop care received more attention. The necessity to use fertilizer to increase production per hectare is probably the main reason for the increase in adoption of BE-3 during the latter half of the 1960s. Farmers started to grow upland crops in the lowland fields: corn as a first crop before rice and mungbean or cowpea (Vigna unguiculata) as a relay-crop after rice. In the upland fields, the area planted to dagmay increased substantially and it gradually became an important commercial crop. Squash (Cucurbita moschata) and melon (Cucumis melo) were other crops introduced in upland fields. By the end of the 1960s the entire usuable upland area was occupied.

However, according to village people, despite these improvements in agricultural production technology, economic conditions for most families remained depressed. Apparently, the increase in land productivity was not sufficient to offset the decline in the size of farm holdings, a process which affected young households in particular. Moreover, tenure conditions remained bad. This was further aggravated by a number of successive years of low rice production due to poor rainfall conditions at the end of the 1960s as well as the decline of the home-based sewing industry. Upland crops became the lifeline of the village. Rice was bought with the proceeds of dagmay production and bananas and corn became important substitutes for rice in daily meals. Nevertheless, a large number of families entered into a heavy debt burden certain amounts of which were still being repaid at the end of the 1970s (Section 6.3.2).

At the end of this period declining birth rates and a new outmigration flow resulted in a sharp decline in the rate of total population growth and net population outflow. Outmigration was mainly due to young single male and female residents migrating to urban areas, in particular Iloilo City and Manila. This youth migration was partly responsible for the lowering of birth rates. Even if they eventually returned to the village, it meant postponement of marriage.

IV. 1970-1980: Intensification of rice crop production associated with an increasing use of family labour

During the period of 1970-1980, the village experienced the introduction of a staggering number of development programmes and institutions. Most of these programmes were in line with the - in the early 1970s - generally held belief that government support programmes in the form of agricultural extension, low-cost credit, and farmers' organizations were essential prerequisites for getting 'agriculture moving'. After a private development organization introduced a consumer cooperative in 1970, and a local credit union in 1971; land reform was proclaimed in 1972; a communal pig fattening and breeding project also started in 1972; a rice production-cum-credit programme (Masagana-99) was launched in 1973, together with a local farmers' association; a cooperative marketing organization was initiated in 1976; a birth control programme started in 1978; the village became a pilot village for an integrated provincial development programme in 1980 (Kabsaka); a new loan scheme was organized by a cooperative rural bank in Iloilo City; and, finally, a new farmers' association was established in 1981.

These programmes have been criticized because of their so-called 'top-down' nature. The fact that they are conceived and initiated from an above-village level without consulting the community about felt needs and project priorities. Also in this village, these programmes have had a limited positive impact on the economy because they were technically ill-conceived, not well adapted to local circumstances, or not serving any particular purpose. If anything, they have instilled the attitude to be cautious with projects initiated from outside the village on a large group of villagers. As one young farmer expressed when asked whether he would join the farmers' association: 'I was not yet farming when they started to organize themselves and if they will reorganize, I will not join because it does not benefit its members although it already exists for quite a long time. This organization is just a big waste of time'. In Appendix II, the experience of the village with two of these programmes is reviewed indicating why they performed poorly and actually had an adverse effect on the development of rainfed agriculture in the village. In fact, they presented substantial risks to farm households.

However, when introduced in 1973, both land reform and the Masagana-99 programme (M-99), provided a welcome relief for the depressed economic situation at the end of the 1960s. Land reform effectively restored share-rent levels to the pre-war one-third share contract, whereas most fixed rent levels were adjusted downwards. But, due to the high fragmentation of land ownership titles, the main objective of the land reform programme - transferring land from landowners to tenants by way of making them amortizing owners - was never realized in the village. Although a considerable portion of the land is in the hands of a small rural elite living in the nearby town, landholdings normally do not exceed the 10 ha size. Apparently, the three town families with

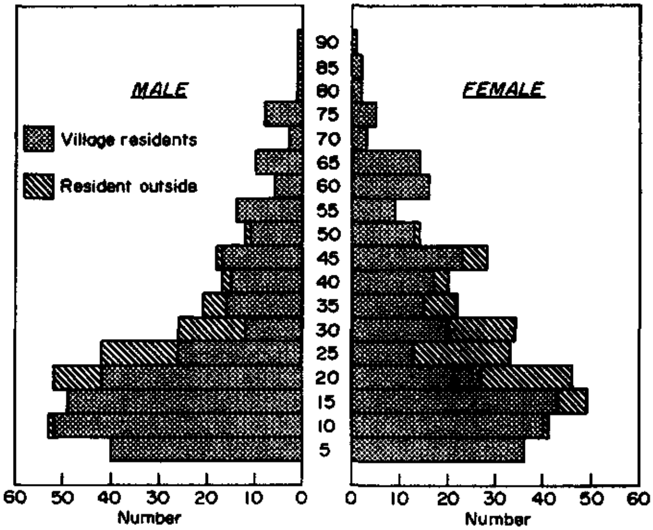


Fig. 4.2 Population pyramid; age distribution of the resident population and of outmigrants (1980)

larger holdings (up to 40 ha) had ample time to redistribute the titles among relatives or were not considered large enough to warrant redistribution by the Department of Agrarian Reform.

For most participating farmers, the M-99 programme meant a one-time injection of cash which was mainly used to convert existing (expensive) local cash debts into bank debts as well as to pay for the school fees of children for High School enrollment. Because of repayment problems (Appendix II), these bank debts were later again converted into local debts. With the introduction of the M-99 package, the new IR-varieties became available and liberal amounts of fertilizer and pesticides were provided in kind. For reasons discussed in Section 4.3, the use of the new varieties increased rapidly after 1975.

After outmigration rates seem to stabilize for a short period (1972-74), probably due to the increased High School enrollment which resulted in a halt of outflow of village youth to the unskilled urban sector, outmigration started to increase at an accelerated pace. High school graduates formed the major stream of the out-migrants moving out to the urban sector. Their employment in urban centres gradually shifted from unskilled to more skilled ones for which a higher education is required. Family outmigration, whose destination remained rural throughout this period, became relatively less important. The rate of inmigration also increased towards the end of the 1970s. The group of inmigrants consisted partly of returning families with kinship relations in the village, and partly of single migrants returning from the urban sector to the village for marriage. However, throughout this phase, the number of outmigrants outweighed that of inmigrants resulting in a large population outflow.

The population pyramid of 1980 (Figure 4.2) shows the striking result of the migration pattern in this period, i.e., half of the population in the age category of 15-30 years were out of the village. During the last few years of the 1970s, most men and nearly all women in this age category, who were not enrolled in High School or married, migrated out of the village. As a result of the large net outflow and of the slowly declining rate of natural population growth, the total population, which had increased at an almost constant rate of around 2% in the previous three decades, even started to decline somewhat during the latter part of the 1970s.

The occupational structure of the village, as of March 1979 (Table 4.2), reflects its agricultural character. If a population between 13 and 65 years of age is assumed as 'economically active' in the sense that they can participate in productive labour, the potential labour force in the village was 363 persons - 178 males and 185 females. Roughly 22% of both the economically active male and female population is attending school. Of the remaining male population, 86% is directly engaged in self-employed farming and 5% is engaged in occupations that are related to agriculture such as farm wage labour or marketing of farm products. More than half of the group of farmers does not mention a secondary occupation,

Table 4.2 Occupational structure of the economically active population (13-65 years) as of March 1979

	Male	Female
Number of economically active persons	178	185
Major occupation		
Farming: own farm	66 1)	1
farm labourer	3	2
Tapping coconut wine	1	0
Carpenter	3	0
Other non-farm self-employed	3	4
Salaried worker	0	1
Household	1	69
Schooling	22	22
None	1	1
Total	100	100
Minor occupation		
Farming: own farm	26	38
farm labourer	24	15
Tapping coconut wine	1	0
Carpenter	3	0
Rice mill	2	0
Other non-farm self-employed	4	10
None	40	37
Total	100	100

1) Percentage of total economically active population.

whereas one-third is engaged in farm wage labour. Other secondary occupations beside farming include carpentry and the marketing of agricultural products. Only few male villagers are employed as full-time wage labourers, indicating the small number of landless workers.

The female population, excluding those who are attending school, is primarily occupied with housekeeping (87%). However, besides housekeeping, a large number of females is active in a secondary occupation, mainly farming (48%), farm wage labour (13%) or other economic activities related to farming. Of the 14% of the female population not primarily engaged in housekeeping, two-thirds are occupied with farming or farm related activities. A considerable number of villagers is employed outside the village; of the total economically active male and female population, 14% and 22%, respectively.

4.3 Technological change in the 1970s

The initial introduction of the non-photosensitive, short-statured IR-varieties - IR20 and IR22 - through the M-99 programme was not very successful. First, and most importantly, according to farmers there was no clear, observable yield difference between these new varieties and the existing BE-3 variety. Production function analysis confirms that both varieties are responsive to fertilizer (Chapter 8). Second, farmers experienced problems with overgrown seedlings because on occasions, fields did not submerge in time to allow timely transplanting. In contrast with BE-3, delays in transplanting of the fixed growth duration IR-varieties may result in substantial yield reductions or total seedling loss. Third, transplanters found difficulties in transplanting the relatively small IR-seedlings which are at least twice as short as the BE-3 seedlings at the time of transplanting.

The attitude of farmers towards IR-varieties changed with the introduction of IR30 in 1975. It had a shorter maturity period compared to IR20 and IR22, and allowed double cropping of rice in the partially irrigated areas in the village. Further, because it could be harvested early October compared to the late harvesting period of BE-3 in December, it reduced the lean month period by two months.

The main reason, however, for the rapid adoption of this variety, and especially its successor IR36, was the farmers' discovery that it was possible to directly sow pre-germinated seeds of these new varieties unto puddled fields (wet seeding), thus skipping the laborious transplanting operation. In essence, this seeding technique is similar to the wet-seedbed preparation for the raising of seedlings. Although, farmers occasionally used this method for establishing BE-3 in larger fields, it was considered an inferior technique. When wet seeded, the tall BE-3 easily lodged and did not recover well after the crop experienced a drought period. However, with the new IR-varieties (IR30 and IR36) it proved to be such a viable and economic crop establishment technique that it could be considered an important breakthrough in rainfed rice agriculture actually stimulating the use of IR-varieties. Despite the substantial higher agronomic risks attached to wet seeding rice crops compared to transplanting rice crops (Chapter 7) and against the explicit recommendation of the extension service (Appendix II), it became the most widely used technique for crop establishment of IR-varieties. The disadvantage that wet seeded rice fields are generally more difficult to weed and require more weedings compared to transplanted fields is largely offset by a substantial reduction in paid-out cost for hiring transplanting labour, amounting to around one-fifth of the farmers' gross production share. Moreover, wet seeding of rice facilitates the spreading and more efficient use of household labour resources through the staggered establishment of small areas of rice crops.

The introduction of IR30 and the possibility to use the wet seeding method of crop establishment with this variety was the start of a series of changes in both rice and non-rice farming causing a structural shift in the pattern of labour utilization during the second half of the 1970s. Until 1975, hired labour constituted the major part of the total labour use in agriculture. Both transplanting and harvesting of rice, comprising 64% of the total labour requirements per ha, were operations traditionally carried out by hired labourers. Land preparation and crop maintenance were typically family and exchange labour activities. After the main rice crop was established (June/July), contract labour groups found employment in the very labour intensive and lucrative harvesting of <u>dagmay</u> which was organized according to a strict group rotation system controlled through a highly centralized marketing system (2). These hired labour activities were carried out by farm households - with smaller farm households participating more frequently - and a few landless households. During peak labour periods, labourers from outside the village participated as well.

This labour utilization pattern drastically changed with the adoption of the fixed growth duration IR-varieties and the wet-seeding method of crop establishment. <u>First</u>, timing became a more important factor, determining the harvesting date of the first rice crop and thereby determining the possibility of a second rice crop as well as the duration of the period for which households possibly had to borrow rice for consumption. This induced individual farmers to concentrate more of their labour on self-employed rice production activities and be less dependent upon outside sources of labour. It caused a pattern of staggered land preparation and seeding of relatively small areas.

<u>Second</u>, by reducing the labour requirements for crop establishment and by expanding the rice harvest period from 13 to 21 weeks, the IR-varieties truncated the two major labour demand peaks (transplanting and harvesting) in rice crop production. As a

Table 4.3 Changes in village labour use for rice production

Labour use per hectare by task and total village labour use

	1953 1)	1970 2)	1978	1980
		(workdays)		
Land preparation	15.1 (18) 3)	25.0 (26)	24.4 (30)	24.7 (38)
Crop establishment	28.1 (34)	24.4 (25)	13.8 (17)	7.4 (12)
Weeding/replanting	9.4 (11)	7.8 (8)	7.8 (10)	8.6 (13)
Other crop care	-	1.9 (2)	2.4 (3)	2.4 (4)
Harvesting	30.7 (37)	37.0 (39)	33.7 (40)	21.1 (33)
Total	83.3 (100)	96.1 (100)	82.1 (100)	64.1 (100)
Total village rice area (ha) 4)	n.a.	113	137	154
Total village labour use (workdays '00)	-	109	112	99
Labour use per household (workdays)	-	129	108	93

Percentage change in total village labour use by task

	1970-78	1978-80	1970-80
		(percentage)	
Land preparation	+18 (-2) 5)	+14 (+1)	+34 (-1)
Crop establishment	-32 (-43)	-40 (-46)	-41 (-70)
Weeding/replanting	+21 (0)	+25 (+10)	+50 (+10)
Other crop care	+54 (+26)	+11 (0)	+71 (+26)
Harvesting	+10 (-9)	-30 (-37)	-23 (-43)
Total	+3 (-15)	-12 (-22)	-9 (-33)

1) Data are based on a 1953 survey conducted by Quintana in a nearby village (Quintana, 1954).
2) Estimated on the basis of the usual labour input profile for transplanted and direct seeded BE-3 crops.
3) Figures in parentheses are percentages of total labour use.
4) This area is the sum of the areas under first and second rice crops.
5) Figures in parentheses are percentages change in labour use per hectare.

result, demand for labour from outside the village declined as a more effective use of the existing pool of village labour became possible. Further, the pattern of staggered crop establishment also resulted in a more effective use of available family labour. Most of the labour required for the extra weeding of wet seeded rice came from this source. It is estimated, however, that the total labour requirements of the village for rice production did not change much during the period of 1970-78, because the reduction in labour use due to wet-seeding was counterbalanced by an increase in labour use for the simultaneously introduced second rice crop (Table 4.3). A <u>third</u> cause for the change in the labour utilization pattern was the abrupt disappearance of the above described harvesting system for <u>dagmay</u>. Following the introduction of a regular <u>jeepney</u> service in 1976 and the death of one of the three large contract buyers in Iloilo, a number of petty, village-based traders penetrated into the highly centralized market of <u>dagmay</u> allowing farm families to harvest this crop in very small quantities themselves during a prolonged harvesting period. Further, it allowed a number of small farmers to start growing <u>dagmay</u>, albeit in very small quantities.

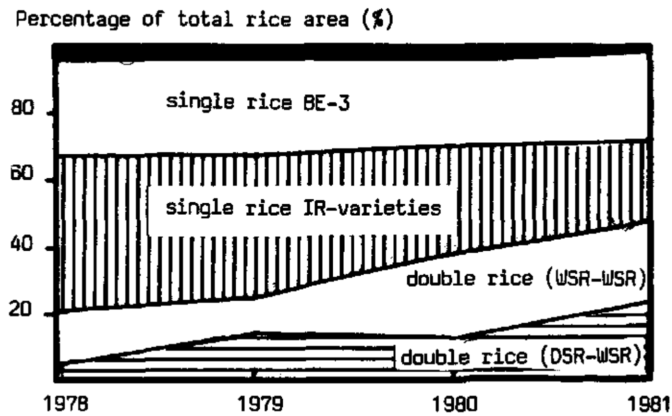


Fig. 4.3 Main rice cropping patterns as percentage of total rice area (WSR: wet seeded rice; DSR: dry seeded rice)

In 1977, a new development in agriculture occurred when farmers started experimenting with dry seeding techniques of crop establishment with IR-varieties, also a technique already in use with the BE-3 variety. The main aim was to advance the harvesting date of the first rice crop to facilitate an earlier, and less risky, second rice crop planting in the more drought-prone areas. Despite the risk attached to dry seeded rice crops and a dramatic failure of these crops in 1979 (Chapter 7), the area planted to double rice crops with dry seeded rice as first crop gradually expanded (Figure 4.3).

The development of a potential labour demand peak, which started to occur in the period of September-October when harvesting of the first crop of IR-rice, land preparation for the second rice crop, weeding for the BE-3, and harvesting of dagmay and upland mungbeans coincided, was prevented by the introduction of three mechanical rice threshers in 1979. They replaced the laborious foot threshing of rice common in this area and almost halved the labour requirement for the combined harvesting and threshing operation per hectare. The rapid adoption of mechanical threshing, almost 100% within three years, actually resulted in an overall decline of labour use in rice production. Despite a large area of double rice crops in 1980, total labour use for rice crop production was 12% lower compared to 1978 (Table 4.3b). This reduction in total labour use came entirely at the expense of hired labour use. This declined by 23% during the same period for the combined first and second crop, whereas family labour use slightly increased (Table 4.4).

Table 4.4 Total household labour use for rice and other crop production (workdays)

	1953 1)	1970 2)	1978			1980		
	Rice 3)	Rice	Rice	Non-rice	Total	Rice	Non-rice	Total
Family labour	55	64	70	43	113	74	31	105
	(35) 4)	(44)	(55)	(88)	(64)	(62)	(79)	(66)
Hired labour	126	81	58	6	64	45	8	53
	(65)	(56)	(45)	(12)	(36)	(38)	(21)	(34)
Total	181	145	128	49	177	119	39	158

1) Figures based on 1953 survey data by Quintana (1954).
2) Based on farmers' estimates of percentage hired labour use by task for BE-3 crops.
3) For the years 1953 and 1970 no available data for non-rice crops. However, for 1953 labour use in non-rice crops must have been low.
4) Figures in parentheses are percentages of total labour use

The above changes had some profound effects on the resource management strategies of households. They increasingly substituted family labour for hired labour, which particularly affected female wage labour participation. In the virtual absence of a landless labour class, it meant that initially households hired less labour from outside the village, and that they increasingly hired each other less frequently. This resulted in a general decline in income sharing between the smaller and somewhat larger farm households. It also meant a deterioration of the economic position of women (Res, 1983). Consequently, during the past few years, it became more difficult for both the small group of landless households and the larger group of small farm households to meet subsistence requirements.

The introduction of 'modern' rice crop technology did not contribute much to increasing employment opportunities in agriculture. It appears that - in spite of a widespread use of new rice production technology -the village economy is reaching a saturation point with respect to the further absorption of rural households. The net village population growth is levelling off and the growth rate in the number of households is declining. Given present farm sizes and level of technology, there is thus a limited future in agriculture for most children in this rainfed area. It explains the substantial sacrifices households make to send their children to high school and university (Chapter 6). Accompanying the decline in farm sizes has been a process of land use intensification that has increasingly become dependent on external inputs (e.g. fertilizers and pesticides) to sustain or raise productivity levels. In this process, the overall level of risk that rural households are facing has increased. Smaller farm sizes imply a lower degree of risk spreading, and combined with a stronger dependency on cash inputs imply a higher risk of indebtedness. As an older farmer eloquently put it: 'Before, if we had a poor production we had less to eat, now we go into debt'.

The above historical description of changes in agriculture and socio-economic conditions in the decision making environment shows that the assumption of a relatively static pre-innovation environment, often implicitly underlying adoption studies is untenable. Ever since the early resettlement of the village at the beginning of the 20th century, small and profound changes in the decision making environment of households continously occurred. Households had to adjust, with various degrees of success, to disruptive and evolutionary processes resulting from changes within and outside the village economy. Also today's farm-household decision making in general and risk taking behaviour in particular should be understood in such a dynamic context. It should refrain researchers from embarking too easily on such arguments as 'risk-induced traditionalism' to explain farmers' adherence to existing practices or non-adoption of recommended technology. Farm-households are by nature used to uncertain production circumstances and usually have a history of risk taking experiences. The commonly made distinction between so-called conservative traditional and modern dynamic farmers is often senseless. Actual situations are usually far more fluid in the sense that on individual farms both existing and new economic enterprises are simultaneously pursued. In fact, old practices may be combined with new technological components to form truly adapted and viable new agricultural enterprises such as is the case with wet and dry seeding of new IR-varieties. Past government-initiated programmes aimed at improving agricultural production did not support such an evolutionary and adaptive agricultural development process. Because of a poor understanding of farmers' management patterns and a poor definition of 'recommendation domains' (3), they turned out to be a detriment to agricultural development in this rainfed area. The 'improved' technology offered and credit packages attached induced farmers to an irresponsible level of risk taking resulting in a severe debt position.

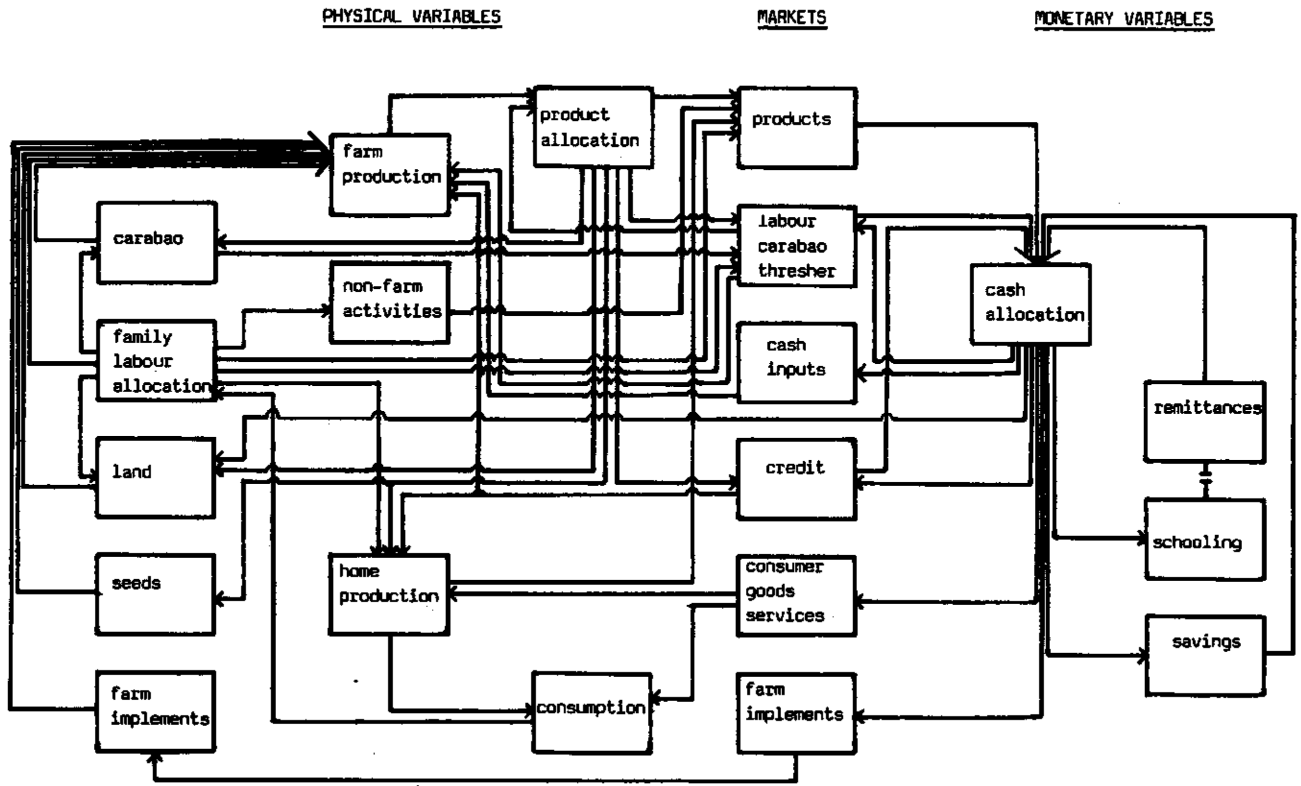


Fig. 5.1 Structure of farm-household unit

5 THE FARM-HOUSEHOLD: RESOURCES AND OPPORTUNITIES

The change processes in the village economy as described in the previous chapter are the result of decisions made by individual households and individual members within these households. Inasmuch as the aggregate effect of individual decisions shapes the decision making environment, it in turn determines the choice options and constraints of individual households. The aim of this chapter is to arrive at a classification of farm-households to be subsequently used in assessing differences in management strategies among household categories. Emphasis will be put on the household's sensitivity to income risks. A brief introductory description of the structure of the farm-household system is given in the remainder of this section. In Section 5.1 the types of resources at the disposal of households are discussed. The range of income earning opportunities through which these resources can be made productive will be analyzed in Section 5.2. In Section 5.3 farm-households will be classified on the basis of two household characteristics - surplus production capacity and family life cycle stage - that account for the household's income generating capacity in relation to essential subsistence needs.

<u>The farm-household</u>
For the economy under study, the individual farm-household is the single most important unit through which decision making concerning production and consumption activitites is taking place. Following Spijkers-Zwart (1980), the household is defined as 'an organized social and economic unit the members of which undertake activities (either communally or complementary) aimed at the satisfaction of material needs of the group and the creation of material conditions to fulfil immaterial needs'. The group comprises all persons that are dependent upon the unit for daily subsistence. Hence, the household may differ from the domestic group as it may include dependent children staying outside the village (e.g. children attending school). Unlike the extended household structure found in semi-subsistence economies of many developing countries, households in this village are typical of the nuclear type consisting of husband, wife and children, occasionally with a single remaining parent of the husband or wife.

The internal structure of the farm-household as well as its (economic) relations with the environment are depicted in Figure 5.1. The indicated components transform inputs into outputs. Such transformations may be the result of complex production processes within components involving various inputs and resulting in different types of output such as the home production system and the farm system (and within the farm system in descending order: the crop and livestock sub-system; the field crop system; individual crops; and crop operations and inputs). They may also involve simple tranformations such as transforming family labour into wages at the labour market or the marketing of products for cash income. The lines connecting these components represent physical and monetary resource flows. The left-hand side shows the physical resources at the disposal of households. They include land and water, family labour, current cash and seed inputs, farm implements, machinery and draught power. Although not indicated, knowledge and skills of household members as well as social and political position are considered to be included in the resources position of households.

Farm-household activities

Resources are used as inputs in various production activities. A broad distinction can be made between activities that are directly productive in the sense that the output can be used for own consumption or sale at the market (marketable output) and activities that can be considered indirectly productive or reproductive in the broad sense that they maintain resources at existing productive levels (non-marketable output) and, thus, are supportive in the generation of income. The main type of activities included in these two groups are:

A. Direct productive activities

- Self-employed activities: they include both farm and non-farm activities. Farm activities consist of crop and livestock production, but exclude feeding of working animals. Non-farm activities include trading, basket weaving, rice milling, etc;
- Wage labour activities: all activities for which either a wage payment is received or which involve product sharing.

B. Indirect productive activities:

- Farm asset maintenance activities: they include activities aimed at maintaining the productive value of assets such as the grazing of working animals, maintaining land and water resources (e.g. bund repair, field levelling, cleaning of irrigation and drainage ditches), etc.;
- Home production activities: all activities aimed at nourishing household members and raising children such as meal preparation, child care, laundry cleaning, etc.;
- Social activities comprising activities aimed at re-enforcing or improving the household's position in the social structure of the village.

Activities included in these groups are, to some extent, complementary with respect to daily time expenditure. Type B activities are carried out at times of the day when type A activities cannot be undertaken, e.g. early morning, noon, evening. In the conventional economic analysis, it is common to disregard type B activities altogether assuming that there is no conflict whatsoever between the two groups of activities. However, in determining family labour availability for type A activities, the participation of relatively young children in type B activities is important (Section 5.1.2). These children usually take over a number of time consuming household chores from adults, thus freeing their time for participation in type A activities. Because of the lack of such labour, adults of young households necessarily have to spend a relatively large part of their time on type B activities. Hence, in determining family labour availability, leisure preferences, and the degree of family labour exploitation, the time needed for indirect productive activities should be explicitly accounted for.

Apart from decisions concerning the allocation of family controlled resources (land, labour, capital) to the above activity fields, other major economic decision making areas of the household include acquisition of non-household means of production such as hired labour, credit, etc. as well as the disposition of income to consumption, savings, and investments. Farm-households in the community studied are not fully self-contained in the sense that they produce all the necessities required for the economic survival of the unit. Depending on land and labour resources, households are, to various degrees, dependent on markets, among others to employ their labour for wages, market their produce, purchases of consumer items, health services, farm inputs, etc. To some extent households are forced to generate cash through market participation. For example, the culturally determined standard of living prescribes medication or hospitalization of household members in case such is necessary, also at the cost of heavy borrowing. On the other hand, depending upon their land resources, households still produce a large portion of their dietary needs through self-employed production activities. The specific character of such semi-subsistence (or semi-commercial) farm-households compared to western-type commercial farm-enterprises stems from the fact that production and consumption decisions are highly interwoven (Chapter 3 and 4).

Division of tasks

It is generally difficult to determine who actually dominates the decision making in the above activity fields. Day-to-day management of activities and associated routine decision making is usually the responsibility of individual household members carrying out those activities. Thus, routine decisions closely follow the division of tasks in the household. Men are responsible for farm asset maintenance activities and rice crop production and crops that are grown in a pattern with rice on rice fields. Apart from home production activities, women are mainly active in vegetable production and pig raising, and participate in rice production activities with weeding and transplanting as dominant activities. Wage labour activities are carried out by men and women. Non-agricultural activities, such as carpentry, basket weaving, and cattle trading are typically male activities, whereas vegetable marketing, making and selling of delicacies are typically female activities. Although, generally a clear division of tasks exists, such division is not entirely rigid. If necessary, women participate in the ploughing of fields and men will do the cooking when women are marketing products or do the laundry when women have just delivered a child. A more detailed discussion of time allocation of household members will be given in Section 6.1.1.

The division of decision making tasks is less articulated in the area of planning and strategic decisions. Although, it is generally accepted (and as such it appears to the outside observer) that planning rice crop production activities is the domain of the husband, women and even children can exercise enough pressure to have at least a strong say in strategic farm decisions. With respect to financial management decisions, women have at least the same influence as men. Of course, who actually makes decisions will also depend on the character of the persons involved.

5.1 Farm-household resources

5.1.1 Land and water

The total land area owned and/or cultivated by villagers is estimated at 146 ha, divided into 10% woodland, 13% upland and the remainder rice lowland (bunded fields that allow ponding of water). Size distribution of all farms in the village in terms of operational holding is given in Figure 5.1.1. About half of the farm holdings are from 1 to 2 ha, 17% between 2 to 3 ha, whereas 22% is smaller than 1 ha. A small group of farmers (9%) has landholdings larger than 3.5 ha (1). All sample households operate farm holdings below 3 ha, with 48% between 1 to 2 ha, 24% below 1 ha, and 28% above 2 ha. The average landholding size of these

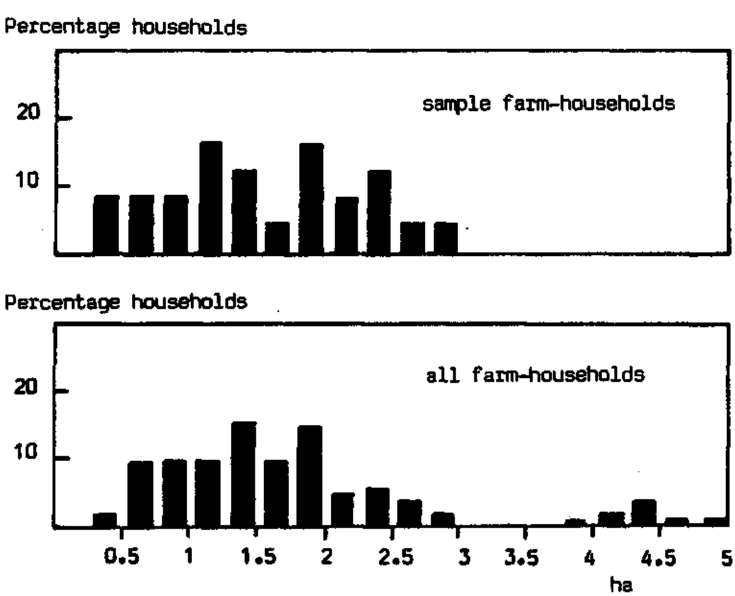


Fig. 5.1.1 Distribution of farm sizes (ha)

households is 1.54 ha of which 84% is rice lowland on average. Farms are usually composed of a number of fields located at various positions in the landscape with different water management classes. Also land tenure conditions differ between as well as within farms.

Land quality

Due to the topography of the area, differences in land quality are considerable. Various landscape positions can be distinguished on the basis of their geomorphic location, i.e., their relative position in the landscape or toposequence and their relative proximity to supplementary sources of water. Following the toposequence of the area from high to low positions, a distinction was made between seven landscape positions (Figure 5.1.2). This classification roughly follows the classification made by farmers.

- High hill summits (bacolod): these are hill summits on the highest part of the toposequence. They have coarse textured soils that can be classified as sandy loam (baras-baras). Cultivation of crops on these fields occurred only recently and is limited to a number of upland crops during the wet season (tomatoes, mung, cowpea). Access to these fields is difficult and crops are exposed to high winds.

- Steep hill-sides (bakili): these are the steep hill slopes located directly below the bacolod areas having the same soil type. They are very prone to erosion and normally they are not continously cultivated. Vegetation mainly consists of trees, shrubs, and bamboo interspersed with grasses. Bananas and coconuts are usually found at the foot of these hill-sides. Further, on cleared portions, tomatoes are grown during the wet season.

- Knolls (banglid): fields in this landscape position are located either on the gently sloping foot portion of the hills or on the highest portion of the relatively low hill ridges which penetrate the plain area. They have yellowish, silty clay soils (buga-buga) which become more clayey as the knoll is further located towards the plain area. Since they are not bunded, they do not accumulate water and drain easily. Crops such as corn and taro (dagmay) can be successfully planted during the early rains followed by mung or squash. With favourable rainfall, a second planting of corn in November is possible.

- Sideslopes (bantod): they are the highest terraced and bunded fields in the landscape and are found directly below the knoll areas. Fields are narrow with their longer sides perpendicular to the slope and with a substantial vertical drop between adjacent fields. Soils can be generally classified as silty clay. Bunds are low to facilitate drainage. Water can be accumulated after heavy rainfall but only for short periods (2 to 3 days). Both upland and rice crops can be grown on these fields, with rice crops limited to local drought resistant varieties.

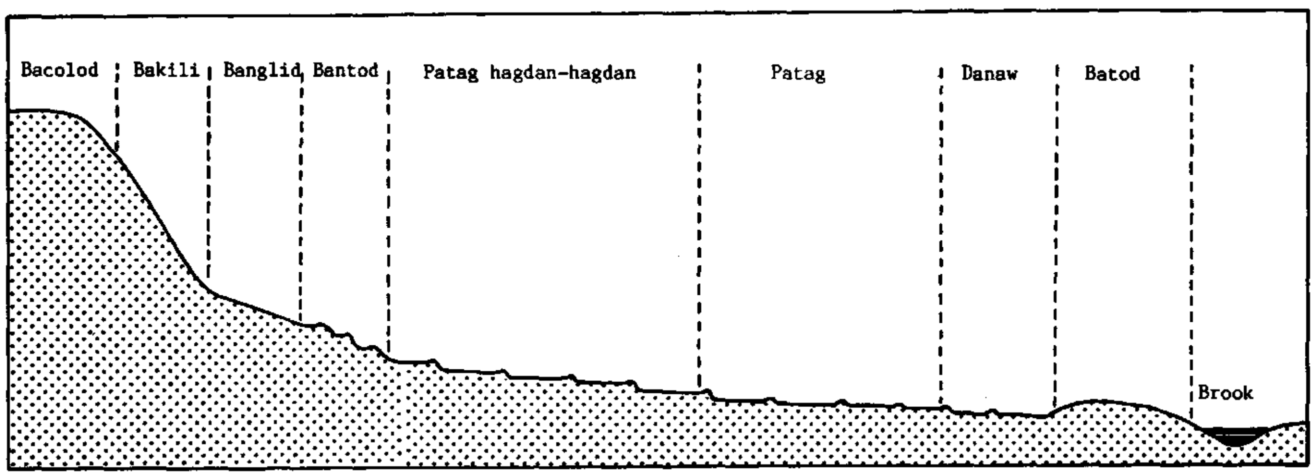


Fig 5.1.2 Toposequence and landscape positions; local classification

- Plateau fields (patag hagdan-hagdan): these fields are transcient between sideslope and plain areas. The soil type is heavier (56% to 64% clay) compared to the sideslope areas and the water retention capacity is higher (1 to 2 weeks). Compared to the plain areas, they have a lower water table and there is still a considerable vertical drop between fields which facilitates good drainage. Crops cultivated on these fields consist of corn followed by rice followed by an upland crop (e.g., mung or squash). More recently, farmers started to grow two sequential rice crops employing dry seeding establishment techniques for the first rice crop.
- Plain (patag): plain areas are located on the lower part of the landscape and have very fine clay soils (62% to 75% clay), locally known as nono-o. The water table is closer to the surface and recedes less rapidly with the onset of the dry season. Fields quickly accumulate water but are difficult to drain. A small elevated portion of the plain area has a distinct lighter soil type that is locally known as hinis-hinis (silty clay loam). Under favourable rainfall conditions, two wet seeded or transplanted rice crops can be successfully grown. Hand-dug wells can provide sufficient water to irrigate small areas of upland crops in the dry season.
- Bottomland (danaw or lungasod): they are the lowest fields in the toposequence. During the wet season sufficient depth of flooding may occur to restrict the use of short statured varieties. Soils are very heavy containing up to 87% clay. Accumulated water can be retained for periods of over one month.

Water management

The flooding regime of rice lands in the village is characteristic of 'Regime 2' as described by Moormann and van Bremen (1978): 'shallow, irregular and prolonged flooding in both pluvial-anthraquic and in phreatic-anthraquic rice lands in areas of higher rainfall'. Rainfall is ponded in bunded rice fields and stays on the land for longer periods, although intermittent drought periods may occur. In addition to rainwater, fields receive water by overflow from higher fields during and after heavy rainfall.

Water availability in rice fields and the possibility to regulate water levels depend on a considerable number of factors. Among the most important are the location of the field in the toposequence of the area, its elevation relative to surrounding fields, the additional supply of water, the soil type and structure, levelling of the field, height/width and condition of the bunds surrounding the field, and the levelling condition of the field. Fields on the highest part of the toposequence have the worst provision of water. Even with sufficient rainfall during the growing season, these fields do not hold water long because of high soil permeability and a deep water table. The vertical drop between adjacent fields is substantial causing high seepage rates whereas bunds are low to prevent the bursting of bunds and erosion of fields. The lower paddy fields in the toposequence usually have a better provision of water than the higher positioned fields. Poor drainage of lower fields, however, may cause excessive water accumulation and flooding for sustained periods. Water control is best in those fields that are close to waterways, but allow the diversion of water flows to other fields. However, strong water currents in waterway fields may cause serious damage to crops.

Based on the hydrology of the area, a further distinction can be made between three water management classes:

- Rainfed fields: fields that do not have any supplemental source of water either through waterflows or springs, i.e., for water accumulation they depend entirely on rainfall.
- Waterway fields: they belong to tracks of fields with a relative low position compared to adjacent fields functioning as drainage ways. Supplemental water is provided during a part of the 5 to 7 month rain period.
- Partially irrigated fields: these fields have supplemental irrigation through springs beyond the 5 to 7 month rain period.

On the basis of the various combinations of landscape position and water management class, 12 different land types could be distinguished in the area. To avoid too small sub-classes and to facilitate data analysis, it was decided to group the original classes into 7 major land units:

a. upland: composed of knolls and some very small areas of hill-summits and hill-sides;
b. sideslope: including both rainfed and waterway fields; the area under waterway sideslopes is small, whereas water availabilty is not much better for the waterway fields due their low bund height and high seepage and percolation losses;
c. plateau rainfed;
d. plain rainfed: including rainfed plain fields and a small area of bottomland; both land types are very similar (in this particular location) in water retention capacity and soil type;
e. plain waterway;
f. plateau waterway;
g. irrigated: including both partially irrigated land types.

Figure 5.1.3 shows what original classes are combined into one land unit as well as the area of each land unit as percentage of the total area cultivated by the sample households. Of the total area cultivated by sample households, 84% is lowland of which 10% is partially irrigated. The remainder is equally divided into rainfed and waterway fields. The main landscape position in the lowland area is plain (45%), followed by plateau fields (28%). A

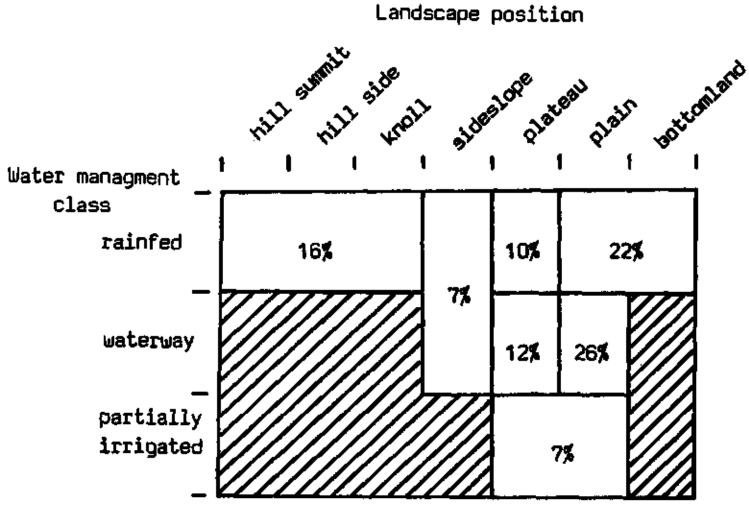


Fig. 5.1.3 Monitored area by landscape position and water management class; percentages of total area

quantitative assessment of the economic productivity differences between these land units will be made in Section 5.3.1.

Land tenure

Around 90% of the land cultivated by sample households is tenanted. Fixed rent (leasehold) contracts (arkilado) occupy about two-thirds of this area, whereas the remaining area is share tenanted. The number of contracts under share and fixed rent arrangements is about equal, indicating that land area per share contract is on average half that of fixed rent contracts. Land under share tenancy is mainly owned by village residents and small landlords in the nearby town. Share contracts are mainly of the 'one-third/two-thirds' type (tresa): after deducting the harvest share (one-sixth of the gross production) and sometimes hauling costs, the landlord receives one-third of the remaining production. Fifty-fifty share contracts (agsa) occur but are not common. Under this arrangement the landlord usually pays half of all the crop expenses. For two parcels, the old 'two-fifths/three-fifths' share arrangement (quinta) - common before the land reform - still persists.

A tenant normally considers the land he tills as his 'own', especially if the household or the parents have been cultivating it for a long time. In fact, the tenant's children claim the right of succession to the tenancy should the father stop farming. Usually, landowners in the area comply with this customary rule. Hence, acquisition of tenanted land is mainly through relatives. Of the total number of tenure contracts, half was obtained through first degree relatives (parents, brothers or sisters) of which three-quarters through internal transfer. For only nine percent of the contracts no kinship relation between the previous tenant and the household who acquired the land could be traced.

Fixed land rents vary from $41-$50 per hectare for upland, $81-$94 for rainfed lowland, up to $125 in palay for partially irrigated land. After the introduction of double rice cropping, land rent levels for areas that allowed such cropping pattern were either adjusted upwards or a combination of fixed rent (first crop) and share rent (second crop) were established. Despite the non-risk sharing nature of fixed rental arrangements, a number of farmers favour fixed rent contracts over share rent arrangements. First, at higher input levels, in most years this contract is more profitable than share contracts. For the crop season of 1978-79, which according to farmers was a normal production season, the fixed rent levels for the upland and lowland fields were, on average, about 18% and 22%, respectively, of the gross production minus the harvesting cost compared to the effective 28% sharing of share contracts. Second, farmers prefer not to share with the landlord in the sometimes very profitable but labour intensive dry-season crops (e.g. squash, tomatoes). Third, farmers prefer not to be bothered by the paternalistic attention of landlords in their crop choice decisions and during the sharing of the rice harvest.

For most households, the only way to acquire land in ownership is through inheritance (panubli). Hence, it is not surprising that owned land of village residents has become highly fragmented (2). Most of the land owned by village households used for crop production is concentrated in the knoll position with only 13% in the plateau or plain area. This concentration of owned land held by villagers in the low productive upland areas and the for rice cultivation marginal sideslope fields is likely the result of a selective land grabbing process by town people through forfeiture of mortgaged land by village residents that occurred from the Second World War onwards.

Ownership rights of land are usually carefully guarded by the family. In case one of the members of a family wants to sell or mortgage (prenda) a piece of land (i.e., wants to alienate it from the family property pool or runs the risk of alienating it) he is required to consult with all his brothers and sisters who have to agree with it and have first option of buying or mortgaging it. If, after the contract period the mortgagee fails to pay the borrowed amount, the family members are again the first to furnish the amount, in some cases by taking turns. No consultation with the family is required if the parents of an individual household decide to transfer their use right to a piece of land to one of their children. In such case, the head of the household remains the legal owner and children are not allowed to sell or mortgage. Generally, parents also maintain and excercise authority over inherited use rights. They are allowed to take them back and this threat is often used as a means of social control over children.

Ownership rights are transferred to children after the death of the parents. Division of land ownership requires a family gathering and the actual allocation of land is carried out in the presence of a few barrio-council men. Inheritance follows a a bilateral system and strict equal allocation of land to the heirs of a given estate with respect to both the size of the area and - as much as as possible - the land quality. This often implies division of property parallel to the slope of a field which results in extremely small-sized fields. In case land remains undivided, heirs may decide to take turns in cultivating it (bolos-bolos). It also occurs that only one of the heirs obtains the right to cultivate the land, in which case land rent is paid to brothers and sisters. Individual property brought in by either of the spouses in marriage legally belongs to either of them, but in actual practice, the husband has usually the final say regarding the use of the wife's property.

Acquisition of land through mortgage is not common among villagers. Mortgage as practised in this area, is essentially a special type of sale, with the right to re-purchase. The right to cultivate the land and the disposal of the produce are locally considered to be sufficient for payment of the annual interest of the principal sum borrowed. In the event the mortgagee fails to pay the amount borrowed, the mortgager has the right to take over the possession of the land which is known as rimata (forfeiture in mortgage).

From the above it will be clear that the land market in the village is highly restrictive. Access to land is governed by strong personalistic ties between landowners and tenant families. It is virtually impossible to obtain tenanted land other than the land already farmed by other family members. Unlike other areas in the Philippines (e.g. Hayami, 1978), sub-renting of tenanted land is a very rare phenomenon in this village. Further, land is rarely offered for sale in a free market situation and in such case almost none of the households can afford land purchases (3).

5.1.2 Family labour resources and wage labour availability

Apart from draught animals, manual labour is the main source of power in the production system. The level of mechanization in agricultural and non-agricultural activities is low. The use of tractors is almost non-existent. Since 1979, machine power has been important in rice threshing and, more recently, mechanical blowers are used for rice winnowing.

Sources of available labour in the village are composed of labour supplied by the household itself, labour hired from other farm households and a few landless households, and labour hired from neighbouring villages and the nearby town. The contribution of labour from outside the village is relatively minor and mainly employed in rice harvesting. To some extent, non-resident labour is also used in fields that are at some distance from the village and often nearer to neighbouring villages.

Family labour resources

Family labour availability is a notoriously difficult concept to use. Problems that arise in establishing a measure of family labour availability are concerned with:

a. determining what type of activities should be included in the labour process;

b. assessing the rate of participation of the various household members in these activities; age

c. combining different types of labour into one measure of labour availability;

d. evaluating possible social restrictions to the use of certain types of labour in certain activities.

(a) In determining labour availability it has been common practice to look only at labour required for production activities and to exclude from the analysis labour required for tasks outside the sphere of income earning. However, as discussed in the introductory section of this chapter, in correctly specifying labour availability for production activities ample time should be allowed for activities that are necessary to support the household as a production unit. They include the earlier mentioned home production activities to reproduce the household as a labour unit; farm asset maintenance activities - such as grazing the working animal - to reproduce the farm as a production unit; and social activities to secure the household's position in the social system. Except for social activities, in the short-run, the labour required for these activities involves a more or less fixed daily time expenditure which can be treated as an overhead cost in the operation of the farm-household.

The relative importance of these reproductive activities in the total time expenditure of the household will depend on the life cycle stage of the household (Section 6.1) as it determines the freedom of movement of women and the potential participation of children in the labour process. Wives of the young households will often devote a substantial portion of their time caring for children and will generally be less available for non-household activities due to the higher rate of pregnancies. Likewise, husbands of these households will also be more involved in home production activities and grazing the working animal because older children are not yet present. In the middle-aged life cycle stage, wives and husbands are freed from a number of household chores which are taken care of by the children, whereas some children will also be available part-time for other activities. In the last life cycle stage, almost no time will be spent on child-care.

Hence, in view of the possible influence of the life cycle on adult labour availability, instead of assuming that these activities are implicitly taken care of by certain members of the household (e.g. husband and wife), they should be explicitly included as part of the labour process. Further these activities should not be treated as non-productive as they are essential to the survival of the household unit. They should rather be considered indirectly productive given the strong complementarity with income-earning activities.

(b) The rate of participation of household members will depend on the age limit at which household members can be expected to contribute to labour activities. Of course, this question closely relates to the above issue about the type of activities that are included in the labour process. Within the context of the above broad definition of labour activities, the age limit used in this study was set at 10 years. Male children above the age of 10 are able to take care of grazing the working animal and carry out various home and farm production activities such as transplanting and weeding. Male children above the age of 14 can be considered full participants in all farm activities, including land preparation. Similarly, female children above the age of 10 carry out various home and farm production activities. The 10 year age limit does not imply that younger children do not contribute labour to the household. In fact these children are often responsible for the provision of water to the household and 8 year old boys sometimes help in grazing the working animal. However, their contribution to total household labour use is limited.

(c) The third problem concerns the extent to which different types of labour (sex and age) can substitute for each other, i.e., whether adult and child, or male and female working hours are equivalent and can be summed up into one measure of labour availability. Based on differences in skills and physical strength, it is common in labour studies to assign different productivity coefficients to the various types of labour, e.g., one child hour is equivalent to 0.5 adult hour. Obviously, such coefficients are often arbitrary and essentially do not solve the problem of the non-substitutability of different types of labour. In this study we take the position that - within the context of assessing total family labour availability - a distinction between different types of labour hours based on age/sex differences is to a large extent meaningless. Although tasks and labour productivities may differ between individual household members and strict substitutability of types of labour may not always be possible, the strong complementarity of the various household activities renders assessment of individual labour productivities impossible. For instance, in rice crop production tasks such as weeding, although generally considered to be low productive, have to be carried out to sustain the overall rice production activity. Similarly, grazing the working animal may be considered a low-productive task carried out by school boys, but such labour is a prerequisite for attaining high labour productivity of male adults in land preparation. Since time allocated to these activities comes out of the common family labour pool, participation of children in these 'low productive' activities allows adults to employ their labour in a more productive manner. Further, in certain tasks children are as competent as adults and receive similar wages on the labour market. Also, no distinction is made between adult male and female labour. Again, although there are typically male and female activities (e.g. land preparation is a typically male activity and weeding is often done by women), if necessary both types of labour are largely interchangeable.

(d) The extent to which social norms are restrictive to the use of certain types of labour in particular activities is of minor importance in this village.

Based on the above considerations, in assessing the total household labour resources neither distinction is made between male and female labour, nor between labour of adults and children above the age of 10. The calculation of the family labour force (above the time required for social activities), is based on the following assumptions:

- On average, both male and female full-time participants are considered to be potentially available for 10 hours daily for 6 days per week;
- Elementary school children above the age of 10 and high school attendants are assumed to be be available 2 hours daily and full-time available during school holidays;
- Non-working college students are full-time available during school holidays.

Given these assumptions, the total family labour force will depend on: the size of the household; the age composition of the houshold; the schooling rate of children; and the health and nutritional status of the household members.

The average total family labour force for the sample households expressed in terms of workday equivalents of 10 hours is 878 days, of which children contribute 36%, and the remainder is equally divided among husbands and wives. Table 5.1.1 shows the effect of the life cycle stage on family labour resources. The young life cycle households have a labour force which is about 60% of the middle-aged households, whereas the labour force of the old household category is about similar to the middle-aged households. The effect of the fixed daily labour requirements for home production and carabao grazing on family labour availability for

Table 5.1.1 Family labour availability by life cycle group, 1979-80 (hours '000)

Life cycle stage	House -hold size	Children above 10 years Non-school		Schooling		Household labour force				Labour avail above fixed daily use 1)	Farm size (ha)	Labour avail per ha
		Male	Female	Male	Female	Husband	Wife	Child	Total			
1	5.2	-	-	0.30	-	2.88	2.88	0.65	6.41	2.67	1.28	2.09
2	7.6	0.82	0.46	1.27	1.27	2.74	2.62	5.47	10.83	6.76	1.55	4.36
3	5.0	1.00	0.75	0.50	0.25	2.88	2.88	4.08	9.84	5.13	2.18	2.35
Mean	6.2	0.52	0.32	1.05	0.60	2.82	2.77	3.19	8.78	4.86	1.54	3.18

1) Fixed daily labour requirements include the time spend on home production and grazing the working animal. Based on actual data crop season of 1979-80 and 1980-81.

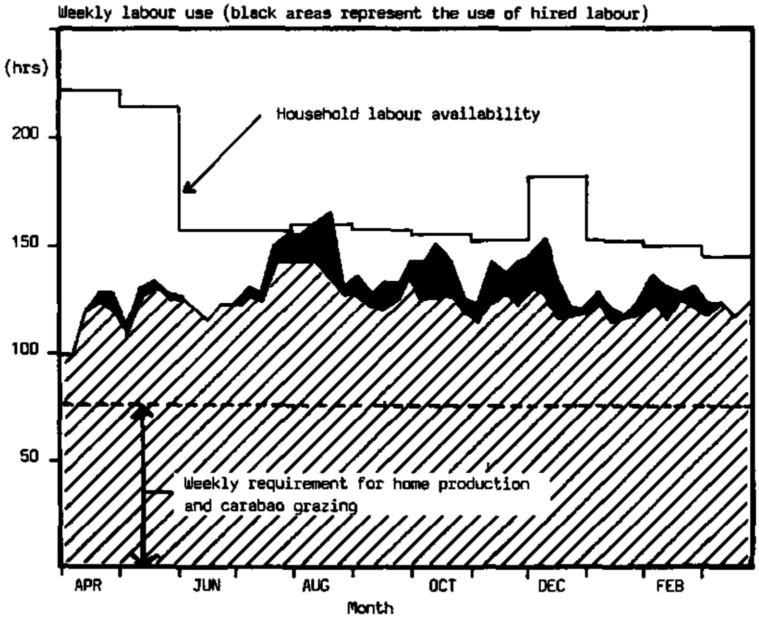


Fig. 5.1.4 Weekly labour utilization of households and family labour availability; averages for sample households (1979-81)

other activities becomes apparent when they are subtracted from the total labour force. The labour availability for direct productive activities of the young households declines from 60% to only 40% of the middle-aged households. Labour availability per hectare of the middle-aged households is more than twice as high as that of the young households, and roughly 85% higher than that of the older households.

Due to the part-time participation of school children and students, family labour availability fluctuates seasonally with peaks during the summer holiday (April-May) and the last two weeks of December. As is shown in Figure 5.1.4, the summer holiday coincides with a slack period in labour utilization.
The same figure shows that weekly total family labour use is always below the calculated weekly labour availability, also during peak labour demand periods. As will be indicated later, this is primarily due to a lower participation of children as indicated by their labour availability.

Wage labour availability

During peak demand periods, family labour is supplemented with wage labour hired from within and outside the village. Given the limited number of landless households, the main source of non-family labour used in agricultural production is from other farm-households within the village. These are usually households cultivating relatively small farm areas with an excess of family labour. They require the extra earnings from wage labour activities to augment their income derived from their own farm. The village labour force is occasionally supplemented by workers from neighbouring villages (ploughing/ harvesting) and the town (harvesting). Since the introduction of the short-maturing varieties, migratory labour from other parts of Panay Island (both from and to the village) has ceased to exist (Chapter 4). The various labour arrangements for hiring labour as well as the earnings (cost) per workday will be discussed in Section 5.2.5.

It is difficult to arrive at an assessment of wage labour availability in the village. This is mainly due to the part-time participation of farm-households in the wage labour market. The supply of labour from these households is, to some extent, uncertain since they also have to perform activities on their own farm. Although these households attempt to plan their farm operations in such a way so as to be free from own farm activities during periods of wage labour demand (Chapter 7), such strategy is not always feasible due to the uncertain influence of rainfall. This particularly affects wage labour availability at the start of the crop season for operations that require animal power such as ploughing and harrowing.

Moreover, the labour utilization pattern in agriculture underwent a profound change in recent years and was still in a state of transition during the study period (Chapter 4). In particular, the introduction of direct seeding techniques of rice crop establishment and the disappearance of the laborious foot threshing of rice, resulted in a sharp decline in the use of non-family labour per hectare of rice. However, total labour demand for rice production declined much less due to the increase in the area under double rice cropping. This change in labour utilization pattern caused the occurrence of a new labour demand peak during the harvesting of the first rice crop and establishment of the second rice crop. Especially in 1980 and 1981, severe labour shortages occurred in this period which affected land preparation for the second rice crop.

Due to differences in earnings per day between the various wage labour activities (Section 5.2.5), temporary labour shortages particularly occur for certain operations during certain periods of the year. Especially during the harvesting periods of rice and <u>dagmay</u>, it is often difficult to find labour for the less remunerative weeding and transplanting operations. Such temporary labour shortages can be severe for fields that are located at some distance from the village. Also, for poor or small rice fields it is often difficult to find labour for the harvesting operation in the midst of the harvesting season.

5.1.3 <u>Capital</u>

In determining the level of capital use and capital formation, a distinction should be made between three types of asset classes:

- <u>fixed capital assets</u> including land, farm equipment, livestock (cattle, working animals, breeding pigs), and houses;

- financial assets that include both positive assets such as cash and rice lent to other households and negative assets consisting of borrowed funds;
- inventory assets that include rice in stock and cash on hand.

In a more detailed discussion on changes in asset holdings and the role of assets in reserve management of households, in Section 6.3 human capital assets in the form of investments in education will also be considered.

Asset holdings

Figure 5.1.5 shows the level and composition of asset holdings for two categories of households as of April 1979 and March 1982, viz. households that have sufficient land to provide for minimum income requirements and households that have not. These household categories are labelled 'surplus' and 'non-surplus' households (Section 5.3). For all asset classes and types of assets within classes, surplus households have larger holdings compared to non-surplus households. As of March 1979, total asset holdings amounted to $472 and $1413 per household for the non-surplus and surplus household category, respectively. For the non-surplus households, roughly 90% of the asset holding consists of fixed assets of which 50% can be utilized in direct productive activities (e.g. land, farm equipment, livestock, etc.). For the surplus households, 85% of the assets are fixed of which 75% is direct productive. For both categories, the level of positive financial assets (cash on hand and outstanding loans) is low. The level of outstanding debts is about equal for both categories of households.

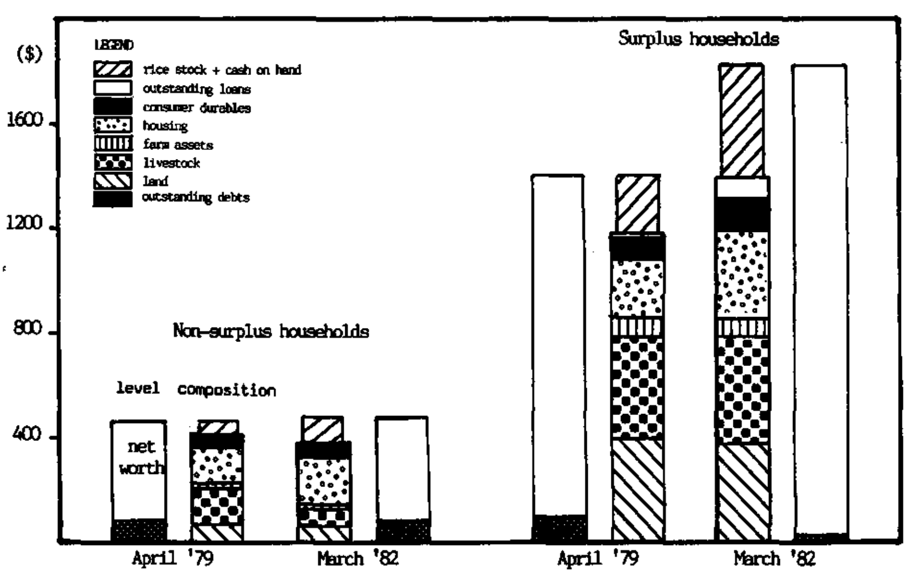


Fig. 5.1.5 Level and composition of asset holdings

Household categories differ substantially in the ownership of land. Land assets consist of farmland and residential lots. Only surplus households own farmland, but a substantial number of households of both categories have their own residential lot. Land values are based on farmers' estimates, checked against the estimates of other knowledgeable persons and actual sale prices for the few transactions that occurred during the study period. No value is attached to rented land. In contrast with other areas in the Philippines, tenancy titles have no real value as the practice of sub-leasing land or selling of a tenancy title is uncommon. For the Laguna area in the Philippines, Hayami (1978) estimated the value of tenancy titles at 35% of the land value if it was leasehold and 25% if it was share tenancy.

The value of houses and other buildings (e.g. farm houses) is estimated at their resale values at the start of the study period also based on farmers' estimates. Depreciation is calculated by dividing the present value by the number of years of remaining usable life. Farm equipment counted as assets include only major items such as ploughs, harrows, carabao-sledges, and knapsack sprayers. None of the households in the sample own machines such as tractors or rice threshers. Also the value of farm equipment is estimated on the basis of the present value. They are estimated by subtracting past depreciation from their new acquisition prices at local dealers assuming linear depreciation and zero salvage value at the end of usable life. Livestock assets mainly comprise carabaos, but also include some cows and sows. The difference between household categories in livestock assets is due to the fact that a number of non-surplus households do not have their own working animal, but rent them from other persons. Hogs are not included as they are usually bought and sold within a period of one year. Consumer durables counted as fixed assets are sewing machines, major items of furniture, radios, and bicycles. These assets are valued in the same way as farm equipment.

Positive financial assets consist of cash savings, sales in credit, and lent amounts in cash and kind. Outstanding debts in cash and kind are enumerated as negative financial assets. Inventory assets only consist of stored palay. Inventories of other crops (e.g. corn and mungbeans) are usually small, whereas inventories in fertilizer and chemicals are virtually non-existing.

Working capital

Production activities require a substantial amount of working capital for the purchasing of cash inputs such as fertilizers and pesticides or the hiring of casual wage labour. Annual investments in current inputs for crop production activities during the two-year period of 1979-1981 - excluding land rent payments and product shares of harvesters - were $70 per household for the non-surplus households and $219 for the surplus households on average. Given the level of current capital assets (cash on hand and rice stocks) at the start of 1979, it will be clear that the majority of households in the village is unable to finance the entire amount of current capital out of own reserves. For the non-surplus households current assets amounted to $59, which is far below the average minimum income requirement for subsistence until the next harvest of $197. The surplus households are in a much better position, however, also in their case, the average level of current assets ($227) is below the requirements for minimum subsistence needs ($185) and current production inputs. Hence, the majority of households has to borrow cash or palay on the credit market in order to sustain consumption and production activities. The role of credit in the financial management of households will be discussed in detail in Section 6.3.

5.2 Main economic activities and sources of income

For most households, agriculture is the main source of income. For the three year period of April 1979 until March 1982, income from this source contributed about 78% to the total annual income of the sample households on average (Table 5.2.1).

Table 5.2.1 Main sources of income by crop season ($); all sample households

	Average	1979-80	1980-81	1981-82
Imputed income of family factors in agricultural production	543 (71) 1)	461 (72)	625 (74)	546 (67)
Crop production	494 (65)	397 (62)	576 (68)	512 (63)
Rice crops	356 (47)	201 (31)	436 (52)	431 (53)
Other seasonal crops	121 (16)	177 (28)	119 (14)	68 (8)
Perennial crops	17 (2)	19 (3)	21 (2)	12 (2)
Livestock production	49 (6)	64 (10)	49 (6)	35 (4)
Earnings from wage labour activities	49 (6)	41 (6)	46 (5)	59 (7)
Imputed income of family factors from non-agricultural activities	53 (7)	55 (9)	63 (8)	40 (5)
Grant to the household	104 (14)	76 (12)	91 (11)	144 (18)
Receipt of rent	2		2	3
Receipt of interest	7 (1)	1	6 (1)	15 (2)
Other income	8 (1)	5 (1)	11 (1)	8 (1)
Total household income	766	639	845	815
Income per consumer unit	168	140	186	178

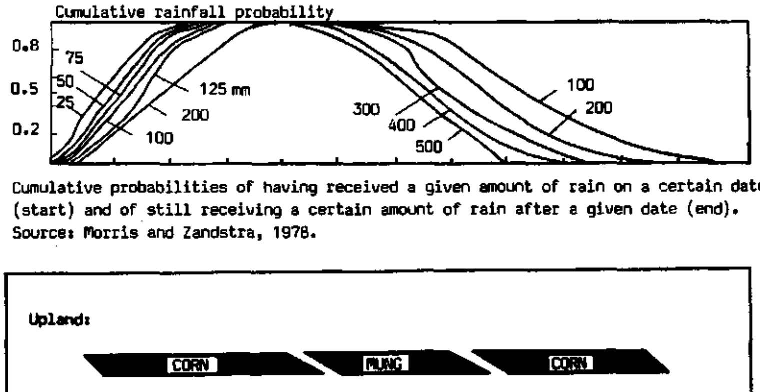
1) Figures in parentheses are percentages of total household income.

This income is mainly derived from self-employed agricultural activities (91%), whereas the remainder comes from agricultural wage labour activities. Annual crop production constitutes by far the most important source of income, contributing 80% to agricultural income and 62% to total household income. Of the total income from crop production perennial crops only constitute a small portion (3%). Pig fattening and breeding as well as poultry production are the main livestock activities. The income from cattle production is minor (4). Income from agricultural wage labour activities, 6% of the total household income, mainly comes from rice harvesting. Table 5.2.1 also shows that the income from annual crops in the 1979-80 crop season was substantially below that of the other two crop seasons. The 1980-81 and 1981-82 seasons were particularly favourable for rice crop production. The crop season 1978-79 (not presented in Table 5.2.1) was more of an intermediate type.

The most important source of non-agricultural income is 'grants to households', contributing 14% to the total household income. This income mainly consists of remittances of children not permanently staying in the household. Income derived from self-employed off-farm activities contributes about 5% to the total household income. Other sources of income include receipt of land rentals and interest payments from rice and cash lending.

5.2.1 Annual crop production activities

The dominant cropping patterns in the area for both upland fields and rainfed and partially irrigated lowland fields, together with cumulative rainfall probabilities are shown in Figure 5.2.1.



Cumulative probabilities of having received a given amount of rain on a certain date (start) and of still receiving a certain amount of rain after a given date (end).
Source: Morris and Zandstra, 1978.

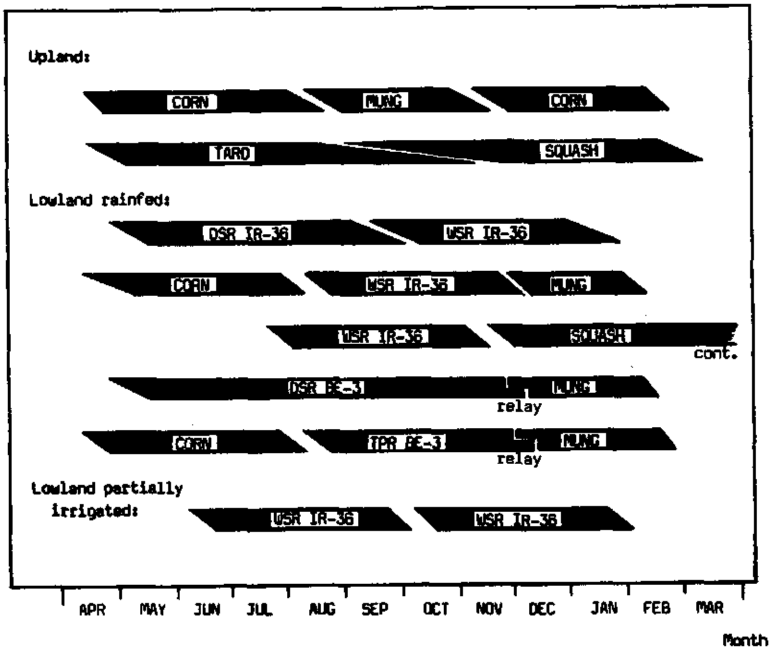


Fig. 5.2.1 Cumulative rainfall probabilities and dominant cropping patterns; WSR: wet seeded rice, DSR: dry seeded rice, TPR: transplanted rice

The growing season can be subdivided into four, broadly defined parts: pre-monsoon, monsoon (early, mid, late), post-monsoon, and the dry season. The pre-monsoon season starts in April and continues until the end of May. Rainfall during this period is highly irregular and consists of a number of scattered showers, some of which can be of substantial intensity facilitating early land preparation in lowland and upland fields and planting of crops such as corn and dagmay as well as dry seeding of rice. Ponding of water in lowland fields does not occur during this period. In the month of June, early monsoon rainfall may be sufficient to allow ponding of water, and planting of rice in puddled soils, especially in the higher positioned waterway fields. The period of intensive monsoon rainfall usually starts in July and continues until October. Crop planting during this season is almost entirely restricted to rice in lowland areas, as soil moisture conditions in the upland areas do not allow the planting of upland crops. The intensity and duration of rainfall starts to decline in November facilitating the establishment of upland crops in upland and sideslope fields. In December, post-monsoon rainfall and residual moisture usually allow seeding of pulse crops such as cowpea and mungbeans in lowland areas. The dry season starts in January.

Table 5.2.2 presents data on the importance of the main crops in terms of area cultivated and contribution to crop income for the period of 1978-1981. These crops are briefly discussed below. A more elaborate analysis of rice crop cultivation is given in

Table 5.2.2 Areas of major crops (ha) and returns per hectare above variable cost and per labour hour ($); 1978-80

	No of plots	Mean plot size (ha)	Percent area (%)	Percent contr. to crop income 1) (%)	Gross margin above varable cost 2) ($/ha)	Gross margin per labour hour 3) ($/hr)
rice	449	0.276	50.8	77.4	218.8	0.62
maize	223	0.215	19.6	2.7	19.6	0.23
mungbeans	129	0.275	14.5	4.1	40.9	0.53
squash	104	0.134	5.7	6.3	159.8	1.66
taro (dagmay)	73	0.074	2.2	6.2	405.4	0.81
tomato	88	0.061	2.2	1.0	67.0	0.27
cowpea	23	0.138	1.3	0.3	36.8	0.46
watermellon	19	0.131	1.0	0.1	13.6	0.20
eggplant	35	0.026	0.4	0.5	198.7	0.34
cassava	20	0.044	0.4	0.3	115.2	0.36
bitter gourd	15	0.055	0.3	0.2	61.9	0.53
alogbate 4)	41	0.012	0.2	0.5	351.6	0.39
other crops 5)	31	0.105	1.3	0.4	37.7	0.34
TOTAL	1256	0.195	100.0	100.0	143.6	0.57

1) Income above variable cost. Variable costs comprise labour inputs (including the imputed cost of family labour), material costs (seeds, fertilizers and pesticides), and power cost (draught animals and machine threshers).
2) Gross returns minus variable cost as defined under (1), thus payments to land are not subtracted.
3) Gross returns minus material and power cost divided by the total labour input in hours.
4) A local spinach-like vegetable.
5) Other crops include sweet mellon, sweet potato, pigeon pea, sweet pepper, mixed croppings.

Chapter 7. Although the various crop production activities are discussed separately, they are, of course, all related to one another by the competitive use of the household's resources including the joint use of the household's management capability. When simultaneously grown on the same field (intercropping), crop activities are further related to each other by competition for light, water, nutrients, etc, but may also show complementary relationships (weed and disease control, symbiotic effects, etc.). When grown on the same field at different times, crops are related through their residual effect on soil fertilizer, weed growth, plant diseases, and when grown sequentially influence each other through the timing of planting and harvesting dates. Crop activities are also related through financial interdependences. The financial position of households is often so tight that the proceeds of the sale of products of one crop are needed for the financing of inputs of other crop activities.

Rice

Rice is by far the most important crop in the area, both in terms of area cultivated and contribution to total crop income. Roughly half of the total cultivated area is planted to rice of which 22% is planted to second rice crops, whereas it contributes 77% to the total crop income above variable cost. This indicates that rice production has a substantially higher profitability compared to the average profitability of all crops taken together.

About two-thirds of the rice area are occupied by IR-varieties. In 1978, a number of different IR-varieties were still grown (IR26, IR30, IR1561, IR29, IR36) as well as two other improved varieties released by the College of Agriculture at Los Banos (C-1, C-4). However, in the following years IR36 almost entirely replaced the other varieties, except for the taller, photo-sensitive BE-3 variety. During the survey period, the area planted to BE-3 remained more or less stable at a level of 29% of the total rice area. A small portion (3%) is still cultivated with somewhat older varieties. They include Camoros - a tasty, reddish grain variety - that is used for own consumption on special occasions and Pilit - a glutinous rice variety -which is used as an ingredient for local delicacies.

The IR-varieties are either grown as single crops or in a double rice crop pattern. As single crops they may be preceded by pre-monsoon corn or a dry season crop such as squash or tomato and may be followed by post-monsoon crops such as mungbean or cowpea. The dominant way of establishing rice crops is direct seeding unto dry or puddled soils. The former method is used in establishing first rice crops in double rice crop patterns and in establishing early seedings of BE-3. Transplanting of IR-varieties still occurred in 1978, but became limited to BE-3 crops in subsequent years.

Corn

Corn is an important crop in terms of area cultivated, but in terms of the value of grain yield it has about the lowest returns per hectare as well as per labour hour of all crops grown in the area. Although it occupies about 20% of the total cultivated area, its total contribution to the total crop income above variable cost is less than 3%. Farmers generally consider corn as a low management 'catch-crop'. However, as corn plantings and yields are, to some extent, covariant with rice plantings and yields, in poor rice production years, corn may serve as an important substitute for rice. In case of low rice supplies, corn is mixed with rice (linamudan) for consumption, bartered for rice or sold at the market. Further, in calculating the economic returns of corn no value was imputed for the crop residue. Corn stalk is, however, an important side-product of corn. It is used as carabao fodder during a period of the year when fodder supplies are low and much work is requested from carabaos. Sometimes corn is specifically grown as cattle fodder in which case it is seeded at a high density. Further, it is common to cut the top portion of the plant 1-2 weeks before it reaches full maturity. These top portions are also used as carabao fodder.

There are considerable between-year differences in the area planted to corn because the feasibility of corn plantings is strongly dependent on the variable early and dry season rainfall. About two-thirds of the total area grown to corn in the period 1978-1980 was planted in April-May 1979 and December-February 1980. The crop is grown in both upland and lowland fields. In upland fields, corn is planted after fields have been ploughed, whereas the larger lowland fields are usually only furrowed after which the corn is seeded in these furrows. When the crop looks promising, the field is ploughed in between the rows of corn (hilling-up). Intercropping of corn with the local rice variety Camoros is common practice in the area. Farmers' attempts to follow the same practice with the IR36 variety were not successful.

Apart from the early season plantings, corn is sometimes grown as a third crop on upland fields usually following mungbean, and also as a last crop in lowland fields following rice. In lowland fields, corn is sometimes intercropped with squash, bitter gourd (Momordica charantia), mungbean, and tomato. In 1980, which was an exceptional good year for dry season corn, a second and third relay planting of corn occurred: the second planting in between the rows of the standing corn crop and the third planting on the rows in between the mature plants of the first corn crop. Farmers mainly use local flint corn varieties. The crop is usually not fertilized because fertilizer tends to increase the damage caused by the Asian corn borer, while pesticides are rarely applied because of the danger of lingering residues on corn stalks fed to animals.

Pulse crops

Pulse crops grown in the area include mungbean, cowpea, and pigeon pea (Cajanus cajan). They are marketed and used for own consumption. Mungbean is by far the most important pulse crop both in terms of area planted and income. Of the total area planted to non-rice crops, 30% is grown to mungbean the largest part of which is grown in lowland areas. Its contribution to total non-rice crop income is 18%. Similar to corn, mungbean is considered a 'catch-crop'. However, for the period 1978-81, returns per hectare and per labour hour were substantially above those of corn. Cowpea occupies a much smaller area, about one-tenth of the area of mungbean. It has about similar returns to variable cost and labour as mungbean. The area planted to pigeon pea is minor.

A number of different mungbean and cowpea varieties are grown which are locally distinguished by the colour, size and shape of the grain. The larger grain varieties were introduced in the 1960s and are locally called 'miracle mungo'. Mungbean is planted in upland areas where it follows corn. Due to its longer growth duration, cowpea is less suitable for cultivation in upland areas. In lowland areas, cowpea and mungbean follow rice and are commonly relayed into the rice stubble. This planting method allows farmers to quickly establish the crop either after or just before the harvesting of rice in order to take full advantage of the residual moisture.

In contrast with cowpea, mungbean is considered an excellent crop to be planted in areas where dry seeded rice crops are planned to be grown in the next season. It effectively prevents the grazing of animals during the dry season and - according to farmers - it has a beneficial effect on the soil structure which faciliates easier tillage. Further, the harvesting of mungbean does not interfere with the establisment of the early rice crops. The harvesting of cowpea often extends well into the beginning of the wet season because this crop is able to survive dry season conditions. Moreover, due to its creeping growth character, the cleaning and ploughing of a cowpea field is difficult. Mungbean is sometimes grown in mixed cropping with cowpea and corn. Cowpea is less suited as an intercrop with tall crops such as corn because the crop yields less under conditions of low light intensity. Moreover, cowpea has a detrimental effect on corn due to its climbimg nature.

Dagmay

Dagmay is one of the major cash crops of the village. In terms of gross margin per hectare it is the most profitable crop, whereas returns to labour are above average. Because its cultivation is both labour and cash intensive, it is generally grown in small areas. It occupies 4.5% of the non-rice area and contributes more than 27% (!) to the total non-rice crop income. Dagmay is a particular type of taro known as dasheen. It is grown in upland and sideslope fields. In contrast with other taro varieties, it cannot withstand waterlogging and crops planted on the lower sideslope fields require proper drainage of fields.

The crop is normally planted after the first rains in April or

May, but can be planted in dry soil conditions in March. Early plantings under irrigated conditions or using watering by hand is practised. Although this requires a substantial amount of labour, these crops are harvested early and fetch high prices on the market. The planting, harvesting and post-harvest operation require substantial amounts of labour. Moreover, the field should be kept more or less weedfree, particularly during the early growth stage, whereas the application of fertilizer is essential for proper plant development and to obtain a crop quality which allows marketing. Limited seed availability, high seed cost, together with high labour requirements and fertilizer cost, are major constraints to the cultivation of this crop by resource-poor farmers.

The crop matures in five to six months. However, harvesting usually starts 17-19 weeks after germination when the main corm has developed two side tubers and may continue for about four months. Both tubers and leaves are edible and marketed. As the crop reaches maturity the ratio tubers/leaves increases. At the end of the harvesting period only side-tubers are sold. The village is almost the sole supplier of this crop to nearby urban centres.

Squash

Another important cash crop in the village is squash. It occupies about 12% of the area planted to non-rice crops and contributes around 28% to the total non-rice crop income. Although it has a substantially lower profit level per hectare compared to *dagmay*, it is about twice as profitable per labour hour. It is grown in both upland areas where it follows *dagmay* or mungbeans, and in lowland fields following rice. It is also grown under irrigated conditions in the dry season and can further be found on borders and bunds surrounding lowland fields. Farmers only grow local varieties which are distinguished by the shape and colour of the fruit.

Squash is either seeded in holes or raised on seedbeds and transplanted. Transplanting is preferred for early crops to prevent seed damage due to excessive moisture, whereas seeding in holes is usually carried out with late crops as it promotes a deeper root development. Although, squash is able to withstand periods of heavy rains and even short periods of standing water, excessive moisture is a common cause for crop failure of early planted crops, particularly in the upland and sideslope fields. For the dry-season squash, farmers usually construct a simple well to allow initial irrigation by hand. Unlike other *cucurbitaceae* grown in the village (see below), squash has the ability to recover after a long dry period and farmers often leave good looking squash crops in the field until the ponding of water destroys the crop. Such crops may grow well in the early season rainfall and produce a good yield prior to the establishment of the first rice crop. In lowland areas, the crop makes an excellent intercrop with corn. It is common to apply fertilizer. Squash fruits can be retained for long periods both in the field and harvested. In the case of low market prices, squash can serve as excellent pig food.

Other cucurbitaceae grown in the village include sweet mellon, watermellon (Citrillus lanatus), and bitter gourd. The area planted to these crops is small. Cultivation practices are similar to squash. Sweet melon is mainly grown for home consumption. Unlike in nearby villages where watermellon is an important cash crop, farmers' attempts to grow an improved variety of watermellon were not successful due to serious pest infestation with root-knot nematodes. Bitter gourd is primarily grown for the market. However, the profitability of this crop is substantially below that of squash. Unlike squash, bitter gourd cannot be stored and timely harvesting is required.

Tomatoes

Apart from squash, tomato is another common dry season crop grown by almost all households in the village. It is primarily grown for the market, but is also an important ingredient in meals. It occupies 4.5% of the area planted to non-rice crops and has a similar contribution to crop income. Although, tomatoes still have a comparatively high profit level on a per hectare basis, returns to labour from this labour intensive crop are low due to the large number of crop failures mainly caused by drought and diseases. Moreover, for certain periods of the year the price of tomatoes is highly variable and unpredictable (see Figure 5.2.3). Tomatoes are planted throughout the dry season. Early plantings commence in the upland fields, whereas late season plantings occur in lowland fields. These late plantings require irrigation by hand and may fetch high prices during the onset of the wet season.

The remaining cultivated area is occupied by a number of minor crops. Of these crops eggplant (Solanum melongena), cassava (Manihot esculenta, and Indian Spinach (Bassella rubra) (locally known as alogbate), have high gross margins on a per hectare basis. Cassava is grown by a number of households primarily for the production of a local delicacy called but'ong which consists of cassava flour with sugar. It is also used for home consumption. The market for cassava is limited. Hence, in the computation of the economic returns the processing of cassava into but'ong was included which explains the relative high returns per hectare and high labour requirements. Alogbate and eggplant are mainly grown by women, usually in very small quantities. Especially alogbate is a high valued, labour intensive crop. Also the marketing of these crops is usually carried out by women. Other minor crops include sweet potato (Ipomoea batatas) and sweet pepper (Capsicum annuum).

Farm input supply and marketing of agricultural products

Chemical inputs are widely used in most of the above crop production activities. A large variety of farm inputs is supplied by a number of retail points in the two nearby towns as well as in the city. Farm inputs can be obtained from stores in the nearby town and at somewhat lower prices in Iloilo City. It is common that farmers buy pesticides and herbicides in the town at times that weed and pest infestations require spraying. The number of brands and types of pesticides and herbicides available is staggering and include both contact and systematic chemicals. The sale and use of a number of these chemicals is prohibited in Western countries. Fertilizers are usually bought in the city and transported by jeepney. It is also common that for a small provision the jeepney driver himself buys the fertilizer at the request of farmers. More recently, it has become possible to buy fertilizer on credit from private lenders. A number of different types and brands of fertilizer available including urea, ammonium phosphate, ammonium sulphate, and compound fertilizers such as 14-14-14. However, certain fertilizers are not available such as pure phosphate-based fertilizers. Fertilizer is only sold in bags of 50 kg.

Fertilizer prices have increased substantially in the period of 1978 until 1982. The main reason for this price increase was the abolition of the subsidy on fertilizer provided by the Government. Also rice prices increased substantially during this period (Table 5.2.3). Of course, this price increase only favours farmers able to sell surplus rice production.

Table 5.2.3 Nominal and real prices of fertilizers ($/50kg)

Type of fertilizer	1978	1979	1980	1981	Percent change 1978 to 1981
urea	10.1	12.5 (11.8) 1)	13.5 (11.0)	16.6 (12.5)	64 (24)
ammonium sulphate	7.0	9.3 (8.8)	11.2 (8.2)	12.9 (9.7)	84 (39)
ammonium phosphate	9.3	12.3 (11.7)	13.0 (10.6)	15.5 (11.7)	67 (26)
14-14-14	8.7	11.0 (10.4)	12.0 (9.8)	14.8 (11.1)	70 (28)
Village Palay Price (VPP) ($cts/kg)	13.9	14.7	17.0	18.5	33

1) Figures in parentheses are deflated prices based on the VPP-index.

The marketing system for agricultural products is well organized and, to a large extent, competitive. Except for rice and corn, a large number of buyers and sellers operate on these markets. The role of government marketing organizations is negligible.

The rice and corn marketing is handled by a limited number of town-based traders and a few large farmers of the village and neigbouring villages. The town-based merchants are contacted by farmers and the merchant provides transportation. The farmer-merchants usually tie rice marketing to money and rice lending, and a number are also involved in rice-milling. Only one farmer in the village has access to the government marketing organization NGA (National Grains Authority) and fills his excess sales quotum with locally purchased rice.

Due to the virtual absence of a government marketing channel, the price support system for rice is ineffective. Hence, farmgate prices of palay show the usual seasonal pattern of variation (Figure 5.2.2). In the period of 1978 until 1982 rice prices have increased substantially, mainly as a result of the increase in rice purchases caused by the establishment of a large private ricemill located some 12 km from the village.

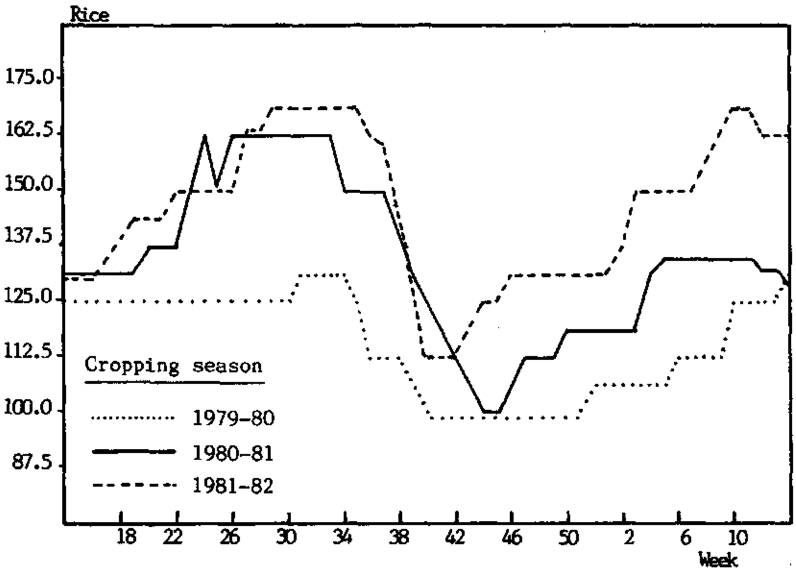


Fig. 5.2.2 Seasonal pattern of palay farmgate prices (indices); Week no. 1 = 1-7 Jan.

The marketing of non-rice crops is handled by petty merchants (in particular middlewomen), farmers and their wives. Market outlets consist of two town markets located some 3 and 4 km from the village having two market days at different times of the week, every week. Two large central markets are in daily operation in Iloilo City. The town markets mainly serve a retailing function, whereas the city markets are used for both retail and wholesale marketing.

A small group of middle-women provides the main marketing channel for vegetables other than dagmay. During the marketing season they pay frequent visits to farmers and often have a special arrangement (suki) with farmers regarding the option to sell their products. They either retail or wholesale the products on the two central markets of Iloilo City. Sale prices are fixed in advance but actual payment occurs after the products are sold. Products are transported by jeepney, usually leaving the village at two o'clock at night and returning at two o'clock in the afternoon.

Small quantities of vegetables like alogbate, tomato, and eggplant are retailed on the two town markets by the farmers' wives. They use the proceeds to buy consumer goods such as oil, fish, soap, etc. It is a typically female circuit since these products are also often grown by women. This small-scale 'subsistence-marketing' is described and analyzed in detail by Szanton (1972). More recently, it has become popular that farmers themselves wholesale larger quantities of non-rice crops, notably _dagmay_ and squash, on the central markets of Iloilo City. They are young, relatively well-off farmers who like visiting the city and consider marketing an attractive opportunity to earn extra cash.

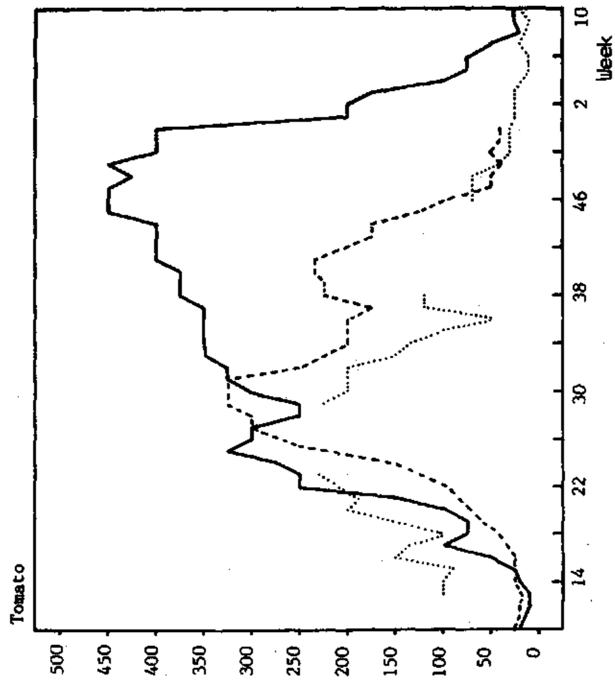
Product prices of storable crops such as corn, mungbeans, and cowpea are fairly stable. Both corn and cowpea are unimportant commercial crops. They are usually home consumed, whereas corn is also used as fodder for animals. Because of the difference in growing season, mungbean prices show a price pattern opposite to that of rice (Figure 5.2.3). The seasonal price pattern of _dagmay_ is very similar between years. Because the village is the main supplier of this crop to Iloilo City, initial crop prices are high but drop quickly when more farmers - eager to fetch high prices, but also forced to sell _dagmay_ due to cash needs for the purchasing of fertilizer - start to harvest the crop. After the initial high price period has passed, prices tend to stabilize as the pressure to sell _dagmay_ decreases. Farmers continue to gradually harvest the crop, thereby taking into account the total amount of _dagmay_ entering the market. Also squash and tomatoes show a strong seasonal price pattern. Compared to other crops, variations in this pattern are much more pronounced and thus less predictable. Moreover, unlike other crops, squash and tomatoes may reach such low price levels that farmers do not take the effort of harvesting the crop and transporting it to the market. Whether farmers decide to leave the crop in the field depends on the wealth status of the households and the immediate need for cash.

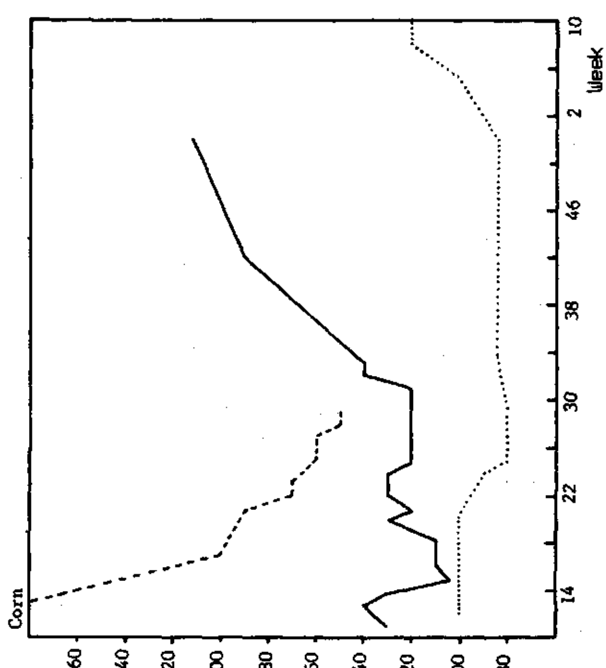
5.2.2 Perennial crops

The cash income derived from perennial crops is minor ($18 per household) and mainly comes from bananas, mangoes, and firewood. This figure, however, underestimates the total income from perennial crops as home consumption of these products is not accounted for (5).

Almost every household has its own supply of bananas. These plants are found around the house, on the higher part of upland fields, on the hillsides, and on the bunds of lowland rice fields. Various local varieties are grown of which some are suitable for direct consumption (_tundal_), whereas other types (plantain) have to be boiled before consumption (_sab'a_). Apart from own consumption, small quantities are sometimes sold at the town markets.

Although the contribution from mango production to the total village income is low, it is an important source of income for a few households. Mango trees are scattered in the hilly area of the village. Production is both for the local market and for export to other countries. In the latter case, quality requirements are high


Tomato
500
450
400
350
300
250
200
150
100
50
0
14
22
30
38
46
2
10
Week


Corn
260
240
220
200
180
160
140
120
100
80
14
22
30
38
46
2
10
Week

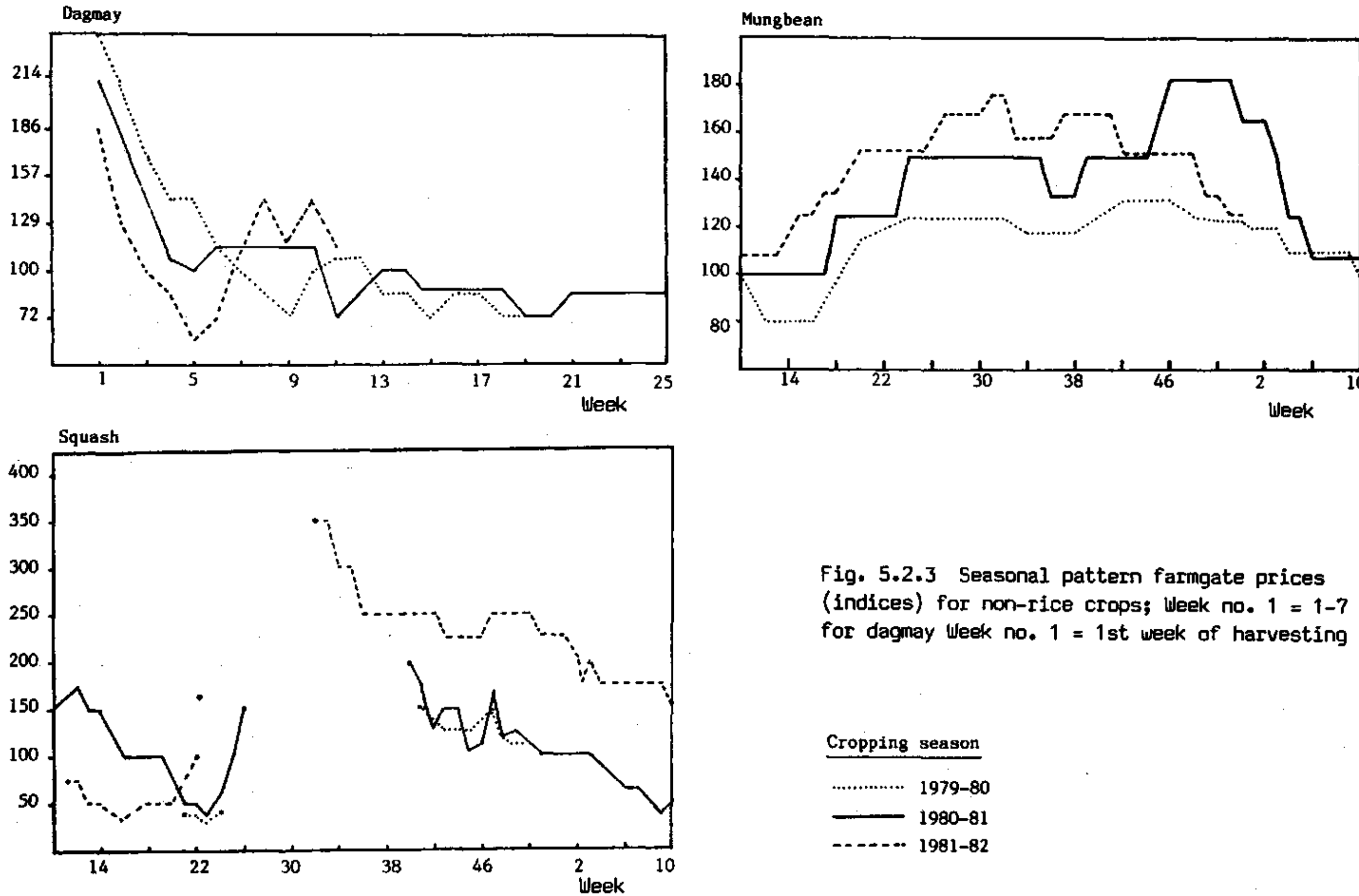


Fig. 5.2.3 Seasonal pattern farmgate prices (indices) for non-rice crops; Week no. 1 = 1-7 Jan; for dagmay Week no. 1 = 1st week of harvesting

Cropping season

- ··········· 1979-80
- ———— 1980-81
- - - - - - 1981-82

and frequent spraying with pesticides is required to prevent damage by insects. It is common practice that a group of men rent a number of mango trees for one production cycle. To induce flowering, trees are sprayed with chemicals.

Coconut trees provide a number of valuable products. The fruits are used in meal preparation and form an ingredient for local delicacies which are sold on the market. The production of copra is of minor importance. However, a large number of coconuts is not used for nut production but is utilized in the production of palm wine (tuba). This mild alcoholic beverage is obtained from the drippings of young flower pods of which a tiny slice is cut twice a day. The tuba is collected daily by a number of professional tuba-gatherers. These people have 10-20 trees in production and usually rent a number of coconut trees from other households. Further, coconuts provide valuable construction materials. From the trunks excellent timber and poles can be obtained, whereas the leaves are used as roofing material. The large mid-ribs of coconut leaves can be used for fuel.

Bamboo is the most important source of building materials. Except for the roofing and the corner poles, most houses in the village are fully constructed of bamboo. It is also used in the manufacturing of furniture, construction of pig pens, etc. A few families have large enough areas of bamboo to sell a part of it on the market. However, most households have a small bamboo area in common property with other members of a family.

Similar to the bamboo areas, a large number of households have firewood lots in common property with other family members. Firewood is mainly used for own purposes, i.e., cooking and feed preparation for pigs. A few households have large enough areas to sell firewood to other households in the village or to market it in the towns or the city. It is also common to sell a standing crop of firewood in which case the buyer cuts it. In the village, households without their own firewood lot are complaining about the worsening firewood situation and increasing prices. During the survey period, a number of farmers were planting a part of their upland fields to the fast growing ipil-ipil trees (Leucaena glauca).

5.2.3 Livestock activities

Livestock production forms an important supplementary source of income to crop production and wage labour activities. Hog fattening is the major livestock activity in the village. Nearly three-quarters of the sample households have their own hog, whereas 30% of the households have a hog under a so-called sagod arrangement. Sagod literally means 'taking care'. In such arrangements the 'sagod-taker' agrees to feed a piglet owned by another person in return for a 50:50 sharing of the proceeds after sale. Only a few households have more than one pig. These pigs are usually kept in a shaded pig-pen in the backyard. Hog fattening is a typically female activity. The local breed pigs are mainly fed with household refuse, rice bran (upa), the inner portion of banana stalks and kangkong (Ipomoea aquatica), a common weed in well-watered lowland rice fields. Women spend considerable time on collecting these materials. Additional time is required to prepare these feed materials before they can be fed to the pig (cutting and cooking). Occasionally, this diet is supplemented with coarsely ground corn and ipil-ipil leaves. If available, squash is also an excellent pig feed.

Recently, under the auspices of a new government development programme (Kabsaka), it became possible to acquire hybrid pigs on credit including cash for feeds and vaccinations. Initial results look promising but feeding and vaccination expenses are high. So far, only two households have made use of this arrangement.

A few households are also active in pig breeding, an activity mainly carried out by women of the older, somewhat wealthier households. The incidence of piglet mortality makes this activity more risky than pig fattening. Also the capital investment (sow) and current input cost (feeding during pregnancy and suckling period) is substantially higher and piglets need to be vaccinated.

Cow raising and fattening is of minor importance in the village. Cows are not kept for milk production but are primarily reared for beef production. They are not permanently stalled. Grazing is done in a similar way as with carabaos, usually by women and children. Due to the high labour requirements for grazing the animals, returns to labour of this activity are generally low. It is an activity typically undertaken by the poorer households who commonly have cows in sagod from other owners. A number of these households do not have a carabao. In upland fields cows are used for land preparation activities.

Virtually all households have chicken that are left free to roam around the house. They are mainly raised for own consumption on special occasions. Productivity is low due to the very contagious fowl pest, a devastating disease which sometimes decimates the village chicken population during the summer months of March-April. A number of farmers have attempted to raise chicken on a more commercial scale in sheds located at some distance from the centre of the village in order to reduce the incidence of fowl pest. However, these attempts have generally not been very successful. One of the problems involves protecting chicken from theft. In contrast with other areas in the Philippines, duck raising is of minor importance. Also goats are rarely found.

A new activity in the village is the rice-fish culture. In 1980, a wealthy farmer started to experiment with this type of intercrop which in other parts of Iloilo was introduced since 1978. Although some fish is always present in rice fields during the wet season (e.g. mudfish), this was the first attempt to controlled fish production with the fast growing tilapia (Tilapia mossambica).

From the first results it appears that it is a very profitable activity. However, conflicts between fish and rice production did not arise yet. It is not clear what should be done when the rice crop is pest infested and requires chemical treatment. Further, since this production system requires sufficient water for storing the young fish during the dry season, few households can make use of this technology.

The main channel for livestock marketing (except poultry), is controlled by a few village farmers. They usually operate in groups of two to three persons of which one finances the operation. Livestock trading is done through a network of weekly rotating markets in the western part of Iloilo Province. At these markets, the traders are represented by commissioners who provide them with market information and further assist in the transportation of cattle, usually on foot. These livestock traders also provide assistance in case a farmer wants to change his working animal for a new one. Before the actual purchase is made, the trader allows the farmer to test the working animal for a week or so and will take it back in case it does not meet the farmers requirement.

Pigs are mainly sold or bartered within the village itself. A large quantity of pork is consumed during the annual fiesta of the village in May. For this celebration, it is common that a number of households slaughter their pig and barter the pork for rice to be paid after the (BE-3) harvest in December.

5.2.4 Self-employed non-agricultural activities

Income derived from self-employed non-agricultural activities amounts to a low 5% of the total household income. Main sources of income include basket weaving, petty-trade of crops, livestock trading, selling of own made delicacies, and selling bread or meals during the main rice harvesting season. Baskets are mainly sold in the village. Basket weaving requires a certain skill which seems to disappear with the young generation. Preparation and selling of delicacies involves the cassava-based candy but'ong earlier mentioned.

5.2.5 Wage labour activities

Hiring labour on a daily wage basis is the most common labour arrangement for crop operations other than harvesting. Depending on the type of operation usually 1 to 3 meals are provided in addition to the wage payment. For the land preparation activities, the wage payment is about double the rate of activities only requiring manual labour such as transplanting and weeding (Table 5.2.4). Wage payments are more or less constant during the crop season. They are rarely increased in response to a tight labour market situation. The usual way to attract labour during such periods is to offer more and better meals to the labourers. In the four year study period, wage rates increased twice, in 1979 and 1981 (Table 5.2.5). According to farmers, wage rate increases in

Table 5.2.4 Hired labour cost/wage labour earnings per workday ($); 1979 prices

Activity	Product share	Wage rate	Meals provided: Breakfast	Lunch	Supper	Food expenses	Total cost/earnings
Land preparation		1.35-1.62	*	*		0.96	2.29-2.58
- without meals		2.70		- no meals -			2.70
Transplanting/ weeding		0.67-0.81		*		0.51	1.18-1.32
Rice harvesting (contract)							
mechanical threshing	1/9 of gross product		*	*	*	0.90	1.95-3.88
foot threshing	1/6 of gross product		*	*	*	0.90	1.47-2.94
Rice hauling	0.14-0.34/bag palay		*			0.78	2.45
Carpentry		1.35-2.00	*	*	*	0.84	2.23-2.88
- without meals		2.70		- no meals -			2.70

this village primarily occur in response to an increase in rice prices. The development of the real wage rate tends to confirm this. When the wage rate is deflated by the price of palay on the local market (VPP-Index), it is surprisingly stable. When the wage rate is deflated with the official consumer price index for Iloilo Province, the wage rate pattern is even more stable. It should be noted, however, that in both cases wage rate increases occurred in a tight labour market situation, i.e., during the period of the establishment of the second rice crop.

The predominant arrangement for harvesting crops involves product sharing. Labour for harvesting can either be obtained on the basis of 'open' participation (pasapar), i.e., anyone is allowed to join the harvesting operation or in the form of contract groups consisting of 6 to 12 persons (pakyaw). The former arrangement is common at the start of the rice harvesting season, whereas the latter is common during the main harvesting periods. The product share differs for the various crops and whether harvesting

Table 5.2.5 Development of real agricultural wage rates (Pesos)

	1978	1979	1980	1981	% change 1978-81
Nominal					
Land preparation	10.0 (17.1) 1)	12.0	12.0	15.0 (24.7)	+50% (+44%)
Weeding/transplanting	5.0 (8.8)	6.0	6.0	7.0 (12.2)	+40% (+39%)
Average	7.5 (13.0)	9.0	9.0	11.0 (18.5)	+47% (+42%)
Deflated by VPP-index	(95)	(100)	(116)	(126)	
Land preparation	10.5 (18.0)	12.0	10.3	11.9 (19.6)	+13% (+ 9%)
Weeding/transplanting	5.3 (9.3)	6.0	5.2	5.6 (9.7)	+ 6% (+ 4%)
Average	7.9 (13.7)	9.0	7.8	8.7 (14.7)	+10% (+ 7%)
Deflated by consumer price index 2)	(80)	(100)	(106)	(118)	
Land preparation	12.5 (21.4)	12.0	11.3	12.7 (20.9)	+ 2% (- 2%)
Weeding/transplanting	6.3 (11.0)	6.0	5.7	5.9 (10.3)	- 4% (- 4%)
Average	9.4 (16.3)	9.0	8.5	9.3 (15.7)	- 1% (- 3%)

1) Figures in parentheses are wage rates including the cost of provided meals.
2) Official consumer price price index for the Western Visayas.

includes cutting or threshing or both. As mentioned earlier, a contract harvesting arrangement also occurs in the harvesting of taro (porcentuan).

Contract group arrangement further occur in non-harvesting activities such as ploughing. The group as a whole is paid a fixed amount for ploughing a certain piece of land. Previously, such contract groups were also active in transplanting rice. It is common that these groups are also active in exchange labour activities (dagyaw, see Appendix II.2).

In contrast with other parts of the province, in this village the sagod arrangement is limited to hog fattening. Particularly in irrigated rice areas where a substantial part of the households is landless, sagod labour also occurs in rice production. Labourers agree to weed rice fields without receiving any payment in return for the option that they will be the sole harvesters of the field (Ledesma, 1982).

The arat-lauwan arrangement is of minor importance. It involves an advance payment of labour that may be requested in the course of the crop season. For the farmer giving the arat-lauwan it has the advantage that he can claim priority for the labourer's time in periods of high labour demand. In such periods it is often difficult to acquire labour for relatively low paying-low status activities such as weeding. The arrangement usually occurs between the somewhat wealthier farmers and young male persons who are anxious to have money to 'properly' celebrate the fiesta in May.

Wage labour opportunities during certain periods of the year are scarce and access to such activities requires a good personal relationship between the wage labourer and farmers usually requesting wage labour. This applies particularly to the relatively high paying early season wage labour activities such as land preparation as well as profitable harvesting activities such as dagmay harvesting. This may appear to contradict the remark made earlier that it is sometimes difficult to find sufficient wage labour to carry out agricultural operations. It should be realized, however, that due to the influence of a highly variable onset of the growing season, the demand for wage labour during certain periods of the season not only strongly varies within any one year but also between years. Thus, imbalances between demand and supply of wage labour activities occur quite frequently.

Apart from the wage labour opportunities in agriculture, other activities that are paid on a daily wage basis or involve a lump sum payment are services rendered by carpenters, needle workers, midwives, hilots (masseur), and herbolarios (traditional doctor or herbalist). Clearly, access to such employment opportunities is restricted as they require specific skills or supernatural power. The sample households included two professional carpenters and one herbolario.

Table 5.2.6 Daily labour earnings for selected income-earning activities ($)

Activity	Average	Range
Self-employed agricultural activities:		
Crop activities: 1)		
rice	4.30	1.82 - 5.81
non-rice	2.06	0.93 - 4.41
Livestock activities:		
hog fattening	1.01	0.68 - 1.51
hog fattening (sagod)	0.57	0.34 - 0.68
pig breeding	1.34	0.86 - 1.82
Self-employed non-agricultural activities:		
But'ong activity	0.92	0.80 - 1.24
Petty-trade agricultural products	1.65	0.03 - 3.32
Wage labour activities: 2)		
Land preparation	2.44	2.29 - 2.58
Transplanting/weeding	1.25	1.18 - 1.32
Rice harvesting (foot threshing)	2.45	1.47 - 2.94
Rice harvesting (mech. threshing)	3.23	1.95 - 3.88
Dagmay harvesting (porcentuan)	5.88	4.63 - 8.23
Hauling palay	2.45	
Carpentry	2.56	2.23 - 2.88
Sewing	0.64	0.53 - 0.88

1) Based on the average annual net return per family labour hour realized by households for the overall rice crop activity during the two-year period of 1979-81. The same applies to the non-rice activities.
2) Earnings include imputed cost of provided meals.

A summary of daily earnings of the above discussed income-earning opportunities is given in Table 5.2.6. Of the self-employed agricultural activities, rice crop production is clearly the most remunerative activity. Daily earnings in livestock activities are comparatively low. A number of wage labour activities (land preparation, rice harvesting combined with foot threshing, hauling rice, and carpentry) have daily earnings comparable to self-employed non-rice crop production. Dagmay harvesting shows the highest level of daily earnings. Of course, the availability of most high pay-off wage labour opportunities is limited to certain periods of the year. This applies especially to dagmay harvesting. Daily earnings in hog fattening and wage labour activities such as transplanting and weeding are relatively low. The worst paying employment opportunities are sewing and hog fattening under the sagod arrangement.

5.3 A typology of farm-households: Surplus production capacity and the family life cycle

In the previous two sections, the type of resources at the disposal of households were discussed as well as the wide range of income earning opportunities through which these resources can be made productive. Before it will be analyzed how individual households make use of these resources and opportunities (Chapter 6), in this section an attempt will be made at a classification of farm-households. The idea underlying the household classification is to allow an assessment of differences in management strategies between households that differ with respect to their sensitivity to income risks.

Generally, the household's risk sensitivity depends on the household's ability to overcome possible shortfalls in income without endangering the future income earning capacity of the production unit. The latter implies that households should not be forced to sell non-liquid productive assets to finance necessary household expenses. A low level of risk sensitivity thus requires the existence of reserves either in the form of own financial means or food reserves or dependable credit reserves with external sources and/or the anticipation of surplus income in the near future from dependable income sources. The accumulation of reserves requires a sufficient income generating capacity to provide in normal years for an income well above normal operating expenses of the household. Normal operating expenses include the usual cost of production consisting of farm inputs acquired from external sources as well as the essential subsistence requirements of the household as a whole, including both workers and non-workers. As discussed earlier, the expenses attached to the provision of daily subsistence needs - including both cash expenditures for household needs and consumption requirements in kind - must be treated as an overhead cost associated with the generation of the total gross household income. Households do not have a choice but to meet these expenses on a day-to-day basis.

Of course, the existence of a surplus income earning capacity does not necessarily imply that for individual years reserves are present. Due to the occurrence of poor production years, high expenditures due to such incidences as illness, or simply because of overspending reserves may be timely depleted. The household's risk sensitivity is thus not a constant entity, but may change from year to year as well as within years. The household will be more sensitive to income risks:

- the closer the expected income flow is to essential daily household expenditures;
- the weaker the present net financial position of the household including requirements for short term debt repayment;
- the more limited access is to reliable credit sources at times of a low repayment capacity.

Given the limited importance of regular income derived from capital and livestock assets (Chapter 6), the household's income flow is primarily determined by the availability of land and labour resources. Further, with scarce opportunities for self-employed non-agricultural activities, the income earning capacity of households mainly depends on self-employed crop production activities and income derived from wage labour activities. Of these two activities, crop production provides the main source of surplus income. As earlier indicated, returns to regular wage labour activities are substantially below the returns of the main crop production activities. In fact, given the wage rate for casual labour and the restricted market for wage labour activities, income from wage labour hardly qualifies as a source of surplus income. It takes an adult person 85 days of full-time wage labour (assuming 25% high paying activities such as rice harvesting ($1.55/day) and 75% low paying activities like weeding or transplanting ($0.74/day)) to earn enough income to cover his personal annual minimum income requirement, excluding the meals he obtains as a wage labourer. For this reason, none of the households in the village depend on agricultural wage labour activities as the only source of income. Moreover, wage labour activities are not a dependable source of income. This aspect is important within the context of determining the risk sensitivity of households. In case households have limited reserves, anticipated surplus income from planned income earning activities may still be sufficient to provide enough income security to allow some level of risk taking, provided such income source is dependable. In such case, anticipated surplus income can be considered to add to the household's near future reserves and thus lower the household's risk sensitivity. In contrast with income derived from self-employed agricultural activities, for wage labour income households are dependent upon decisions of others and may face the risk of non-availability of timely income earning opportunities. Hence, wage labour activities do not provide a dependable income flow on which anticipated reserves can be based.

Thus, self-employed crop production activities are the prime source of surplus income in the present village economy. The availability of land is therefore more or less a prerequisite for the generation of surplus income. The surplus production capacity of the crop production sub-system largely determines the risk sensivity of households and depends on:

- the production capacity of the farm holding determined by the size of the area cultivated, the land quality, and level of employed technology;
- the number of consumer units in the household determined by the household size and composition.

Another aspect of the risk sensitivity of farm-households is their ability to control the negative effect of unfavourable environmental conditions on crop production. The ability to adequately react to crop production risks largely depends upon the availability of family labour. Due to the restricted wage labour market, casual labour may be hard to find, particularly at times such labour is badly required for crop husbandry activities such as weeding or replanting. When such operations are not carried out in time, the risk of crop failure and thus household income risk may substantially increase. The availability of ample family labour resources, although a liability in terms of the claims it puts on subsistence requirements in case such labour cannot be made productive, is thus, on the other hand, an asset when it comes to risk reduction in crop production activities.

From the above discussion, the following two classification variables logically follow:

- The production capacity of the farmholding determining the extent to which the household is capable of producing enough income through self-controlled agricultural activities to meet the subsistence requirements of the family;
- The family life cycle stage determining family labour availability, the minimum income requirements of the household, and the ratio workers/consumers determining the extent to which individual household members have to produce a surplus above own subsistence requirements.

5.3.1 Production capacity of farm holdings

Defining a meaningful measure of the production capacity of farm holdings is difficult for three reasons. First, given the earlier discussed heterogeneity in land quality due account should be given to possible differences in productivity between the various land units, i.e., the size of the farmholding is an imperfect measure for the production capacity of the farmholding. Second, under changing technological conditions, existing differences in productivity between land units may change in case new agricultural technologies are only suitable for a particular type of land. In the present case, the introduction of double rice cropping initially affected only the partially irrigated areas and at a later stage, with the introduction of dry seeding, only the relatively favourably positioned rainfed fields. Third, to be relevant within the context of determining the production capacity of land holdings, land productivity should be defined in economic terms rather than in terms of physical productivity. This, however, prevents a rigorous assessment of production capacity as economic conditons differ between households.

The distinction between physical and economic productivity is an important one. An exact measure of productivity is provided by the potential physical production per unit of land. Physical land productivity is determined by a number of physical land characteristics such as soil type, soil fertility, water retention and drainage capacity as well as the type of agricultural technology used. Technology includes both the type of crops grown and the type and level of applied crop inputs such as labour and cash inputs. In case agronomically the best crop production technology is used, the resulting output level is called potential physical production.

Potential crop production has often a limited meaning when economic considerations are taken into account. Depending upon input prices and other cost factors, the economically efficient gross output level will usually be much lower than the level of potential production. In fact, it is possible that land unit A has a higher physical production potential than land unit B, but is economically less productive than B if input prices and other costs are taken into account. Similarly, farmers facing different cost structures, budget and/or other constraints to production may evaluate the economic productivity of various land units differently. For example, economic land productivity will be influenced by the type of land tenure arrangement as well as differences in production cost due to varying distances of fields from the homestead. Another clear example is found in the productivity of upland and sideslope fields. Farmers who are not growing the very profitable, but input intensive *dagmay* on these fields, rate them as low productive, whereas *dagmay* growers consider them as productive or even more productive than lowland rice fields. Hence, a physical crop productivity index is usually not meaningful within the farmers' context, not even in a relative sense.

Under conditions of a perfect land market, land rents usually provide a good proxy value for differences in economic productivity between land types of different quality. However, the land market for this village is far from perfect (Section 5.1.1). It is a highly personalized market where social relations between tenants and landowners are often more important in determing rents than productivity factors. An alternative method to determine economic land productivity is to use actual crop production data. Figure 5.3.1 presents the ranges of net returns per hectare of crop production activities by land type group for three production seasons (For a description of the various land units see Section 5.1.1). They represent area weighed aggregates of all crops cultivated on individual fields. Net returns are calculated as gross returns minus all variable production costs, including an imputed value for family labour cost. Prices are deflated by the VPP-index. The end-points of these ranges are the mean values of the worst 25 per cent outcomes and the best 25 per cent outcomes, respectively. This latter return value can be considered to represent the potential economic productivity of land given local costs of production and management conditions. A 'modal' value for the range is computed as the mean of the mid 50 per cent outcomes. Within year differences in returns are primarily due to differences in the type of crops grown (e.g. dagmay in upland and sideslope fields), the cropping intensity (e.g. double rice cropping in lowland areas) and input levels (e.g. fertilizer). Between year differences in return ranges exemplify differences in growing season conditions (e.g failure of double rice crops on plateau waterway fields in 1979-80) and the effect of changing cropping patterns (e.g. increase in double rice cropping on irrigated fields).

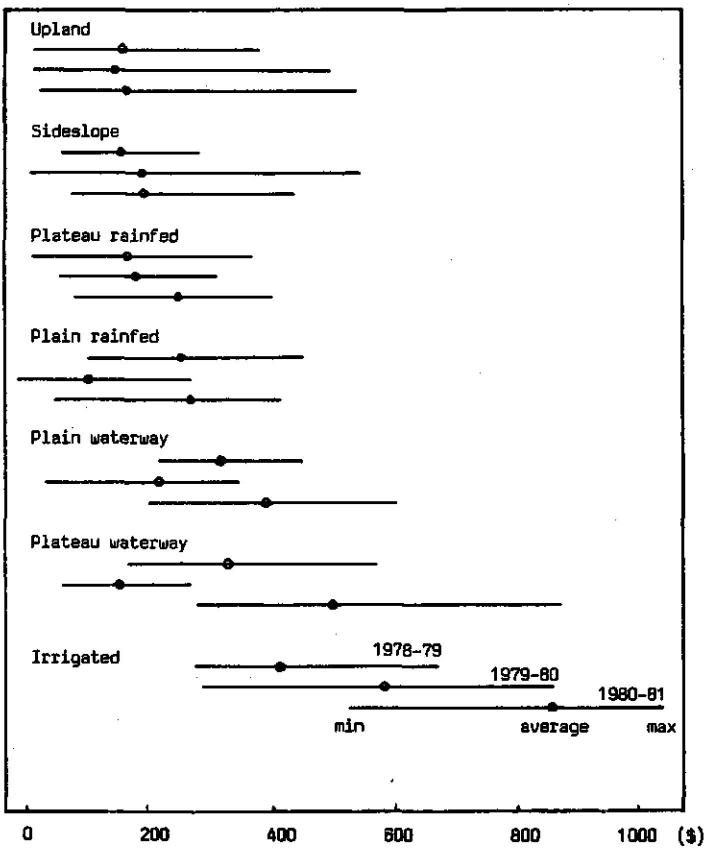


Fig. 5.3.1 Average net returns and ranges of net returns per hectare of crop production activities by land unit ($/ha)

Figure 5.3.1 shows that economic productivity differences between land units are substantial. Because they are influenced by technological changes over time as well as by differences in crop choice and crop inputs within years, it is difficult to define a generally applicable land productivity measure that can be used to determine the production capacity of landholdings. Although it would be possible to determine a 'potential economic productivity index', such index has little bearing on the production situation of most farmers. It obviously cannot be used as a standard to determine the likely crop production output of farms.

As the principal aim of the land productivity index is to determine the household's ability to cover basic subsistence needs through crop production activities at the start of the study period, we opted for a mean economic productivity measure for the bench year of 1978. According to rainfall data and farmers' information this year can be considered more or less 'normal' from a production point of view. The mean economic production capacity of fields is defined as the area weighed sum of the mean net returns to family labour of the various crops grown on such fields. Net returns to family labour are computed as gross crop output minus paid-out cost (e.g. hired labour and cash inputs). The mid 50 per cent of observations were used to calculate the net return values. Obviously, this will underestimate the production capacity of the better than average farm managers and/or richer farmers who may use higher levels of crop inputs compared to resource poor farmers. Thus, this will generally underestimate the ability of the households that already have excess subsistence capacity. Table 5.3.1 presents the various net return figures for the crop season of 1978 for the different land units.

Table 5.3.1 Income from crop production activities per hectare by land unit, middle 50% outcome observations ($/ha); 1978-79

Land unit	No. of observations	Gross crop income	Variable cost	Gross margin 1)	Family labour income	Gross margin to family factors 2)
a. upland	42	294	133	161	103	264
b. sideslope	24	335	173	162	112	274
c. plateau rainfed	21	376	200	176	106	282
d. plain rainfed	21	431	180	251	91	342
e. plain waterway	28	533	210	323	74	397
f. plateau waterway	22	600	261	337	102	439
g. irrigated	16	704	288	416	140	556

1) Gross margin equals gross crop income minus all variable cost, including imputed wages for family labour (see family labour income).

2) Gross margin to family factors equals gross margin plus family labour income.

The overall crop income earning capacity for farm holdings was computed by aggregating the returns to family factors of the various fields of which farm holdings are composed. Actual fixed land rents or imputed share rents were subtracted from the computed overall net return to family factors. In view of the substantial differences in income derived from crop activities in upland and sideslope fields due to differences in the area of dagmay, an adjustment was made in the total production capacity on the basis of the farmers' seed inventory of dagmay. Table 5.3.2 shows the results of the above computations. In the same table, a comparison is made between the household's crop income capacity and the actual income derived from crop production activities during the 3-year period of 1978-81. On the basis of the household's excess capacity to cover basic subsistence needs with self-employed crop production activities, a distinction is made between surplus and non-surplus households. Of the 25 case-study households, 11 classify as non-surplus.

5.3.2 The family life cycle

Although, the effect of the cyclical development of the family on household décision making was recognized by Chayanov (1925) as early as 1925, until recently, it received minor attention in the economic literature on farm management and household decision

Table 5.3.2 Net crop income earning capacity based on cultivated area crop season 1978-79

Household category	No. of house -holds	Farm size (ha)	Gross margin to family factors ($)	*dagmay* income adjust. ($) 1)	Total gross capacity ($)	Land rent cost ($)	Expected net crop income capacity ($)	Actual net crop income ($) 2)
Non-surplus: 3)								
young	5	0.95	267 (0.44) 4)		267	72	195 (0.42)	207 (0.51)
middle-aged	6	0.90	324 (0.43)	8	332	82	250 (0.39)	326 (0.48)
Surplus:								
young	5	1.65	532 (0.24)	71	603	139	464 (0.26)	548 (0.24)
middle-aged	5	2.32	886 (0.20)	69	955	202	753 (0.21)	753 (0.19)
old	4	2.18	786 (0.18)	26	812	153	659 (0.22)	556 (0.15)
Mean		1.60	564 (0.49)	34	589	128	461 (0.52)	478 (0.45)

1) The *dagmay* income earning adjustment is computed as 'planted area 1978-79 * $608'.
2) Average net annual crop income to family factors realized during the three-year period of 1978-81.
3) For the classification of households see Section 5.3.2.
4) Figures in parentheses are coefficents of variation.

making. The basic ideas underlying Chayanov's analysis of the farm-household as a 'labour firm' were discussed in Section 3.1. Here the discussion is confined to the influence of the family life cycle on a number of important household characteristics.

On the basis of the presence and age of children and their potential participation in the labour process, a distinction can be made between five phases in the developmental cycle of households (Res, 1983):

I. 'no children', early marriage stage;

II. 'child-bearing': young households with children who are all 10 years of age or younger;

III. 'child-rearing': middle-aged households having children younger than 5 years and children 10 years of age and older;

IV. 'child-leaving': old households that comprise children all above the age of 5 and one or more children who have left the household;

not actively in agr.

V. 'no-children': mature households with no dependent children.

The life cycle groups I and V are not represented in the sample. The first life cycle stage is usually of a very short duration or does not occur, whereas the last life cycle group is commonly not actively engaged in agriculture. Of the eleven non-surplus households, five are in the category of young households, whereas the remaining six households can all be classified as middle-aged. Of the fourteen surplus households, five are young households and an equal number is middle-aged. Four surplus households belong to the old household category.

The possible effect of the expansion and decline of the farm-household size on a number of important household characteristics is graphically depicted in Figure 5.3.2. First, the minimum income requirements for basic subsistence are determined by the household size which in turn is largely dependent on the age of the household. For young households the minimum income requirements will be relatively low but will increase sharply in the course of the first life cycle stage. During the second stage they remain more or less constant, and will subsequently decline during the third stage. Minimum income requirements are defined as those requirements necessary for daily living which are culturally accepted as a minimum standard of living. For this village, this implies a subsistence level which is well above the bare minimum required for sustaining human living. It includes such basic necessities as food, clothing, shelter, elementary education, and health. The annual staple food intake in terms of rice requirements per standard (adult) consumer unit is estimated at roughly 190 kg of cleaned rice. Although, this amount is well above the requirements established by the Philippine Food and Nutrition Research Institute which estimates requirements at about 160 kg, it should be realized that the latter estimate assumes certain quantities of complementary foodstuffs such as fats, oil, and sugar. In the village, these items are consumed to a much lesser extent than recommended in the official dietary allowance tables. As indicated by De Guzman et al (1974), such a situation

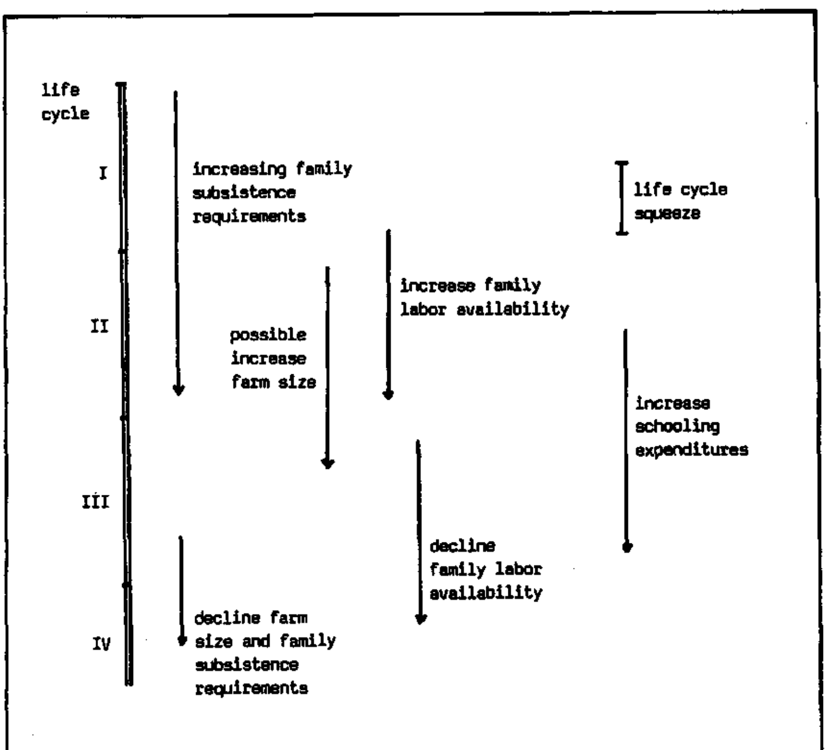


Fig. 5.3.2 Effect of life cycle stage on selected household characteristics

is typical in rural areas of the Philippines where in the absence of fat in daily meals, a diet containing a high intake of carbohydrate is common due to the consumption of a large quantity of rice. Apart from the main staple, daily meals always comprise some kind of vegetable and - depending on the income of the household - fish. Other household necessities include kerosine or electricity for lightning, fuel for meal preparation, edible oil, soap, clothing, etc. Expenditures for housing include maintenance cost and repair.

The total annual minimum income requirement per standard consumer unit in 1979 prices is estimated at roughly $80 half of which is needed for rice consumption. This amount excludes requirements for housing. For individual years, actual expenditures per consumer unit may fall below this level as certain expenditures can be postponed for short periods (e.g. house repairs, clothing). However, a consecutive number of years with expenditures below a level of $80 per consumer unit would endanger the functioning of the household. This minimum income level is about equal to the official poverty line used by the Philippine Government, but substantially below the poverty line used for rural areas by USAID (USAID, 1980) of roughly $150 which is based on a poverty line figure for 1975 (inflated with a conservative 8 per cent increase in the cost of living). Table 5.3.3 shows the minimum income requirements for the various household categories in terms of standard consumer units. In the same table, the crop income earning capacity of the household categories is given, also in terms of standard consumer units. The <u>subsistence coverage factor</u> is computed as the ratio 'minimum household income requirement/crop income earning capacity'. Based on the earlier definition, non-surplus households have a subsistence coverage factor below one and surplus households above one.

Table 5.3.3 *Number of standard consumer units (SCU) and subsistence coverage factor (SCF)*

Household category	Number of standard cons. units (SCU units) 1)	Expected net crop income capacity 2) ($)	(SCU units)	Subsistence coverage 3) factor (SCF)	SCF range	Actual mean annual SCF 4)
Non-surplus:						
young	3.84	195	2.44	0.70 (0.43) 5)	0.18 - 0.94	1.32 (0.27)
middle	5.64	250	3.13	0.59 (0.42)	0.20 - 0.94	1.26 (0.33)
Surplus:						
young	2.62	464	5.80	2.18 (0.10)	1.87 - 2.50	2.97 (0.19)
middle	6.56	753	9.41	1.47 (0.21)	1.11 - 1.83	2.10 (0.22)
old	4.14	659	8.24	1.94 (0.23)	1.41 - 2.40	2.76 (0.08)
Mean	4.55	461	5.76	1.41 (0.54)	0.18 - 2.50	2.08 (0.38)

1) A standard consumer unit (SCU) is based on the food requirements of an adult household member. The minimum requirements for a SCU are estimated at $80.
2) The crop income earning capacity is based on 1978-79 farm sizes and is derived in Table 5.3.2.
3) The subsistence coverage factor (SCF) is defined as the ratio 'minimum household income requirements/crop income earning capacity'.
4) The actual SCF is based on the average annual household income realized during the three-year period of 1979-82.
5) Figures in parentheses are coefficents of variation.

Figure 5.3.3 shows the distribution of sample households both according to the above defined 'subsistence coverage factor' and the family cycle.

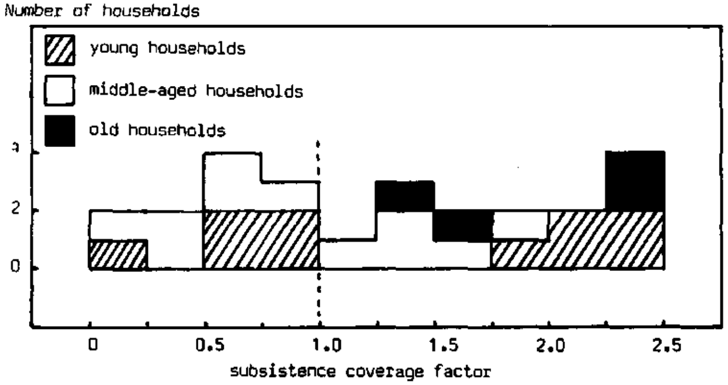


Fig. 5.3.3 Distribution of sample households according to the 'subsistence coverage factor' and family life cycle

Second, as earlier discussed the family labour force is determined by the household size and sex/age composition which in turn is dependent on the stage of the household in the developmental cycle. With an increasing labour force, the income earning capacity of the household will also increase either through a reduction in the use of hired labour or through an increased participation in the wage labour market. However, it is important to take into account the time lag between increasing consumption requirements and the extent to which family members can actively participate in income generating activities. In particular towards the end of the first life cycle stage minimum income needs may have increased to a high level without a substantial increase in the household's productive capacity in terms of the availability of family labour for farm or wage labour activities. Especially, for resource-poor households this is a difficult management period (life cycle squeeze).

Third, also the transfer of cultivation or ownership rights to land from parents to children is governed by the life cycle stage. Young households usually receive a part of land farmed by one of the parents, while the parents continue to farm the remaining area. As the parents move towards the end of the third life cycle stage, they will gradually transfer all their use rights to land to their children. This usually occurs when their children are in the second life cycle stage. Thus, in case parents own land or have ample use rights to land, the increase in the availability of family labour occurring in the households of their children coincides with an expansion of the farm holding size.

Fourth, with the importance attached to formal education of children, there is an increasing pressure on households to spend substantial amounts of cash on education as childen grow older. Starting at the beginning of the second life cycle stage, education expenditures increase due to high school enrolment, thus at the same time increasing total household expenditures and reducing the income earning capacity of the household as the family labour force declines. Education expenditures again sharply increase when children finish high school and move to university.

Fifth, at the end of the second and during the third life cycle stage parents may benefit from the acquired skills of children in the form of remittances. They may involve substantial amounts, especially when children have received university training and work abroad.

6 PATTERNS OF HOUSEHOLD RESOURCE UTILIZATION, INCOME FORMATION AND EXPENDITURE

In this and subsequent chapters resource utilization patterns of surplus and non-surplus households will be contrasted and, within these categories, behaviour of households at different life cycle stages. In the previous chapter it was shown that even within an apparently homogeneous class of farm-households, substantial differences occur between households both with respect to their capacity to produce enough food for own subsistence purposes through self-employed crop production activities and the availability of family labour per unit area. Depending on the life cycle stage of the family, households also differ with respect to the pressure of generating extra income above basic subsistence requirements for the education of their children.

The key question that will be addressed is whether households that differ with respect to subsistence risk sensitivity also differ with respect to the management of their resources and income flows derived from these resources. In particular, attention is focused on the issue whether households with a high worker-land ratio are able to employ their labour resources remuneratively so as to guarantee a minimum level of subsistence, and whether such is positively or negatively associated with recent agricultural changes in the village, specifically with regard to the introduction of new rice production technology.

The two key factors determining the remunerative use of family labour in self-employed agriculture and thus the viability of small farm-households and their proneness to subsistence risks are:

- the <u>family</u> labour absorption capacity per unit of land, i.e. to what extent can households continue to invest family labour per unit of land while still realizing additional output, and
- the extent to which family labour absorption depends on the quality and level of complementary inputs and level of agricultural technology.

In line with the classification of non-surplus households having insufficient crop production capacity to meet subsistence needs, it can be expected that when such households solely depend on self-employed crop production activities employing an 'average-type' production technology, they would face a severe subsistence risk even in normal years. Thus, in case market demand for labour is limited and self-employed income earning opportunities for labour outside agriculture are restricted, non-surplus households can be expected to exploit their family labour resources in agriculture to a fuller extent against lower returns compared to richer households. These households are likely to employ crop production strategies that differ from the 'average-type' in the sense that they are aimed at maximizing output to fixed family labour resources. Elements of such strategies may include:

- Substitution of as much family labour as possible for inputs that have to be bought from external sources. By minimizing the paid-out cost in production activities they will be able to raise the product accruing to the family labour force. Paid-out cost minimization may take various forms: family labour may be substituted for hired labour; crops that allow an intensive use of family labour may be substituted for crops that heavily depend on external inputs; manual activities employing family labour may replace the use of machines (e.g. foot threshing instead of machine threshing) or externally purchased crop inputs (e.g. hand weeding instead of herbicides);
- Increasing the cropping intensity per unit area. By increasing the number of crops on a given unit of land, households may be able to make a more efficient use of fixed family labour resources;
- Increasing the family labour input per crop in self-employed crop production activities so as to increase total output to fixed family labour resources by raising average product per worker.

The nature of household resource utilization and activity patterns can best be understood through observation of the labour utilization pattern of the household. In evaluating household labour utilization patterns, the specific character of the farm-household as both a unit of production and consumption should be accounted for (Section 3.1). In Section 6.1, differences between household categories in the allocation of labour to direct and indirect productive activities is analyzed together with differences in the intensity of labour use and labour productivity in agriculture. The sources and level of household income as well as the level and pattern of household expenditures will be discussed in Section 6.2. Section 6.3 focuses on the household's risk management strategies, i.e., the household's ability to deal with variations in income and expenditure flows.

6.1 Pattern of household labour utilization

The total household labour utilization (including time expenditure for both direct and indirect productive activities) for the two-year period 1979-81 is presented in Table 6.1.1 (1). On average, households utilize family labour at a rate of 78% of the earlier calculated family labour availability. The latter figure is based on an average working day for full-time participants of 9 hours for 6 days a week throughout the year. Husbands and wives contribute about equally to total family labour use at about 84% of their calculated time availability. This amounts to an average daily time expenditure of 7.4 hours during 6 days a week throughout the year! Children contribute around 50% of their available time which is equal to 27% of the total household labour

Table 6.1.1 Annual household labour utilization by type of labour for direct and indirect productive activities (hours '000); 1979-81

	Average	- Non-surplus - young	middle	- - - - Surplus - - - - young	middle	old
Total labour use	6.97	6.14	6.76	6.09	7.80	8.06
Total family labour use	6.55	5.94	6.65	5.60	7.23	7.33
husband	2.37	2.59	1.92	3.03	2.00	2.31
wife	2.28	2.67	1.60	2.56	2.04	2.53
children	1.90	0.68	3.13	0.01	3.19	2.49
Hired labour use	0.42	0.20	0.11	0.49	0.57	0.73
Percent family labour utilization 1)	78%	88%	64%	96%	63%	79%
husband	84%	92%	68%	108%	71%	82%
wife	83%	95%	68%	91%	72%	90%
children	50%	62%	61%	5%	55%	68%

1) Family labour use and labour use per type of labour as percentage of total labour availability.

use. The use of hired labour is minor when compared to total household labour use, but may constitute a substantial portion of the labour used for specific activities, notably rice crop production.

In absolute terms, total labour use is lowest for the young households, but at the same time their time expenditure per working member as shown by the percent of family labour utilization is highest. This indicates that both young household categories are relatively short of family labour. Especially, the high labour input of the husbands of the young surplus households is striking. Most households in this category are at a very early life cycle stage and have children that are still too young to participate in the labour process. Hence, activities commonly carried out by young children such as baby sitting, house cleaning, fetching water, etc., have to be carried out by the parents. As the wife is occupied with the care for young children, many of the household chores have to be carried out by the husband. This applies to a lesser extent to the young non-surplus households where children already take over some of the household chores. Both middle-aged household categories have the lowest family labour utilization rate. In particular, the labour input of husbands and wives is substantially below that of the young and old households. This is possible due to the high participation of children in the labour process.

6.1.1 Labour allocation

Allocation of labour to the various direct and indirect productive activities is presented in Table 6.1.2. All households spend a relatively large part of their time on indirect productive activities, 64% on average. Especially, young households show a high time expenditure for these activities. The young surplus and non-surplus households spend 72% (!) and 67%, respectively, of their time on indirect productive activities. Except for the old household category, absolute time expenditure for indirect

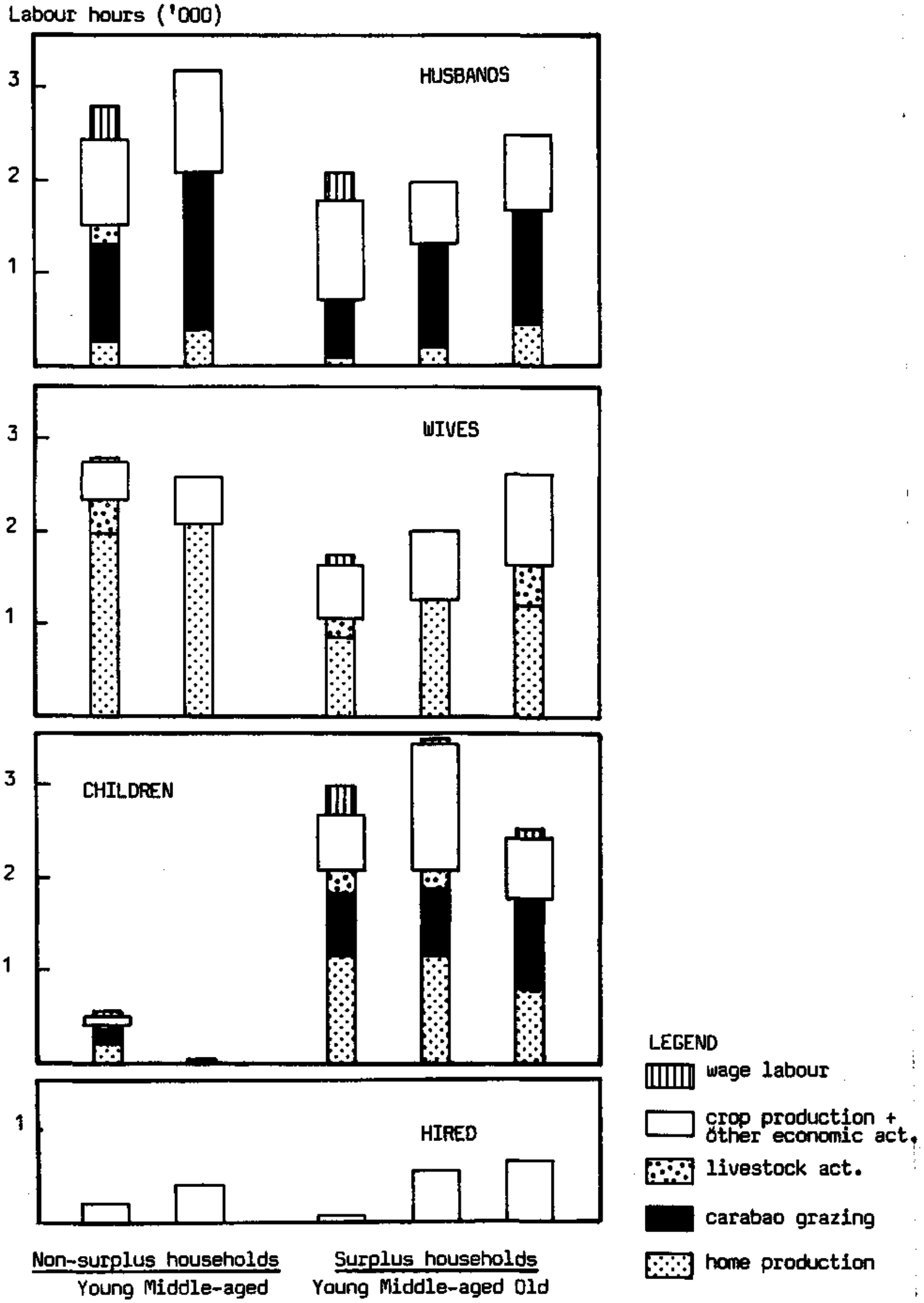


Fig. 6.1.1 Time allocation to direct and indirect productive activities by type of labour input per households; annual average per household category (1979-81)

Table 6.1.2 Family labour utilization per type of activity; 1979-81

	Mean		- Non-surplus - young	middle	- - - - Surplus - - - - young	middle	old
A. Direct productive activities (hours)	2379		1976	2825	1562	2910	2620
	(36)	1)	(33)	(42)	(28)	(40)	(36)
Labour use as percentage of A.:							
Total farm production	77		65	56	87	88	88
rice production	25		19	23	24	32	23
other crop production	24		22	16	38	26	21
pig raising	18		11	9	25	21	27
livestock production	10		13	8	-	9	17
Wage labour	10		21	23	-	2	2
Other economic activities	13		14	21	13	10	10
B. Indirect productive activities (hours)	4169		3957	3821	4047	4315	4710
Labour use as percentage of B.:							
Grazing working animal(s)	43		41	43	41	41	48
Home production	57		59	57	59	59	52
Total family labour use (hours)	6551		5933	6646	5609	7225	7330

1) Labour use as percentage of total family labour use

productive activities do not differ much between household categories. The relatively high figure for the old household category is due to a higher time expenditure on grazing working animals because some of the households in this category have more than one working animal.

Due to their lower family labour availability and equal time expenditure on indirect productive activities, young households, and especially the surplus households in this category, have a much lower family labour input in direct productive activities compared to the other household categories. Time allocation to the different direct productive activities varies substantially between household categories, with a pronounced contrast especially between the surplus and non-surplus household categories. Both the young and middle-aged households of the latter category show a relatively high time expenditure on wage labour activities, whereas surplus households are almost entirely concentrating on self-employed farm production and other economic activities. Surplus households are also far more active in pig raising, an activity which requires a relatively high initial cash investment.

Apart from the differences between surplus and non-surplus households, differences also occur between young and middle-aged households. Young households devote more family labour to non-rice crop production activities compared to the middle-aged households that spend relatively more time on rice crop production. The old households take a position in between.

The time allocated by different members of the household to the various household activities is depicted in Figure 6.1.1. The effect of children's contribution to the labour process is clearly visible. Due to the virtual absence of grown-up children, there is no choice for adult members of young households but to spend a relatively high percentage of their available time on day-to-day indirect productive activities. This is particularly visible in the differences in time expenditure of the wives. Apart from being heavily involved in indirect productive activities, especially the husbands of young households contribute as much or more to direct productive activities as the husbands of other households.

As can be expected, the husbands of the young surplus households concentrate entirely on self-employed activities, whereas the husbands of the non-surplus households are also involved in wage labour activities. Consequently, total labour input of both husbands and wives of the young households is high, especially when compared to the labour input of middle-aged households. The relatively minor contribution to direct productive activities of husbands of middle-aged surplus households is striking. In contrast with their counterparts in the non-surplus category, they spend much time on grazing the working animal.

From the above, it will be clear that young households are in a very tight labour supply situation. Compared to the middle-aged and old household categories, they are in a much weaker position to quickly mobilize labour in case farm conditions make such necessary, e.g. due to an unexpected heavy weed infestation, replanting of rice crops after a drought period, etc. As will be discussed in Chapter 7, this is one of the main reasons for these households to refrain from adopting double rice cropping.

6.1.2 Intensity of labour use and labour productivity in agriculture

Table 6.1.3 shows the returns per family labour hour for various direct productive activities as well as the percentage income derived from these activities. Livestock activities are not included because of the seasonality of production and the problem of assigning inputs and outputs to specific years. Self-employed rice crop production is clearly the most remunerative activity with returns per family labour hour that are, on average, 85% higher compared to the returns for the next best activity, wage labour activities. Returns per family labour hour for other self-emloyed non-farm activities are somewhat below the returns for wage labour activities. On average, roughly three-fourths of the income derived from direct productive activities is composed of income from crop production.

Table 6.1.3 indicates that there is a sharp contrast in returns per family labour hour between surplus and non-surplus households. For all activities taken together, surplus households attain a level of family labour productivity which, on average, is twice (!) as high as that of the non-surplus households. This implies that non-surplus households have to apply twice as much family labour to attain a net output level comparable to that of surplus households. A relatively low level of family labour productivity of non-surplus households applies to all direct productive activities. Apart from realizing relatively low returns per labour

Table 6.1.3 Productivity of family labour for different types of direct productive activities; annual average 1979-81

	Mean	- Non-surplus -		- - - - Surplus - - - -		
		young	middle	young	middle	old
Self-employed crop production						
percent of total income 1)	72%	54%	55%	83%	84%	72%
income to family factors ($)	466	209	326	493	771	533
family labour input (hrs)	1148	807	1120	974	1682	1156
returns per labour hour ($cts/hr)	39.5	25.9	29.1	50.7	45.8	46.2
Wage labour activities						
percent of total income	7%	19%	20%	-	2%	2%
income to family factors ($)	44	72	116	-	17	13
family labour input (hrs)	238	419	650	-	67	52
returns per labour hour ($cts/hr)	21.4	17.2	17.8	-	25.4	25.0
Other economic activities						
percent of total income	9%	9%	18%	9%	6%	6%
income to family factors ($)	59	33	106	55	54	48
family labour input (hrs)	320	266	587	200	293	253
returns per labour hour ($cts/hr)	19.1	12.4	18.1	27.5	18.4	19.0
Total activities						
percent of total income	88%	82%	93%	92%	92%	80%
income to family factors ($)	569	314	547	548	841	596
family labour input (hrs)	1716	1545	2348	1173	2054	1461
returns per labour hour ($cts/hr)	34.4	20.3	23.3	46.7	40.9	40.8

1) Total income derived from direct productive activities, excluding grants, receipts of interest and rents, etc.

hour, non-surplus households are also more engaged in low productive activities such as wage labour and self-employed non-farm activities. In contrast with non-surplus households, surplus household categories derive a high percentage of their income from the high productive crop activities.

Table 6.1.4 shows that households do not employ labour at the same rate per hectare. Total labour use is distinctly higher for both middle-aged household categories compared to the other households. In fact, when compared to the family labour availability per hectare for direct productive activities (i.e., total family labour availability minus labour use in indirect productive activities), the data tend to support the hypothesis that labour investment per hectare in part depends on the size of the family labour force relative to the size of the farm area. The middle-aged non-surplus hosehold category clearly has the highest labour input per hectare, whereas the young surplus households show the lowest labour input. The data also tend to confirm the hypothesis that households with a high rate of family labour availability per hectare employ hired labour at a lower rate compared to households with a low level of family labour availability per hectare. Family labour use as percentage of total labour use per hectare is highest for the middle-aged non-surplus category (91%) and lowest for the young surplus categories (63%). However, the figures are not entirely consistent due to the influence of financial constraints and possibly leisure preferences. For example, one would expect the young, non-surplus households to employ hired

Table 6.1.4 Structure of crop production; annual average 1979-81

	Mean	- Non-surplus -		- - - - Surplus - - - -		
		young	middle	young	middle	old
Total farm area (ha)	1.584	1.064	0.913	1.702	2.240	2.000
Gross return ($/ha)	534	376	560	582	627	519
Gross return per unit capacity ($/$) 1)	1.14	0.84	1.16	1.33	1.27	1.08
Net return to family factors ($/ha)	291	196	356	290	344	267
Net return to family factors per unit capacity ($/$)	1.06	0.72	1.24	1.18	1.21	0.96
Total labour use (hrs/ha)	1036	979	1348	910	1011	934
Net return per labour hour ($cts/hr))	34.6	24.7	28.7	40.8	41.4	37.3
Total family labour use (hrs/ha)	777	758	1227	572	751	578
Net return per family labour hour ($cts/hr)	39.5	25.9	29.1	50.7	45.8	46.2
Fertilizer and pest-/herbicide use ($/ha)	38	27	31	51	47	36

1) In the employed gross and net crop income capacities no adjustment is made for the degmay seed inventory (see Section 5.3, Table 5.3.2).

labour at a higher rate compared to the middle-aged surplus households. However, the former group of households is in a much weaker position to finance hired labour and is forced, by subsistence requirements, to utilize family labour at a high rate of family labour availability.

The comparatively low labour productivity of non-surplus households is partly due to a high labour use per hectare (middle-aged non-surplus households) and partly caused by a low gross return level per hectare (young non-surplus households). The young surplus households and middle-aged non-surplus households show an opposite input combination with respect to labour and cash inputs (fertilizer and pesticide) per hectare, but attain a very similar gross return per hectare. With a substantially higher labour input per hectare compared to the young surplus households, the middle-aged non-surplus households are able to raise total output per hectare comparable to that of the young surplus households despite substantially lower levels of fertilizer and pesticide use. The middle-aged surplus households have a relatively high labour input and complementary input level per hectare, and they also attain the highest gross output level per hectare of all household categories. From these input-output combinations, it can be tentatively concluded that, at the aggregate farm level, the possibility of input substitution exists between labour and other farm inputs, or more importantly between inputs requiring financing in cash or kind and inputs that can be supplied by the family itself.

Given the differences in the percentage of family labour use per hectare and returns to family factors per hectare, it can also be concluded that the possibility exists to raise the returns to fixed family labour resources through substitution of family for hired labour. By supplying 91% of the total labour use per hectare from family labour resources, middle-aged non-surplus households are able to attain the highest net return to family factors per hectare of all household categories, reaching 64% of the gross return per hectare compared to a level of slightly above 50% for the other household categories.

The above indicated differences in returns per hectare and labour productivity cannot be explained by differences in land quality. One way of taking into account land quality differences is to express the actual gross return levels in terms of the gross production capacity of farm holdings based on the earlier calculated mean production potential of the various land units (Section 5.3). In case land quality differences would fully account for differences in gross return levels per hectare, the ratio gross return/production capacity, expressed as 'gross return per unit capacity' ($/$) would be the same for all households. As indicated in Table 6.1.4 this is certainly not the case. Differences between household categories in the production capacity of the farm holding are not sufficient to explain gross yield differences. In fact, the gross return per unit capacity ratios indicate substantial differences in the level of resource exploitation between household categories. The young non-surplus households show a very low gross return per unit capacity level of 0.84, followed by the old household category with a ratio of 1.08. The young and middle-aged surplus households show a high level of resource exploitation with ratios of 1.27 and 1.33, respectively. The middle-aged non-surplus households take an intermediate position. A similar pattern occurs for the net returns per unit capacity, with the notable exception of the middle-aged non-surplus household category. Due to a very low level of paid-out costs, the middle-aged non-surplus households are able to attain the highest level of net returns to family factors per unit capacity.

<u>Returns to rice crop production</u>
Total labour use per hectare per crop for rice crop production is strikingly similar between household categories, with the notable exception of the non-surplus middle-aged households that have a relatively high labour input (Table 6.1.5). As indicated by the double rice cropping ratio and the percentage area of first rice crops under HYVs, this similarity in total labour input per hectare per crop covers some major differences in rice production technology among household categories. Middle-aged households are growing a substantial area under double rice crops using HYVs, whereas young households are cultivating relatively large areas of the more traditional BE-3 variety. When transplanted, BE-3 requires a substantially higher labour input per hectare compared to direct seeded HYV crops, 720 hours/ha compared to 510 hours/ha for HYV crops. Direct seeded BE-3 crops require a somewhat higher labour input than wet seeded HYV crops, whereas second rice crops have a labour input substantially below that of first HYV crops, because of lower land preparation requirements. When the actual labour use per hectare per crop is compared to an average rate of labour use based on average labour inputs per type of rice crop, middle-aged non-surplus households show a high ratio of actual labour use/average labour use of 1.27, whereas the young non-

Table 6.1.5 Structure of rice crop production; annual average 1979-81

	Mean	- Non-surplus -		- - - - Surplus - - - -		
		young	middle	young	middle	old
Area (ha): 1st rice crop	1.317	0.914	0.811	1.288	1.917	1.657
(percent HYV)	(67)	(50)	(73)	(48)	(78)	(84)
2nd crop	0.387	0.107	0.352	0.238	0.871	0.365
Total rice area	1.704	1.021	1.163	1.526	2.788	2.022
Double cropping ratio	1.28	1.12	1.43	1.18	1.45	1.22
Gross return ($)						
per hectare	458	304	449	488	574	477
per hectare per crop	357	272	313	412	395	391
Net return to family factors ($)						
per hectare	234	147	276	213	295	237
per hectare per crop	180	131	193	180	203	194
Total labour use (hrs)						
per hectare	731	599	929	677	766	686
per hectare per crop	569	535	650	571	528	562
(actual / average labour use) 1)	(1.06)	(0.94)	(1.27)	(1.01)	(1.03)	(1.05)
Net return per labour hour ($cts/hr)	41.1	31.8	33.1	45.1	49.6	45.8
Total family labour use (hrs)						
per hectare	472	407	810	293	480	368
per hectare per crop	362	363	566	247	331	302
Net return per family labour hour ($cts/hr)	53.7	36.1	34.1	72.6	61.5	64.4
Fertilizer and pest-/herbicide use						
per hectare	40	25	30	54	49	40
per hectare per crop	31	22	21	45	34	33

1) This ratio indicates the actual labour use per hectare per crop to a computed rate of labour use based on average labour inputs per type of rice crop.

surplus households have a labour input somewhat below the average level showing a ratio of 0.94. The high labour input for middle-aged non-surplus households is primarily due to problems encountered with dry seeded HYV crops in 1979. Poor growing conditions necessitated a heavy labour input for replanting and weeding. The apparent paradox that especially young households with limited family labour resources grow rice varieties and employ crop establishment methods requiring a relatively high labour input per hectare per crop will be discussed in Chapter 7.

Of the total labour input in rice crop production, on average 65% is supplied by the family. Except for the young non-surplus households, the percentage of family labour use of total labour use closely follows the earlier indicated family labour availability per hectare for direct productive activities. It is highest for the middle-aged non-surplus households (87%), followed by the middle-aged surplus households (63%) and old surplus households (54%), and lowest for the young surplus households (43%).

Because differences in labour input per hectare per crop are minor, the observed differences in labour productivity among household categories are primarily due to differences in gross returns per hectare per crop. Gross rice yields per hectare per crop of surplus households are about one-third above those of the non-surplus households, with the young non-surplus households attaining the lowest yield level of $272 per hectare per crop.

The higher gross yield level of the surplus households results in a rate of average returns per labour hour (including hired labour) that, on average, is roughly 1.5 times higher than the returns per labour hour for the non-surplus households. Differences in gross yields and labour productivities are primarily due to differences in the use of complementary inputs. Both non-surplus household categories apply fertilizer at a level substantially below that of the surplus households. Although the differences between fertilizer levels per hectare per crop may appear minor, the resulting gross yield differences are substantial. For example, in the fertilizer application range of $20 to $30, each dollar of fertilizer contributes on average about $6 to the gross yield (fertilizer response functions will be discussed in Chapter 8). Yield differences are also due to the inclusion of low yields of second rice crops, particularly affecting the yield level of the middle-aged and old households. Further, the yield levels of the young non-surplus households are relatively low due to their involvement in wage labour activities early in the season affecting timely management of self-employed rice production activities.

The realized net return to family factors (imputed cost of family labour and residual profit) is on average roughly half the level of the gross return. Due to a much lower use of hired labour, middle-aged non-surplus households realize a relatively high net return to gross return ratio of 0.62, whereas young surplus households, due to a higher rate of hired labour use, have a relatively low ratio of 0.44. Because of the low level of paid-out cost for hired labour, middle-aged non-surplus households are able to realize a net return to family (-owned) factors per hectare per crop above that of the young surplus households and comparable to the net returns of the other surplus household categories, in spite of a substantially lower gross return level. When we further consider the high double rice cropping ratio of the middle-aged non-surplus households, the realized net returns per hectare are - together with the middle-aged surplus households - the highest of the sample households. Due to a lower use of hired labour by the non-surplus households - on average wage rates are well below the average return per labour hour in rice production - differences in the productivity of family labour are even more pronounced than differences in the productivity of total labour. Surplus households attain on average a return per family labour hour which is almost twice as high as that of the non-surplus households.

From the above, it is concluded that the labour absorption capacity of rice crop production on an indiviual crop basis is limited. The possibility of raising output per hectare per rice crop through the application of more labour and at the same time lowering the average output per worker appears to be marginal. The bulk of labour used in rice cultivation is simply needed to carry out necessary tasks such as land preparation, crop establishment and harvesting. Although, an extra labour input may, to some extent, increase yield (e.g. through better land preparation and weeding), fertilizer soon becomes a limiting factor. In fact, it is common to observe that rice crops showing a relatively high labour input are poor crops affected by, for instance, heavy weed infestation, poor germination requiring replanting, etc., whereas crops showing low labour inputs are often good crops under optimal growing conditions. It is thus not unusual to find for individual crops a negative relationship between the level of labour use and output in production functions. However, double rice cropping allows for an increase in labour input on a per hectare basis. Of course, in such case, rice crops may compete with the cultivation of other crops and to be economically attractive, returns accruing to family factors should be above those for alternative crops. The relative attractiveness of double rice versus other cropping patterns will be discussed in detail in Chapter 7. A second way of increasing the family labour input in rice production is to opt for production strategies that allow for a minimum of hired labour use. As indicated earlier, differences among households in the percentage of family labour in total labour use are substantial and middle-aged non-surplus households are quite successful in reducing the use of hired labour.

Returns to non-rice crops

Total labour use per hectare in non-rice crop production is, on average, about 40% below the labour use per hectare in rice crop production. These non-rice crops are either grown on upland fields or on lowland fields before and after the cultivation of rice crops and comprise a large number of different crops. Some of these crops require a high labour input and complementary cash inputs (e.g. dagmay, early season squash), whereas other crops only require labour for seeding and harvesting (mungbeans and cowpea). Total labour use as well as family labour per hectare is highest for both non-surplus household categories with the middle-aged households of this category having the highest labour input (Table 6.1.6).

Table 6.1.6 Structure of non-rice crop production; annual average 1979-81

		- Non-surplus -		- - - - Surplus - - - -		
	Mean	young	middle	young	middle	old
Total farm area (ha)	1.584	1.064	0.913	1.702	2.240	2.000
Gross return ($/ha)	151	115	161	213	136	124
Net return to family factors ($/ha)	95	71	111	129	91	71
Total labour use (hrs/ha)	421	464	523	398	355	366
Net return per labour hour ($cts/hr))	25.1	16.8	21.6	35.4	26.4	24.0
Total family labour use (hrs/ha)	376	408	507	350	340	273
Net return per family labour hour ($cts/hr)	25.8	17.4	21.9	36.8	26.8	26.0
Fertilizer and pest-/herbicide use ($/ha)	5	6	4	10	5	3

In contrast with rice production, labour used in non-rice crop activities is almost entirely supplied by the family, except for the old household category. The middle-aged households show the highest percentage of family labour use of total labour use (96%), followed by the young households (88%). The old households use hired labour at a rate of 25% of the total labour input, primarily for the harvesting of crops. However, when compared to the family labour use in rice production, both young households apply more family labour to non-rice crop activities. Especially the young surplus households concentrate their time on these activities with a family labour input per hectare which is about 20% higher compared to rice production on a per hectare basis. Middle-aged and old households concentrate their time on rice production.

For all households, labour productivities of non-rice crops are much below the labour productivity of rice crops. Differences in labour productivity between surplus and non-surplus household categories for non-rice crops are much less pronounced compared to rice crops, except for a notably high labour productivity for the young surplus households, On average, returns per labour hour for non-rice crops are about 40% below those of rice crops, whereas returns per family labour are almost half of those of rice crops, indicating the substantial difference in income earning potential between rice and non-rice crops. The relatively high returns per labour hour for the young surplus households are due to the relatively large areas of dagmay grown by these households as well as the high returns obtained with early season squash crops due to exceptionally high market prices for this crop during the observation period. Given the relatively weak relationship between labour productivity and labour input per hectare as well as the high rate of family labour use in non-rice activities, it appears that these activities provide a good potential for family labour absorption.

Summarizing, the above findings regarding the intensity and productivity of family labour support the view that neither labour inputs into agriculture nor average returns per labour hour are equal. The intensity of labour use is partly dependent on the size of the family labour force relative to the size of the farm holding, whereas the productivity of labour strongly depends on the wealth status of households. Both findings indicate that there are market restrictions to (wage) labour and capital. Middle-aged non-surplus households face serious problems in finding remunerative employment for their labour. This follows from the relatively low intensity in the utilization of family labour, the high rate of family labour use per hectare in both rice and non-rice crop production, and the relatively high labour input in low productive activities. Young non-surplus households face similar problems of low family labour productivity but at a high rate of family labour utilization. Apparently, underlying these low family labour productivities are constraints to the use of complementary cash inputs and possibly to hiring wage labour. Further, due to short-term subsistence pressures, young non-surplus households are forced to engage in wage labour activities early in the season, thus reducing their ability to timely invest family labour in self-employed crop production activities and attend to crop management (opening and closing of bunds, monitoring weed and pest infestation, etc.).

6.2 Household income and expenditure pattern

The above indicated differences between household categories in resource characteristics, resource allocation, and expenditure pressures (e.g. increasing minimum income requirements and education expenditures for the second and third life cycle stage) are clearly reflected in the sources and level of the household's income as well as in the level and pattern of the household's expenditure. To provide for a consistent set of data giving a complete picture of both the household's income and expenditure pattern, tables presented in this section show annual averages covering the two year period of 1979-81. Due to the earlier indicated restrictions on data collection (Section 2.4), data sets concerning farm production and the household's income and expenditure pattern are not entirely matching. A comprehensive set of production data is available for three production seasons (1978-81), whereas monthly household income and expense data are available for the three year period of 1979-82. To show the between-year variability in household income and expenditure levels data covering all three years will be presented.

6.2.1 Household income

Table 6.2.1 presents the mean annual income of the different household categories by source for the two-year period of 1979-81. Annual crop production income is composed of income to family factors (labour and profit) derived from all crops planted in the period between April 1 until March 31. Income to family factors is defined to be net of all paid-out production costs, except for interest payments. For the computation of crop income to family factors see Appendix III. Annual household income excludes income derived from the sale of assets, except for a certain percentage of income derived from the sale of livestock assets. Changes in asset holdings will be discussed in detail in Section 6.3.

Table 6.2.1 Structure of household income formation ($); annual average 1979-81.

		- Non-surplus -		- - - - Surplus - - - -		
	Mean	young	middle	young	middle	old
Imputed income of family factors in agricultural production	545	282	365	545	844	681
Crop production	489	247	335	514	787	551
rice crops	320	135	225	274	567	393
other seasonal crops	148	74	101	219	204	140
perennial crops	21	38	9	21	16	18
Livestock	56	35	30	31	57	130
Earnings from wage labour activities	44	72	116		17	1
Imputed income of family factors from non-agricultural enterprises	59	33	106	55	54	48
Grant to the household	84	2	18		207	193
Receipt of rent	1		1			5
Receipt of interest	3	7		2	2	5
Transaction cost	-7	-3	-10	2	-18	-7
Other income	8	15	14	4		8
Total income: household	737	408	610	608	1106	948
consumer unit	160	100	102	203	158	237

Annual income for the period 1979-81 is $737 per household or $160 per consumer unit on average. This income level is twice the minimum income requirement (Section 5.3). Household categories differ substantially with respect to the level of income. Total household income is highest for the middle-aged and old surplus categories. Their income is about 60% higher than the income levels of both the young surplus and middle-aged non-surplus categories, and roughly 2.4 times higher than the income of the young non-surplus category. However, this picture changes when incomes are defined on a per consumer unit basis. Annual income per consumer unit is highest for the young and old surplus households, $203 and $237 respectively. The income per consumer unit of these two surplus categories is about twice as high as that of the non-surplus households - for the young and middle-aged households, $100 and $102, respectively - and about 1.5 times higher than that of the middle-aged surplus category of households ($158).

For all categories of households, agriculture is clearly the most important source of income. On average, 80% of the total household income is derived through activities that are directly related to agriculture. Self-employed rice crop production is by far the most important single source of income contributing as much as 44% to the total household income. Other seasonal crops contribute another 20% to the household income bringing the total contribution from self-employed seasonal crop production activities to a level of 64%. Other sources of self-employed agricultural income include perennial crop and livestock activities contributing 3% and 8% to total household income, respectively.

In line with the earlier discussed differences in labour allocation, household categories differ substantially with respect to the source of agricultural income. Surplus households almost entirely derive their agricultural income from self-employed farm activities. The relatively large contribution of non-rice seasonal crop income for the young surplus households indicates the different farm management pattern compared to that of other surplus households. Instead of double rice crop cultivation, these households tend to concentrate on early post-monsoon non-rice crops in lowland areas (Chapter 7). Also the substantial income derived from livestock activities for the old surplus households is striking. Women of these households have ample time and financial resources to engage in pig fattening and breeding. In sharp contrast with the surplus households, both non-surplus household categories depend for a considerable part of their agricultural income on wage labour activities, 20% for the young households and 24% for the middle-aged households. Also the contribution of income from non-agricultural enterprises is high compared to that of the surplus households. Without the income of these sources, non-surplus households would not be able to meet essential subsistence requirements (Section 6.2.2).

The main other income source, on average accounting for 11% of the total household income, is 'grant to households'. These 'grants' mainly consist of remittances of children employed in regular jobs outside the village, e.g., government jobs in the town or city or employment abroad. Obviously, because of the life cycle stage, for young households this income source is negligible. However, the difference between the middle-aged/old surplus and non-surplus households is striking. These grants constitute on average almost 20% of the income of the middle-aged and old surplus households, whereas they only contribute 3% to the income of the middle-aged non-surplus households. In absolute terms the difference is even more pronounced: surplus households receive about ten times more income from remittances of children than the middle-aged non-surplus households.

Clearly, this finding is not surprising. Given the limited availability of other income earning opportunities, surplus crop production capacity is essentially a prerequisite for investment in education and thus for the creation of this source of income. Existing differences in income earning potential arising from differences in agricultural resource endowments between households will thus be further accentuated by the inability of non-surplus households to sufficiently invest in education of their children. Moreover, similar to livestock proceeds, this income source plays an important role in stabilizing the income flow. In contrast with the seasonal pattern of crop production income, it usually provides for an independent, regular income flow. Particularly at the start of the crop production season when household's reserves are low and investment requirements of agriculture are high, income from this source may contribute to investments in current inputs in agriculture and increase the returns to crop production activities.

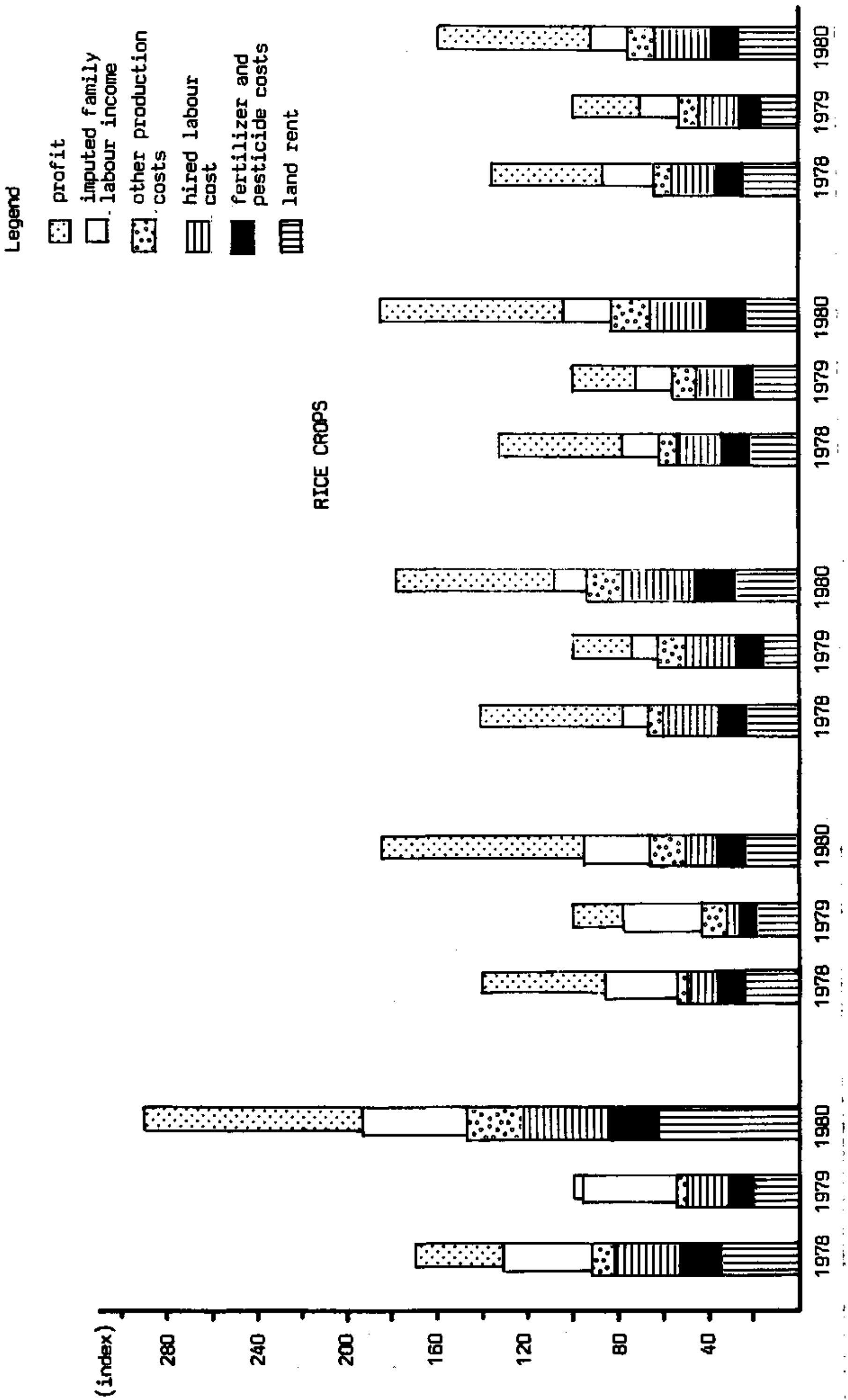
Minor income sources include receipt of rental payments for (sub-rented) land and receipt of interest on loans. It is interesting to note that despite their tight budget situation, non-surplus households still lend money or rice to other households as indicated by the interest receipts. This lending primarily occurs to households in a similar poor budget situation (shared poverty). However, interest payments of these households are far in excess of interest receipts (Section 6.2.2). Due to differences between the imputed value of home consumed crops (for storable crops based on the annual average market price and for perishable crops based on the market price at the time of harvest) and actual sale values of crops sold on the market, an adjustment had to be made in crop income indicated in Table 6.2.1 as 'transaction cost'.)

Given the importance of agricultural income sources, in particular seasonal crop production activities, household income variability is primarily determined by the level of crop production income. Figure 6.2.1 presents the annual input-output structure of crop production activities for the three-year period of 1978-81. The gross crop income figures represent returns from all crops planted in the period April 1 until March 31. Since we are primarily interested in the variability of income, the input-output data of the 1978-79 and 1980-81 season are indexed with the 1979-80 season as base year (i.e., 1979-80=100). Of these years, the crop season of 1979-80 experienced poor rice growing conditions. A prolonged dry spell late in the season affected both yields of the long-maturing BE-3 variety and growing conditions for the second rice crop. In contrast, the 1980-81 season experienced excellent climatic conditions for rice cultivation with favourable rainfall for both first and second crop. The season of 1978-79 was of an intermediate type. These annual differences in growing season conditions are clearly reflected in the level and type of crop income.

Variability in the gross returns to rice crop production is particularly pronounced for the young non-surplus households, whereas the pattern for the other households is strikingly similar. The higher rice income variability for the young non-surplus households can be expected, given the problems they encounter in mobilizing sufficient labour to remedy poor production circumstances. They neither have excess family labour resources nor the cash to hire labour. Since for most households the variability in cost of production is less than the variability in gross production, the income to family factors is more variable than the gross income, whereas profits (income to family factors minus the imputed cost of family labour) are more variable than income to family factors.

The level of non-rice income appears to be negatively correlated with the level of rice crop income. Except for the young non-surplus households, the pattern of variability in non-rice crop income is opposite the pattern of rice income. This indicates that there are distinct opportunities in the crop production system to reduce crop income risk. The general mechanism is that a combination of rainfed lowland rice and non-rice crops on upland areas diversifies and reduces rainfall risks. In case rainfall is good for lowland rice crop production, soil moisture and humidity conditions in the upland areas are usually unfavourable, whereas the opposite applies to situations of poor rainfall conditions for lowland rice crop cultivation. To some extent, maize planted before rice in lowland areas serves a similar purpose. In case early season rainfall conditions are poor for rice, maize crops will usually mature and yield a good harvest. Essentially the same applies to late season rainfall with non-rice crops planted in lowland areas after rice. Because of the negative covariance between rice and non-rice crop production, the variability in overall crop income is less pronounced than the variability of each crop component.

Figure 6.2.2 shows the annual differences in total household income per consumer unit for the three year period of 1979-82. Although between-year income differences may not appear to be very dramatic, for the non-surplus households, even minor shortfalls in


RICE CROPS
Legend
profit
imputed family labour income
other production costs
hired labour cost
fertilizer and pesticide costs
land rent
(index)
280
240
200
160
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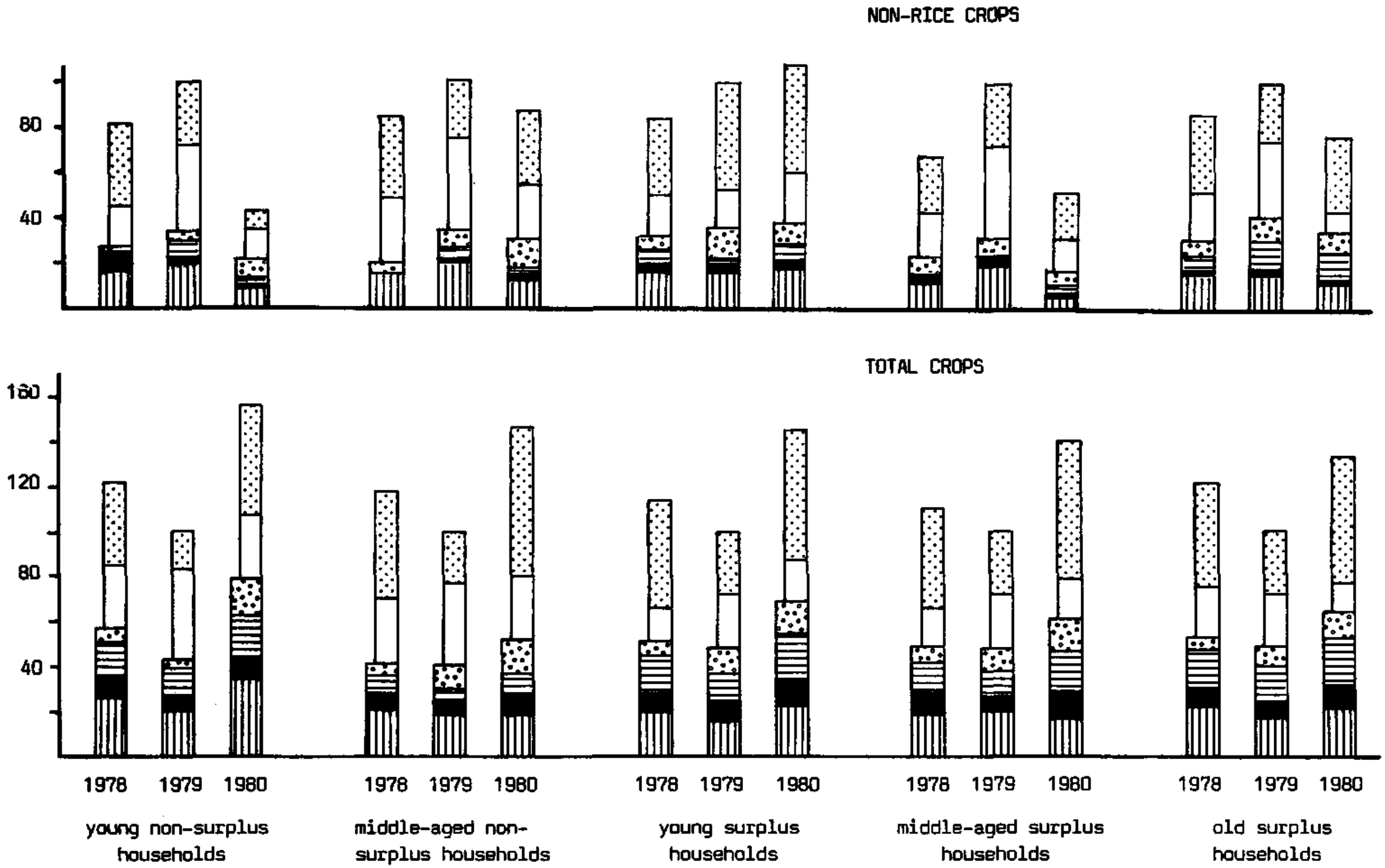


Fig. 6.2.1 Relative differences in the input and output structure of crop production activities with the 1979-80 season as basis for comparison (i.e., 1979-80 = 100)

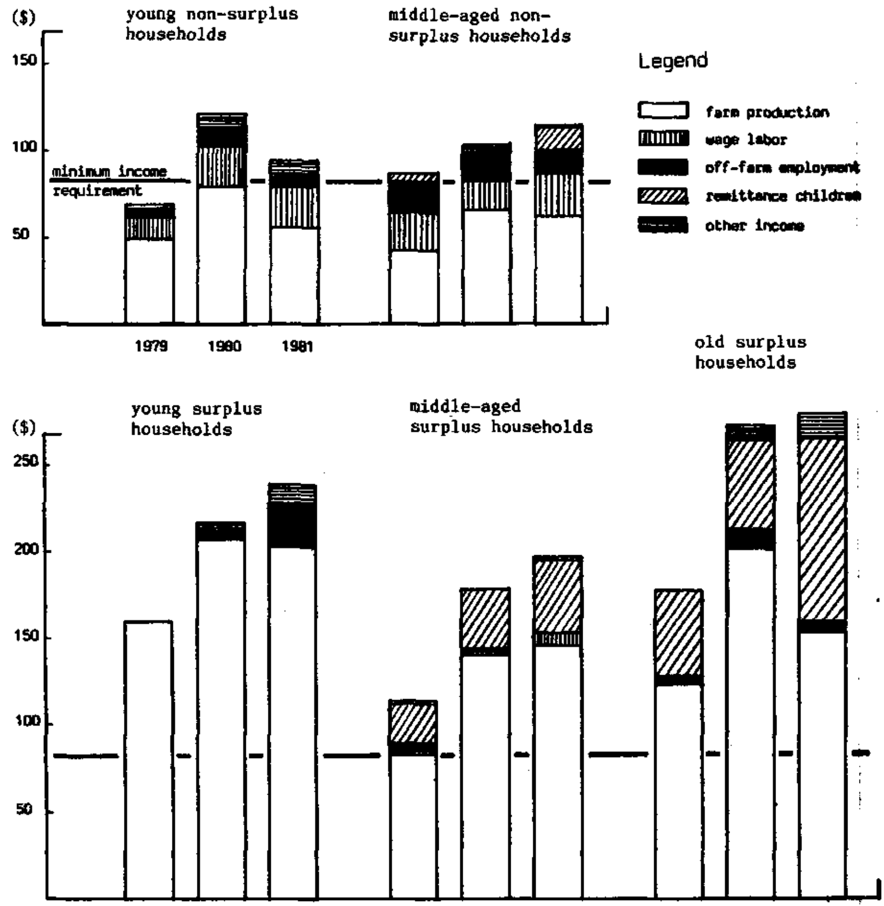


Figure 6.2.2 Composition of total household income per consumer unit by year; averages per household category ($)

income have major implications for the survival of the unit, especially in case they are forced to high expenditure levels due to such unforeseen events as diseases, funerals, the death of a working animal, etc. In Figure 6.2.2 also the minimum subsistence requirement per consumer unit is indicated. For the non-surplus households, in almost all years the income derived from self-employed farm production falls short of the minimum subsistence requirements. This underlines the necessity for these households to participate in off-farm activities. In contrast, for the surplus households the income derived from self-employed farm activities is more than sufficient to cover minimum subsistence requirements for all years.

6.2.2 Household expenditure pattern

The household expenditure data presented in Table 6.2.2 are annual averages covering the two year period from April 1 1979 until March 31, 1981. Because total household income as defined in Section 6.2.1 includes income from standing crops planted in the period between April 1 and March 31 and thus may include income from standing crops obtained in the next season, total annual household income and expenditures are not necessarily balanced. To allow for this discrepancy, it was necessary to include in Table 6.2.2 an expenditure component 'crop income transfer'. This figure is positive in case income derived from standing crops at the end of the season exceeds the income derived from standing crops at the start of the season. Further, because household income was earlier defined to be net of farm production cost and the cost of other income generating activities (except for interest payments), these figures are not included in Table 6.2.2. The cost of crop production is accounted for in the respective production accounts (Appendix III).

Table 6.2.2 Pattern of household expenditures ($); annual average 1979-81

		- Non-surplus -		- - - - Surplus - - - -		
	Average	young	middle	young	middle	old
Home consumption of agricultural						
products	227	148	225	163	304	297
rice	190	122	178	144	244	264
other crops	37	26	47	19	60	33
Purchase of consumption goods	362	203	316	228	577	484
food	218	158	204	173	344	210
clothing	30	14	28	25	47	37
household needs and equipment	8	5	10	12	13	2
health needs	24	18	4	18	49	31
education	82	8	74		124	204
Interest payments	40	41	26	26	80	25
Grant from the household	17	6	5	35	15	27
Funerals and weddings	18	26			35	28
Crop income transfer	7	-2	3	30	2	-1
Savings (residual)	65	-14	33	126	94	83
Total household expenditure	737	408	610	608	1106	946

On average, roughly 90% of the earlier defined annual household income is disposable for own consumption or investment purposes. 'Disposable income' is defined as the income received in the period between April 1 and March 31 minus expenditures that do not directly contribute to the satisfaction of consumer needs of household members. These latter type expenditures include interest payments, grants from the household, and expenditures for funerals and weddings. Differences among household categories in disposable income as percentages of total household income are minor. With 84% for both young household categories they are somewhat below those of the other household categories. For the young non-surplus households this is due to relatively high expenses for interest payments and funerals. For young surplus households it is caused by the high level crop income transfer.

For the non-surplus households interest payments form a relatively important expenditure component taking into account that these payments have to be made out of the surplus income. A large part of these interest payments can be attributed to loans acquired by households to meet subsistence needs (Section 6.3.2). Grants from the household include gifts in cash or kind to relatives or (neigbouring) households in need or are given on certain occasions such as funerals or weddings. They also include contributions to village fund raising activities for the construction or maintenance of public facilities (water supply system, street lighting). These grants are distinctly higher for the surplus households compared to the non-surplus households. Although, on average, expenditures for funerals and weddings appear minor, for individual households such expenses may put a severe burden on the household budget. The minimum expenses for a funeral or wedding are in the neighbourhood of $150.

The household consumption and saving pattern for the period of 1979-81 is summarized in Table 6.2.3. Disposable income per consumer unit is $142 on average, of which 89% is consumed and 11% is invested in liquid assets (cash and inventories) or fixed assets. Differences between household categories in disposable income per consumer unit are substantial. The disposable income for the non-surplus households is roughly half that of the surplus households. It is lowest for the young non-surplus households for which it is roughly equivalent to the earlier defined 'minimum subsistence level' of $80 per annum and highest for the old surplus households ($220).

The average level of total consumption of the non-surplus households ($88) is about 58% of that of the surplus households ($152). Total consumption is highest for the old surplus household category ($198) and lowest for young non-surplus households ($85).

Table 6.2.3 Household consumption and saving pattern ($/consumer unit); annual average 1979-81

		Non-surplus		Surplus		
	Mean	young	middle	young	middle	old
Disposable income (D) 1)	142.4	81.6	95.6	174.3	140.0	220.3
Total consumption (C)	126.5	85.4	90.5	132.4	126.6	197.7
home produced	49.5	35.9	37.5	55.1	43.7	75.1
outside purchases	77.0	49.5	53.0	77.3	82.9	122.6
Total consumption excluding education expenditures (C')	109.7	83.3	78.2	132.4	108.9	145.7
Food consumption (F)	96.2	74.5	71.2	113.8	93.1	128.2
Home produced	49.5	35.9	37.5	55.1	43.7	75.1
rice	41.9	29.6	29.6	48.6	35.0	66.7
other crops	7.6	6.3	7.9	6.5	8.7	8.4
Outside purchases	46.7	38.6	33.7	58.7	49.4	53.1
rice	9.5	14.9	13.9	5.0	10.0	3.5
non-rice	37.2	23.7	19.8	53.7	39.4	49.6
Propensity to save (1-C/D)	8.9	-4.7	5.3	24.0	9.6	10.3
Propensity to save (1-C'/D)	19.2	-2.1	18.2	24.0	22.2	33.9
Engel coefficient (F/D)	72.9	91.3	83.2	65.3	66.5	58.2
Number of consumer units	4.8	4.1	6.0	3.0	7.0	4.0

1) Disposable income is defined as total household income minus interest payments, grants from the household, and expenditures for funerals and weddings.

The young and middle-aged surplus household categories have total consumption levels of $132 and $127, respectively. Differences in levels of consumption per consumer unit are primarily due to differences in education and non-rice food expenses including such items as fish, cooking oil, soap and also personal necessities such as drinks and tobacco.

The level of rice consumption is very similar among household categories. Except for the old surplus households, households have rice consumption levels in line with or slightly above the earlier determined 'standard rice consumption' of $43 per consumer unit. The relatively high level of $70 for the old surplus households is due to the habit of these households to prepare rather liberal amounts of rice to be able to offer a meal to relatives or friends in case they pay a visit to the household. Left-over rice is used as food for dogs and pig fattening and breeding, an important economic activity of the wives of the old surplus households. Differences in non-rice food consumption are substantial mainly due to differences in purchased food items. Non-surplus households have purchases of non-rice food items at an average level of $22 which is less than half that of the surplus households ($48). Both middle-aged categories have a non-rice food consumption level which is low relative to the other age categories of the same wealth status. The average percentage of total food consumption to total disposable income - given by the Engel coefficient - is about 73%. As can be expected, the Engel coefficient is relatively high for the non-surplus households. It is highest for the young non-surplus households (91%), followed by the middle-aged non-surplus households (83%). For the surplus households it is substantially below this level, with the young and middle-aged households having an Engel coefficient of around 65%, and the old households having the lowest coefficient of 58%.

Also the differences in purchased non-food items are pronounced, particularly due to differences in education expenditures. Of the total consumption expenditures of middle-aged households, 14% is spent on children's education, whereas it reaches a high level of 26% for the old households. Further, non-surplus households spend considerably less on clothing and health compared to the surplus households.

Table 6.2.3 clearly shows the semi-subsistence character of the village economy and the dependency of households on markets. All households purchase a large part of their total consumption requirements from outside sources. On average, roughly 60% of the total consumption and roughly half of the total food consumption is purchased on local or urban markets. These purchases include household necessities such as soap, cooking oil, kerosine, electricity, fish, etc; personal consumer items such as tobacco and drinks; education expenses; and rice purchases. The ratio consumption of home produced goods to total consumption is very similar among household categories. The middle-aged surplus households have the lowest ratio (35%), followed by the old household category (38%). The other households have a ratio of 42%. Around 19% of the rice consumed is purchased, with the non-surplus households as the largest buyers. These households have to purchase around one-third of their rice requirements. Also the middle-aged surplus households had to purchase a large part (22%) of their rice requirements. The young and old surplus households are minor buyers with 9% and 5%, respectively. It should be noted that although all households are purchasing a part of their rice consumption, this does not imply that households are not selling rice. Within and between year shortages in either rice or cash often necessitates alternating selling and buying of rice. Except for the young non-surplus household category, all households have an excess of selling above buying rice, ranging from an annual $25 for the middle-aged non-surplus category to $188 for the middle-aged surplus household category.

The '<u>propensity to save</u>' differs substantially between household categories. It is highest for the young surplus households (24%) and negative for the non-surplus households (-5%). The middle-aged and old surplus households have savings at a level of around 10%. However, if education expenditures are also considered investments and included as savings, the propensity to save considerably increases for the middle-aged and old household categories. The average propensity to save for all households more than doubles from 9% to 19%. The savings of the middle-aged non-surplus household category increases to a level of around 18%, and for the middle-aged and old surplus households it reaches a level of 22% and 34%, respectively.

6.3 Household risk management strategies

This last section concerns the household's ability to deal with fluctuations in income and expenditure flows. Variations in the income flow may arise from the usual seasonal fluctation of agricultural production as well as from unpredictable fluctuations due to uncertain yields, production costs, and commodity prices. Unpredictable variations in the household's expenditure flow may arise from uncertain production cost and unforeseen household expenditures such as hospital and other medical expenses, cost of funerals, etc.

Households may deal with income variability and the associated subsistence risk in two different ways. <u>First</u>, they may attempt to reduce the variability of the income flow as much as possible through the selection of income earning activities with low but relatively certain returns in favour of activities that may produce higher returns but also have a higher risk of very low output levels. <u>Second</u>, households may select the latter type of activities, thus choosing a highly variable income pattern, but attempt to diffuse the possible negative consequences of such risk taking strategy through risk diffusion measures, either by own means (e.g. reserves) or through the involvement of other parties (e.g. credit). In case households have adequate means of risk diffusion, risk averse attitudes are not necessarily translated into risk averse behaviour in the choice of income earning activities.

Of course, in between these two extremes are numerous combinations of both types of measures. In fact, risk reduction strategies are often an inherent feature of existing, well-proven production systems. A well-known example is the spreading and diversification of activities across space and time as well as between agricultural and non-agricultural enterprises. Risk reduction in rice crop production will be discussed at length in Chapter 7. This section focuses on risk diffusion measures at the household level. The main issue that will be addressed is by what measures households overcome periods when the household income falls short of expenditures and whether these measures are effective in preventing or reducing the occurrence of serious subsistence crises.

This section will start with a discussion of risk diffusion measures that are under the control of the household. Subsequently, measures requiring the cooperation of other parties will be dealt with. An assessment of the household's sensitivity to income risks concludes this section.

6.3.1 Household means of risk diffusion

There are two principal ways by which households may internally overcome a shortfall in income. Keeping reserves is a common means by which households cope with seasonal and between year fluctuations in incomes. The household's primary aim of keeping reserves is to ensure that subsistence demands can be met on a day-to-day basis and that cash or kind can be generated timely and efficiently in order to meet cash or kind demands for agricultural inputs and consumer items. In case reserves in cash or kind are not sufficient to overcome income shortages, households may attempt to cut back or postpone current household expenditures.

Reduction in current expenditures

An obvious household measure is to cut back current expenditures in consumption and reduce inputs in production activities. Expenditures on luxurious items such as cigarettes, soft drinks and other beverages, but also the consumption of fish, meat and other purchased consumer items are commonly reduced to almost zero levels in situations of severe cash shortages. Households may also change the diet from rice meals to rice mixed with (cheaper) corn or may skip one of the daily rice meals and substitute it with plantain or cassava. In severe cases, even the number of daily meals is sometimes reduced. Similarly, education expenses can be reduced by withdrawing children from school. However, as it may imply a loss of earlier investments, such a decision is not taken lightly, particularly not when a child has been at school for a number of years. Further, households may limit the expenses for celebrations such as the annual village *fiesta*.

For households living near the subsistence level of living, the scope for reduction in expenditure levels through the above risk diffusion measures is clearly limited. As indicated earlier, the non-surplus households are in such a tight budget situation that a reduction in consumption expenditure is virtually impossible without endangering the normal functioning of the household. This applies particularly to the young non-surplus households, that - given the limited number of consumer units - have less buffer capacity, whereas with very young children the incidence of diseases is more likely. In fact, in 1980 such a situation occurred when two households experienced the death of a child, causing high expenses for the funeral and the forced sale of fixed assets.

Households may also postpone expenditures that are due to be made. For example, necessary house repairs or other maintenance activities (e.g. new roofing) may not be carried out, children may not be sent to high school, or formal weddings may be postponed. It also occurs that households defer a part of the land rent payment until the next season's harvest. This is usually accepted by the landowner (without interest charges) in case such is due to circumstances beyond the control of the household. Of course, this is particularly important for households with fixed rent arrangements. Non-repayment of due loan amounts is another important way of postponing expenditures. In such a case, it is usual only to pay the interest on the loan. Finally, as a last resort in a very severe subsistence crisis, it is not uncommon to ask other households to take care of one or more of the children, thus substantially reducing the household's consumption requirements.

<u>Reserve management</u>
The manner in which households tend to deal with between year variations in income and expenditure levels through reserve management and the importance they attach to keeping reserves that are in excess of normal daily subsistence requirements is best seen in the household's (dis-)saving and (dis-)investment pattern.

Table 6.3.1 presents the household's total <u>net investments</u> in assets during the three year period of 1979-82. Apart from the earlier defined asset categories (i.e., fixed, financial, and inventory assets; see Section 5.1.3), also education expenses are included here and treated as investments in human capital. Prices increases, depreciation of assets, and addition to livestock assets due to natural growth and birth is not accounted for. These adjustments will be made in the total asset balances that are presented in Section 6.3.3. During the three-year period of 1979-82, households realized on average a net investment of \$571 per household or \$128 per consumer unit. Positive net investments total \$643 and are made in education (43%), rice stocks (22%), house construction (16%), repayment of borrowed funds (5%), and lending cash and rice to other households (7%). Investments in farm equipment and consumer durables are low, at a level of 3%

Table 6.3.1 Pattern of total net investments for the three-year period 1979-82 ($)

	Average	- Non-surplus - young	middle	- - - - Surplus - - - young	middle	old
Rice inventory	140	27	41	384	234	14
Fixed capital	77	-54	32	178	154	73
Farm assets	-52	-101	-17	-75	16	-84
farm equipment	20	7	5	13	47	28
livestock	-61	-116	-22	-88	-31	-50
land	-11	8				-62
Household assets	129	47	49	253	138	157
house construction	105	37	26	207	104	152
consumer durables	24	10	23	46	34	5
Financial assets	81	37	-25	36	127	232
cash on hand	4	4	5	-2	-1	16
borrowed funds	32	33	-39	5	111	51
lending	45		9	33	17	165
Education	273	19	279		476	591
Deflation of cash assets	0	1	5	-14	17	-10
Total investments	571	29	327	598	991	910
(per consumer unit)	(128)	(7)	(57)	(193)	(144)	(240)
positive	653	145	388	688	1023	1022
negative	-82	-116	-61	-90	-32	-112

and 4%, respectively. Negative investments in assets occur for livestock and land due to the net sales of livestock and the return of pledged land to owners.

Both investment levels and the type of investment differ substantially between household categories. Young surplus and old household categories have the highest investment level per consumer unit, followed by the middle-aged surplus households. Non-surplus households show net investments substantially below the level of the surplus households, with the young non-surplus households showing almost no addition to asset holdings.

All household categories in the sample show an increase in rice in stock. Net investments in rice stocks are large for the young and middle-aged surplus households. Although the net investment in rice stocks is low for the old household category, the total stock at the end of the investment period (March 1982) is as high as that of the middle-aged and young surplus households because, compared to these households, initial stocks in 1979 were much higher. When compared to the total positive investment, the young surplus household category invests more than half of the amount in rice inventories, followed by the middle-aged and young non-surplus household categories that make around one-fifth of their positive investment in rice stocks. Middle-aged non-surplus households show a comparatively low level of rice stock investment of about 10%. Monthly fluctuations in rice stocks will be shown and discussed in Section 6.3.3.

Except for the middle-aged non-surplus households, all households show a substantial increase in net financial assets, partly due to a higher rate of repayment of loans compared to acquisition of loans and partly due to net additions to lending activities. Changes in cash on hand are minor which can be expected given the generally low level of cash savings, also on a month-to-month basis. Cash savings are of limited importance in reserve management. Although households usually have small amounts of cash on hand, the amounts are generally too small to be sufficient to overcome even minor shortfalls in income (Section 6.3.3).

In fact, for various reasons most households attempt to minimize their cash on hand as much as possible. First, as one farmer eloquently put it 'cash is easily spent. With rice it always takes some time to find a buyer and to haul it to the road'. Second, and probably more important, cash invites other persons to borrow. Cash is generally in such a short supply in the village that it is quickly known when a household receives money from the sales of products or otherwise, e.g. when a well-to-do member of the household pays a visit to the village. Selling of rice without immediately buying something in return is 'just inviting other people to borrow cash'. Third, it is easier to steal cash than to steal palay. Hence, cash on hand is primarily meant to pay for day-to-day consumer needs and relatively inexpensive farm inputs such as pesticides. In the case of large cash expenditures, e.g. purchases of fertilizer, consumer durables, clothing, etc., the generation of cash is carefully planned in advance either through the liquidation of rice in stock or otherwise.

Especially, middle-aged surplus households show a large net repayment of debts. Addition to positive financial assets of the young surplus and old household categories is primarily due to a net investment in lending cash or kind to other households. In particular the old households are active in this field, investing about 16% of their positive investment in lending activities.

All household categories show net sales of livestock. In fact, no investments in livestock were made during the observation period (excluding chicken and pigs). Livestock sales are particularly large for both young household categories. The young non-surplus households had to sell livestock during the lean month period of 1980 to pay for funerals, whereas the young surplus households sold cattle to finance house construction. A negative investment in land occurred for one of the old surplus households because it had to return pledged land in 1979. The opposite occurred for one of the young non-surplus households.

Investments in house construction (e.g. repairs, new extensions, roofing, improvements such as the replacement of bamboo walls with brick walls, etc.) are particularly large for young surplus and old household categories. Relative to total positive investments, young surplus households show the highest investment in housing (30% of the total positive investment), closely followed by the young non-surplus households (26%). Both middle-aged household categories show the lowest relative investment in housing: for surplus and non-surplus households of this category 10% and 7%, respectively. Both in an absolute and relative sense, investments in consumer durables are minor for all households, with both young household categories having the highest investment level of 7% of the total positive investment.

Finally, large investments in human capital are made by middle-aged and old household categories. The highest rate of investment in education of children is made by the middle-aged non-surplus household category. These households almost invest three-fourths (!) of their total outlay in human capital formation. Also the old and middle-aged surplus households show very high rates of 58% and 47%, respectively. As can be expected, both young household categories have minor or no investment in education.

Figure 6.3.1 graphically shows the investment and dis-investment pattern on a year-to-year basis. For the poor production season of 1979-80, all household categories show a depletion of rice stocks and, except for the young surplus households, an increase in outstanding debts. Negative investments also occur in livestock assets, notably for the young surplus households that use the proceeds of livestock sales for house construction. Against their negative investment, the young non-surplus show hardly any positive investment resulting in a dis-saving in 1979-80 of $90. Despite poor production circumstances, all other household categories still show a net investment, for both middle-aged household categories primarily due to investments in education, whereas the young surplus households as the only household category apparently could afford investments in house construction and maintenance. Apart from investing heavily in education, old surplus households appear to act as an important buffer for other households in terms of providing substantial amounts of consumption loans. In the poor production season of 1979-80, these households lent rice to other households at the cost of depleting their own rice stocks and borrowing rice or cash.

For the next two seasons, all households show a net positive investment in assets. In contrast with the young and middle-aged surplus households, non-surplus and old households show lower positive investments in 1981-82 compared to 1980-81. All households replenish their rice inventories in the season of 1980-81, whereas a decline in debt position occurs for all household categories, except for the young surplus households. The young non-surplus households sell livestock to improve their liquid asset position.

The young and middle-aged surplus household categories continue to invest in rice stocks in 1981-82. The young non-surplus households show a depletion in rice stocks to repay debts, whereas the old

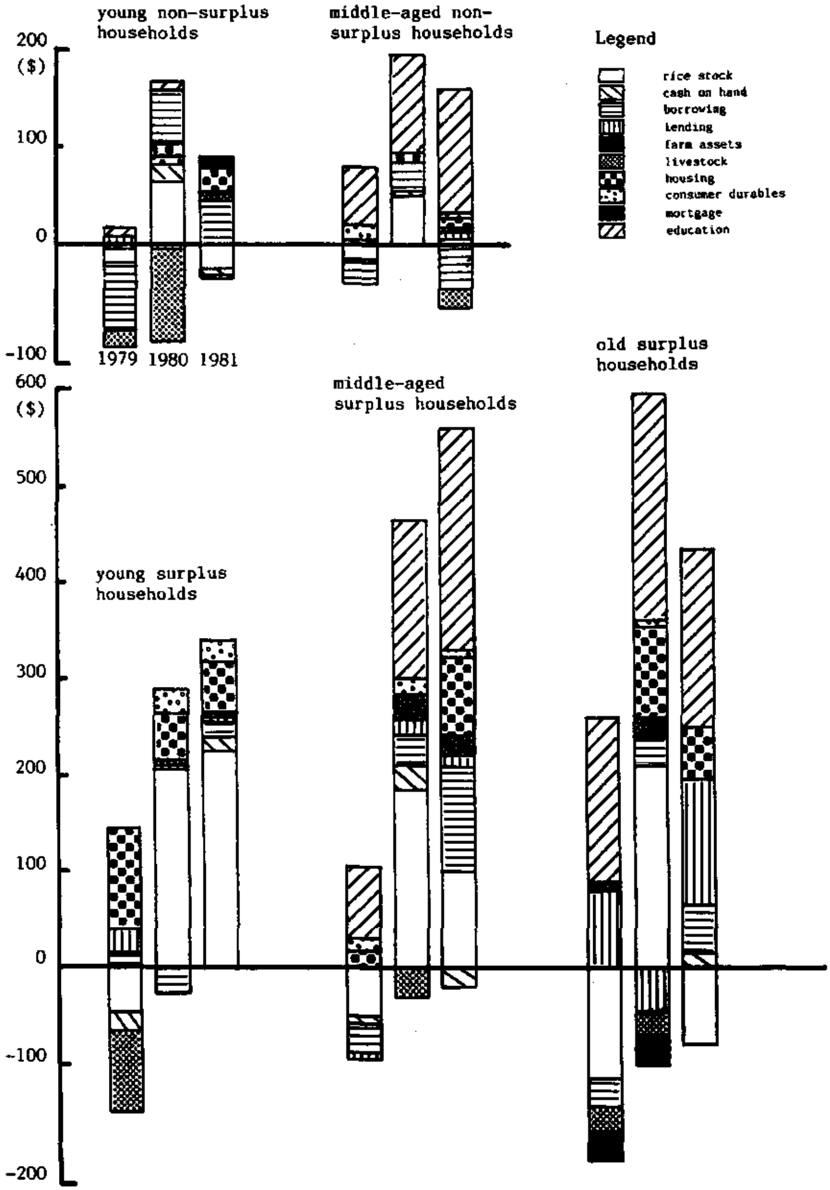


Fig. 6.3.1 Household investment and dis-investment pattern by year; averages per household category ($)

households show again a net investment in lending at the expense of a decline in rice stocks. The middle-aged non-surplus households show a minor addition to rice stocks, but as the only household category, they borrow a substantial amount in 1981-82 as well as sell livestock apparently to finance the education of children.

6.3.2 External means of risk reduction and diffusion

Apart from internal risk reduction and diffusion measures, households also depend on outside means of risk management that require the involvement of other parties. Risk sharing is a typical example of risk reduction where other parties take part in the risks incurred by activities of the household. Risk sharing implies that no claims can be made in case households - due to circumstances beyond their control - are not able to return the resources or funds given to them. Other important external means of risk diffusion are credit and mutual-aid arrangements. Especially credit reserves may function as a source of liquidity that provides a means of generating cash that avoids the costs associated with liquidating productive assets to meet cash or kind demands and then reacquiring assets later when adverse conditions have passed.

Risk sharing arrangements

A typical example of risk sharing is found in share tenancy contracts. Under this broad heading various types of risk sharing between the tenant and landowner occur, ranging from the landowner's participation in all costs of production (except for the labour input) to only the provision of land. As mentioned in Section 5.1.1, despite the risk reducing effect of share tenancy contracts, a large number of farmers favour fixed rent contracts. It is, however, striking that especially young households have tenanted land under share contracts. For 1981, young households had about half of their land under share tenancy contracts compared to roughly one-fifth for the middle-aged and old households. From discussions with young farmers it appeared that they were generally less inclined to demand fixed rent contracts compared to older farmers. In fact, in one case a son receiving a piece of tenanted land from his father, who paid a fixed rent, asked him to change the tenure contract between them to a share tenancy. The main reason for this preference for share contracts among young farmers is probably the higher management risk they face in agriculture due to labour limitations. Another reason may be that these young households view share tenancy as a means to tie up with a stronger economic party and to find a place in the social network (e.g. through the creation of a patron-client relationship).

A second form of risk sharing in production activities occurs in the earlier mentioned sagod system. Under such arrangement, one party provides a piglet or cow, whereas the other party takes care of the feeding of the animal. Sometimes extra feed costs are shared. The proceeds after sale are equally divided. This type of arrangement is typical between relatively rich and poor households, the former providing for the animal and the latter supplying labour to feed the animal.

Of course, a certain element of risk sharing is also involved in lending cash or kind to households in times of crop failures or, more generally, to households with a low repayment capacity. Loan repayment may get seriously delayed and it is not uncommon that after a certain period lenders have to agree on a debt settlement in order to salvage part of the outstanding debt amount. Risk sharing through institutional insurance programmes is virtually non-existing. In 1981, crop insurance was introduced in the area on a very limited scale as a component of the revived M-99 programme. The few farmers obtaining such loan had to take crop insurance as part of the lending conditions.

<u>The role of credit in risk management</u>
The main source of credit in the village is from private money or palay lenders. Around 70% of the total amount borrowed during the period of April 1979 until April 1982 by the sample households is from non-institutional lending sources. Roughly 30% of this amount is borrowed through purchases on credit, whereas the remaining 70% consist of cash and palay loans. The group of private lenders is composed of close kinsmen, wealthy farmers in the village, professional moneylenders in the towns, landlords, and, recently, fertilizer dealers. Institutional lenders are the rural bank in the nearby town; a provincial cooperative bank in the city; and the revived Masagana-99 programme.

The various types of loan arrangements are presented in Table 6.3.2, together with information on the lending periods and interest rates. Both <u>alili</u> and <u>produktuan</u> are generally used for production purposes. The loan amount is provided in cash and repayment is either fully or partly in kind. In this category, <u>alili</u> is the most important. In contrast to <u>produktuan</u>, it is a commercially oriented type of loan which does not require specific relations with the lender. The term <u>alili</u> literally means 'repayment in kind'. Both the principal sum and the interest is repaid in rice, usually during the main harvesting period in December. The loan amount of one <u>alili</u> loan is $8.1 for which a repayment of two bags of rice ($12.5) is required. These loans are usually obtained during the period of May-June to pay for inputs such as fertilizer and pesticides. They are provided by the wealthier farmers in the village who are active in rice trading and also by landlords and town moneylenders. Of the private loan arrangements it is the most impersonalistic type, generally the easiest form of credit to obtain and thus it is relatively expensive. In order to secure repayment, the lender is usually present during the measurement of the rice harvest and able to force loan repayment. As shown in Table 6.3.3, middle-aged surplus households are the largest users of this type of credit. Because of their substantial buffer capacity, these households represent a

Table 6.3.2 Loan arrangements

Type of loan	Typical loan amount	Amount to be repaid	Typical loan period	Interest per month
Alili	$8.1	2 bags palay	May/Jun - Dec/Jan	4.2 - 7.7%
Produktuan	$13.5	$13.5 + 2/3 bags 4/3 bags palay	Feb/Mar - Feb/Mar	2.3 - 5.0%
Sagahay	2 bags palay	3 bags palay	Feb/Mar - Dec/Jan	3.3 - 5.0%
Saka-an	small amounts	original amount + interest	short periods	5.0 - 10.0%
Sibu	- idem -	original amount	- idem -	-
Arat lauwan	- idem -	payment in labour	May/Apr - Dec/Jan	?
Coop Rural Bank	$116		any period	1.6 - 1.8 %
M-99 programme	$146		JUN/JUl - May/Jun	2.1%

low credit risk to lenders and generally encounter few problems in obtaining these loans. Although non-surplus households are similarly pressed to make use of this type of loan, the percentage of alili loans to total loan acquisition is far below that of the middle-aged surplus households, 6% and 16%, respectively. Both the young surplus and the old household categories make limited use of this expensive type of loans.

Produktuan is a more attractive but less common loan arrangement which is usually provided by village people to borrowers who are, to some extent, related. The term literally means 'interest in kind'. The principal sum is repaid in cash and the interest is paid in rice. One produktuan loan amounts to $13.5 for which the interest charge varies from 2/3 ($4.2) to 4/3 ($8.3) bag of rice, depending on the closeness of the relation between borrower and lender. These loans are usually obtained in the period of February-March to pay for cash expenses such as dry season land preparation and cash inputs for the dry-season crops. The maturity period of one year is longer compared to the alili loans. The young households are the largest users of this type of loan which they mainly obtain from their parents.

A typical consumption loan is sagahay which means 'extra of the same kind'. Both the borrowed amount and repayment of the principal sum and interest is in rice. For two bags of rice an interest of one bag of rice is charged. Sagahay lending usually occurs during the off-season in February-March and, generally between close relatives. Sometimes it is provided by landlords. Sagahay arrangement also occurs with seeds (e.g. mungbeans). Both in absolute and relative terms, the non-surplus households are the largest users of these sagahay loans.

Between very close relatives, interest-free consumption loans also occur. These so-called sibu arrangements involve small amounts of rice and cash and are (apart from very limited amounts given as

Table 6.3.3 Pattern of debts by type of loan arrangement ($); 1979-82

	Average	- Non-surplus -		- - - - Surplus - - - -		
		young	middle	young	middle	old
Loan acquisition:						
Institutional	88 (30) 1)	12 (5)	49 (18)	36 (23)	287 (48)	55 (28)
Coop Bank	73 (25)	12 (5)	49 (18)	36 (23)	212 (36)	55 (28)
M-99 programme	15 (5)				75 (12)	
Private	145 (34)	169 (68)	187 (69)	89 (58)	216 (36)	66 (33)
'Soft' loans	101 (9)	138 (55)	156 (57)	71 (46)	98 (16)	42 (21)
sibu	37 (13)	44 (17)	40 (14)	48 (31)	32 (5)	20 (10)
sibu (landrent)	12 (4)	30 (12)	21 (8)		10 (2)	
sagahay	52 (17)	64 (26)	95 (35)	23 (15)	56 (9)	22 (11)
Produktuan	10 (4)	17 (7)	7 (3)	16 (11)	6 (1)	6 (3)
'Commercial' loans	54 (18)	63 (25)	28 (11)	6 (3)	125 (22)	47 (23)
10% loan	7 (2)	1 (1)	4 (2)		16 (3)	14 (7)
alili	27 (9)	13 (5)	20 (7)	2 (1)	95 (16)	4 (2)
fertilizer loans	20 (7)	49 (19)	4 (2)	4 (2)	14 (3)	28 (14)
Purchase on credit	41 (14)	19 (8)	32 (11)	26 (17)	79 (13)	50 (25)
Porc	26 (9)	15 (6)	13 (4)	21 (14)	48 (8)	33 (16)
Palm wine	15 (5)	4 (2)	19 (7)	5 (3)	31 (5)	17 (9)
Total	294	249	272	155	595	199
Loan repayment:	327	281	233	161	706	251
Institutional	80 (25) 2)	5 (2)	42 (18)	33 (21)	260 (37)	60 (24)
Private	187 (57)	213 (76)	155 (66)	97 (60)	354 (50)	114 (45)
Purchase on credit	60 (18)	63 (22)	36 (16)	31 (19)	92 (13)	77 (31)
Deflation of cash debts	8	4	6	2	21	8
Change debt position	-41	-36	33	-8	-132	-60
Total	294	249	272	155	595	199

1) Figures in parentheses are percentages of total loan acquisition
2) Figures in parentheses are percentages of total loan repayment

gifts) a clear form of mutual-aid between households. They are usually given to households that cannot otherwise obtain loans because they are over-extended. Sibu may also occur between tenants and landlords in case tenants defer part of the landrent payment. Both non-surplus household categories are strongly dependent on these loans. The large amount of sibu loans for the young surplus households is somewhat surprising. They mainly involve loans from their parents.

The most expensive form of borrowing in the village is the saka-an arrangement, literally meaning 'lending for interest'. Amounts of cash borrowed through this arrangement are generally very small and the maturity period is short. Interest rates vary from 5 to 10% per month depending on the relationship between lender and borrower as well as the amount involved. It is an impersonalistic type of loan provided by non-local lenders.

A separate group of private loans includes arrangements where consumption goods or production inputs are purchased on credit. A common arrangement is the suki. It involves a subscription to regular purchases on credit of certain consumer goods the full amount of which is paid after a predetermined period. A typical example is the purchase of palm wine: the suki-taker agrees to pay a certain number of bags of rice at the time of rice harvesting to the suki-giver in return for a fixed (guaranteed) daily quantity of palm wine. Purchase on credit is also involved in the buying of pork for the annual fiesta. Usually, a number of households slaughter their pig on this occasion and barter a portion of the pork for rice which is repaid during the rice harvest period in December. The intrinsic interest rate for this arrangement was calculated at roughly 4% per month.

A more recent non-institutional loan arrangement involves the purchase of fertilizer on credit in June-July in return for a rice payment in December. This type of loan is provided by local middlemen who obtain fertilizer on credit from the city-based fertilizer dealers which they in turn offer to individual farmers at higher interest rates. Also wealthy farmers in the village provide these fertilizer loans. In 1980, a bag of urea ($12.7) was offered in June in return for 2.33 bags of rice ($17.6) to be paid in December, resulting in a monthly interest rate of 6.4%. This expensive, commercial type of loan is primarily used by the young non-surplus households.

For 1978 and 1979, availability of institutional credit was limited to bank loans secured with land as a collateral. These loans could be obtained from the rural bank in the nearby town against an interest rate of 12%. In 1980, it became possible to lend money from the newly established Cooperative Rural Bank (CRB) in Iloilo City. Loans have to be secured with a collateral. Interest rates depend upon the type of collateral offered: 14% and 16% for working animals and land, respectively. The maximum loan amount is $116 if a working animal is provided as a collateral. The maturity period of the loan is 9 months and no restrictions to the use of the loan are attached. In contrast to these CRB-loans, M-99 loans, that again became available in 1981 through the earlier mentioned Area Marketing Corporation, do not require a collateral. The utilization of these loans are considered to be supervised by a number of organizations and the local extensionist. Consequently, the procedure for acquiring such loans is far more cumbersome compared to the CRB-loan. The only time a group of farmers made use of this scheme, it took one farmer a week and $20 travel expenses to obtain the necessary certificates and clearances before actual loan disbursement was made. The maximum loan amount under this scheme is $175 per hectare of which a total of $35 is subtracted for interest payment (12%), a crop insurance premium ($3.5), and two obligatory contributions to village saving funds.

In the above description of types of loan arrangements, the commonly used distinction was made between consumption and production loans. Although for a lender it makes a substantial difference whether loans are used for productive purposes (e.g.

purchase of fertilizer) or for consumption, for the household itself such distinction is, to a large extent, artificial. Finances for both consumption needs and production inputs have to come out of the same cash/kind flow. From a risk management point of view, a more important distinction between types of loans is based on the terms and conditions under which loans can be acquired. To serve as a means of risk diffusion, credit should be available at times the household faces problems in financing subsistence needs due to poor production or unexpectedly high expenditures, i.e. at times that the household shows a poor credit rating and is a substantial credit risk to the lender. In this respect, it is better to distinguish between types of loans which are provided as an aid to other households ('soft condition' loans) and loans that are provided on a 'commercial' basis.

When the total loan amount disbursed to the sample households is considered, roughly half consists of soft condition loans, 29% of institutional loans, and 20% of local commercial loans. Of the soft condition loans 45% are sibu loans for which no interest is charged, indicating the importance of mutual-aid in local lending. Of the total loan volume to non-surplus households, roughly two-thirds consist of soft condition loans. The young non-surplus households make almost no use of institutional credit (5%) and are relatively strongly dependent on commercial loans (28%). The middle-aged non-surplus households are able to secure 20% of their loan volume from institutional sources and obtain 12% through commercial channels. Also the young surplus households show a high percentage (67%) of soft condition loans (as mentioned earlier mainly in the form of aid from their parents) as well as the lowest percentage (5%) of commercial loans. In contrast, the middle-aged and old surplus households only acquire 20% and 32% soft condition loans, respectively, but obtain a relatively large percentage of their loans (56% and 37%, respectively) from institutional sources. It is not surprising that the middle-aged surplus households are the largest users of institutional credit. In contrast with the non-surplus households, they easily meet the loan conditions and the interest rate makes it worthwhile to go through the laborious routines of acquiring such loans. Moreover, given their surplus production capacity (or, alternatively, their repayment capacity), non-surplus households run a substantial risk of losing their collateral due to their inability to repay the loan as occurred earlier during the M-99 programme in 1974.

Table 6.3.4 shows the loan acquisition, interest costs, and the debt position in relation to the surplus income and liquid asset position of the various categories of households for the period of 1979-82. In absolute terms, the middle-aged surplus households are by far the largest users of credit. The total acquired loan amount during the three year period ($595) is more than twice as high as the next highest users, the middle-aged non-surplus households ($272). With on average $249 per household, the young non-surplus households have borrowings somewhat below this level, followed by the old household category ($199), whereas the young surplus

Table 6.3.4 Household debt position and interest costs in relation to surplus income and liquid asset holdings ($)

	Mean	- Non-surplus -		- - - - Surplus - - - -		
		young	medium	young	medium	old
(1) Annual household income (1979-82)	761	419	599	649	1172	964
(2) Annual surplus income (1979-82) 1)	378	75	143	401	620	652
(3) Liquid asset position (March 1982) 2)	302	78	115	553	407	356
(4) Debts outstanding (April 1979)	93	75	90	19	217	64
(5) Loan acquisition (1979-82)	294	249	272	155	595	199
(Total education expenses (1979-82))	(273)	(18)	(279)	(-)	(477)	(591)
(6) Total incurred debts (4+5)	387	324	362	174	812	264
(7) Loan repayment (1979-82)	334	285	239	163	727	259
(8) Debts outstanding (March 1982)	53	39	123	11	85	5
(9) Average monthly debt position (1979-82)	131	133	137	28	277	80
(10) Net annual interest payments (1979-82) 3)	31	31	34	13	70	9
Monthly debt to total debt (9/6)	0.32	0.41	0.38	0.16	0.34	0.30
Monthly debt to annual income (9/1)	0.18	0.32	0.23	0.04	0.24	0.08
Interest-surplus income ratio (10/2)	0.16	0.41	0.24	0.03	0.11	0.01
Debt-surplus income ratio (8/2)	0.31	0.52	0.86	0.03	0.14	0.01
Debt-liquid asset ratio (8/3)	0.37	0.50	1.07	0.06	0.21	0.01

1) Calculated surplus income based on the total income minus calculated subsistence requirements, i.e., the number of standard consumer units * $80.
2) Liquid assets only include product inventories and cash savings.
3) Represents interest cost for loans obtained during the period 1979-82 minus interest payments on outstanding loans received during the same period.

households have the lowest level of credit use ($155). When the duration debts are outstanding is taken into account and the average monthly outstanding debt amount during the three year period is compared (including outstanding debts at the beginning of this period), differences between households - notably for the young surplus households - are more pronounced. As indicated by the ratio 'monthly average debt to total debt incurred during the three period of 1979-82', the duration of debts outstanding is substantially shorter for the young surplus households compared to the other households, whereas the non-surplus households show the longest debt periods.

When the debt position is considered in a relative sense, by comparing the average monthly debt position to the average annual household income for the period of 1979-82, young non-surplus households show a very high debt to income ratio of 32%, implying a high level of continuous indebtedness. Both middle-aged household categories also show a high ratio of 23%. Old and young surplus households have much lower ratios of 8% and 4%, respectively. When these debt to income ratios are set against the expenditure pattern discussed in the previous section, it is interesting to note that for the middle-aged non-surplus households education expenses are roughly equal to the total acquired loan amount. For the middle-aged surplus households the level of education expenses is about 80% of the level of the total loan volume. Given the fact that these expenditures mainly occur during the lean period from April until October, this implies that a large part of the borrowed funds of middle-aged households is used for financing education. Further, given the low level of disposable income per consumer unit of non-surplus households which virtually precludes the reduction in consumption levels, these households cannot reduce the loan volumes without endangering the functioning of the household (young non-surplus households) or reducing investments in education (middle-aged non-surplus households). A reduction in loan volume would endanger the functioning of the middle-aged surplus households to a much lesser extent, and is virtually no problem to the other surplus household categories.

Table 6.3.4 also shows the net annual interest payments during the period of 1979-82. They represent the interest incurred on loans obtained during this period minus the interest received on outstanding loans with other households. When compared to the surplus income, interest payments usurp a large part of this income of non-surplus households. For the young non-surplus households, 41% (!) of the realized surplus income goes to interest payments, whereas for middle-aged non-surplus households this amounts to a level of 24%. For the former category of households, it indicates the substantial cost that is associated with sustaining minimum subsistence requirements. For the middle-aged non-surplus households it actually indicates the substantial interest costs that are incurred for financing education.

Except for the middle-aged non-surplus households, all household categories show a larger repayment of loans than loans acquired. The resulting debt balance as of March 1982 is highest for the middle-aged non-surplus households, followed by the middle-aged surplus households. The young surplus and old households show a very low debt balance, whereas the young non-surplus households take a position in-between. However, compared to the average surplus income realized during the period of 1979-82, i.e., the income out of which accumulated debts have to be repaid, both middle-aged and young non-surplus household categories show very high indebtedness levels. The ratio outstanding debts to surplus income is 0.86 and 0.52 for the middle-aged and young non-surplus households, respectively, compared to a ratio of 0.14 for the middle-aged surplus households and very low ratios for the young and old surplus households.

The differences in net debt position (outstanding debts minus outstanding loans) between household categories become even more pronounced, when the amounts of rice and money lent to other households are taken into account. As shown by Table 6.3.5 old households and, to a lesser extent, young surplus households have accumulated a substantial amount of outstanding loans to other households as of March 1982, so much so that their net debt balance becomes negative. Middle-aged surplus households show a balance of outstanding loans at half the level of that of the young surplus households. This reduces their debt position of $85 to a net debt position of $59. Also the middle-aged non-surplus households show a minor outstanding loan balance, but this hardly affects their indebtedness level. It is striking that even the non-

Table 6.3.5 Pattern of outstanding loans and loan repayment ($); 1979-82

	Average	- Non-surplus - young	middle	- - - - Surplus - - - - young	middle	old
Lending balance April 1, 1979	11	0	2	28	10	14
Cash	4			19		
Kind	7		2	9	10	14
Lending (1979-82)	123	28	32	109	78	370
Cash	24	8	13	51	12	35
Kind	99	20	19	58	66	335
Total	134	28	34	137	88	384
Total loan repayment (1979-82)	78	26	23	76	61	205
Cash	13	5	13	18	9	19
Kind	65	21	10	58	52	186
Deflation of loans	6	1	1	11	1	16
Lending balance March 31, 1982	50	0	10	50	26	163
Cash	12			45	3	13
Kind	38		10	5	23	150
Total	134	28	34	137	88	384

surplus households, in spite of their poor financial situation, lend money and rice to other households. They are usually small amounts given to neighbouring households of the same economic position in the sphere of mutual help.

It is difficult to determine actual credit limits to individual households because of the complexity of credit determinants affecting the supply of credit and type of loans available to individual households. Access to credit sources largely depends on the credit-worthiness of individual households determined by such factors as the managerial qualities and personal characteristics of the farmer and his wife, the wealth position and credit history of the household, and the personal relationship households have with potential lenders. The supply of credit further depends on above village level factors determining the availability of loans from institutional sources as well as village level factors such as the general level of (surplus) agricultural production and the existence of opportunities for alternative investment outlets.

The social network plays an important role in the acquisition of loans, and thus in the risk diffusion of individual households. The maintenance of good social relations with a number of other households in the village is essential in obtaining help in the form of loans, in particular interest-free loans, at times the household faces a subsistence crisis. Social ties between households may consist of kinship, neighbourhood, or the so-called patron-client relationships. Especially links with families that have a regular income (e.g. government employees) are important. In contrast with farm-households their income is not susceptible to strong seasonal fluctuations. In case households cannot acquire help or loans, they may ask a close relative or neighbour to act as intermediary. In such a case, the lender will hold the intermediary responsible for loan repayment. The household actually receiving the loan is obliged to give high priority to repay the loan to the intermediary. Of course, good social relations are also important in creating wage labour opportunities for poor households, for example in the form of preferential access to early land preparation and rice harvesting activities.

Although it is difficult to arrive at a general assessment of credit availability to individual households, it was a common observation among farmers that it was difficult to acquire loans at the local credit market during the 1979-80 crop season. Farmers mainly complained about the almost non-availability of porcentuan loans and the unusual problems encountered in obtaining alili loans. This was generally attributed to poor loan repayment in recent years causing a large number of households to be financially overextended. This observation was confirmed by local lenders who argued that it was becoming more difficult to enforce loan repayment. Moreover, some of these lenders found good opportunities for investing their capital in other profitable enterprises, notably threshers and winnowers. Thus, reliance on credit as a source of liquidity introduces an additional risk in terms of the lenders' responses to changing conditions in agriculture and in financial markets that influence their lending decisions and resulting credit availability.

A special study concerning the debt position of sample households carried out in March 1980, supports the assertion that substantial debts had accrued during recent years, some of which are dating back as far as 1974. Some of the respondents argue that many of these debts are still the result of excessive borrowing during the

Table 6.3.6 Average outstanding debt per household by loan arrangement, time of acquisition, and purpose of loan ($); March 1980

		Private palay loans			Private cash loans			Inst. loans	
	Total	Sagahay	Sibu	Land 1)	Alili	Produkt.	Sibu	Bank	M-99
Year of acquisition									
1974-75	2.9 (3) 2)				2.9				
1975-76	11.7 (12)		2.7			5.9			3.2
1976-77	27.2 (28)	9.5				4.7			13.0
1977-78	13.7 (14)	7.2			0.7	5.9			
1978-79	6.5 (7)	2.1	0.5		0.3	1.8	1.7		
1979-80	34.5 (36)	13.6	2.8	10.4			1.4	6.4	
Total	96.5 (100)	32.4	6.0	10.4	1.0	21.2	3.1	6.4	16.2
(%)		(34)	(6)	(11)	(1)	(22)	(3)	(6)	(17)
Purpose									
Consumption	52.8 (55)	28.4	5.5	10.4		2.7	0.7		5.1
Farm inputs	19.1 (20)		0.5		0.7	10.9			7.0
Education	17.0 (17)					5.9	0.6	6.4	4.1
Construction	5.3 (6)	4.0			0.3	1.2			
Medicare	1.1 (1)					0.5	0.6		
Others	1.2 (1)						1.2		

1) Deferred land rent payments.

2) Figures in parentheses are percentages per column.

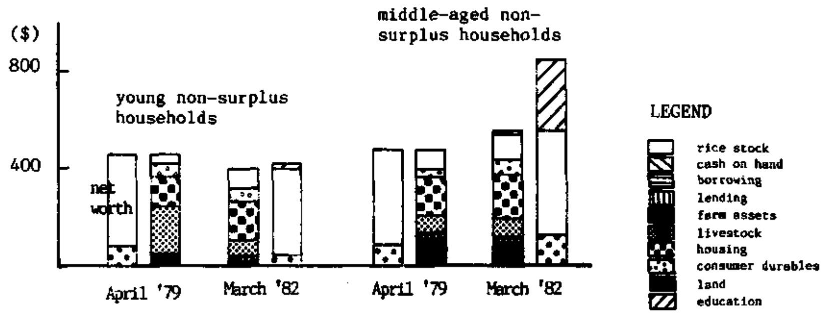
M-99 programme in 1974. The results of this study are summarized in Table 6.3.6. The average debt per household as of March 1980 amounted to $97. As became apparent from subsequent loan repayment records in the course of 1980-81 and 1981-82, under-reporting of old debts was substantial. The actual debt position amounted to a high level of $128 per household. However, in spite of the fact that households were overextended, it will be clear from the above that they were quite successful in acquiring loans at the local credit market. Local credit plays a critical role in the risk diffusion strategies of households.

6.3.3 Asset composition, net worth, and the household risk sensitivity

The asset composition and net worth position of households as of March 1982, resulting from the above investment activities, is presented in Figure 6.3.2 together with the same data for April 1979. The earlier defined rules for depreciation of assets (Section 5.1.3) are also employed here. During the investment period the real price of land is considered to be constant, i.e., the nominal increase in land prices is assumed to be equal to the increase in the earlier defined VPP-index. The actual cost of maintenance, repairs, and additional construction is added to the initial present value of housing assets in the year such investments take place. Similar to land, it is assumed that the real prices of structures and equipment remained constant. However, real prices of livestock (in particular working animals) increased during the observation period and are - together with stock additions due to natural growth and birth - included in the valuation of livestock assets. Financial and inventory assets are deflated by the VPP-index. Since previous investments in education are not accounted for in the initial balance, the investments in human capital are only shown as part of the net worth column of the terminal year in order to facilitate a better comparison between the initial and terminal asset balance.

Due to very good rice crop production conditions in the seasons of 1980-81 and 1981-82 following the poor rice production season of 1979-80, total net worth of all households taken together increased substantially. When investments in human capital are excluded, total asset holdings increased with 25% during the three-year period of 1979-82, from $1036 per household in April 1979, to $1293 in March 1982. Except for the young non-surplus households showing a decline in asset holdings of 15%, all households show an increase in asset holdings, with the young surplus households showing the largest increase (50%), followed by the middle-aged surplus households (36%), and at a much lower level the middle-aged non-surplus households (19%) and old surplus households (15%).

When taking into account investments in human capital, the total asset holdings increased with more than 50% to a level of $1566 per household. With investments in education included, the middle-



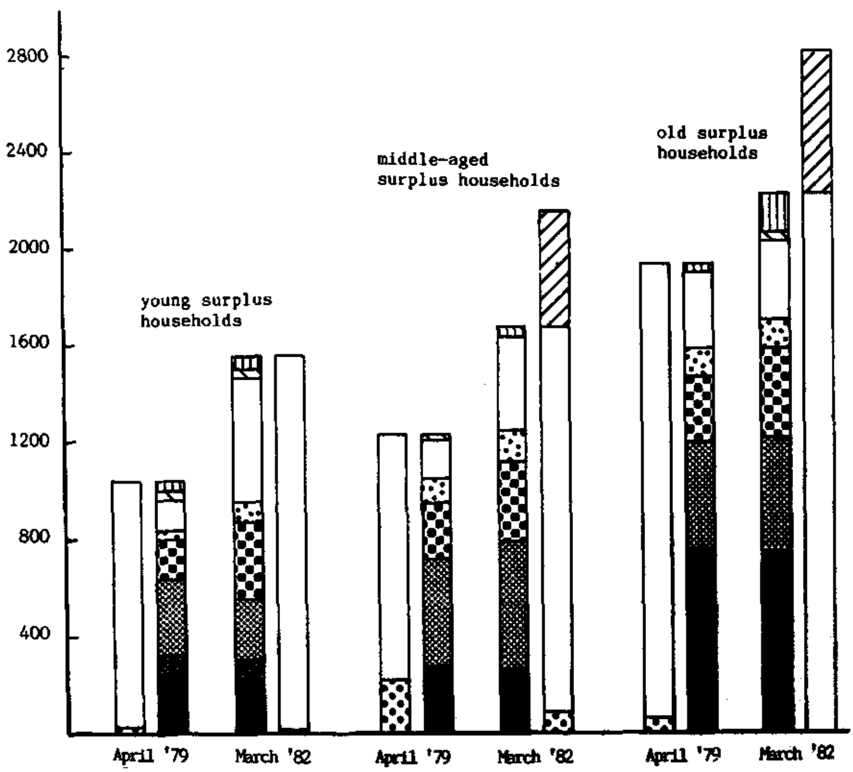


Fig. 6.3.2 Changes in asset composition and net worth for the period of April 1979 to March 1982 ($)

aged non-surplus households show the largest increase in asset holdings (77%), closely followed by the middle-aged surplus households with 75%. The young surplus and old household categories show an increase of 50% and 45%, respectively, whereas the young non-surplus household still show a decline in total asset holdings of 11%.

Except for substantial net investments in rice stocks, house construction and education, other asset holdings remained fairly constant on average. On the terminal date of the investment period (March 1982), asset holdings were composed of 60% fixed assets (comprising as major components 15% land, 18% livestock, and 18% housing); 17% investment in human capital; 18% rice stocks; and 4% positive financial assets (cash on hand and lending). As shown by Figure 6.3.2, all households show an increase in rice stocks compared to April 1979, especially the young and middle-aged surplus household categories. Together with the old households, they have rice stocks that are more than four and a half times larger compared to the rice stocks of the non-surplus households. Differences in rice stocks are even more pronounced when compared on a per consumer unit basis in which case surplus households have rice stocks that are six times larger than those of non-surplus households on average. Also livestock assets of non-surplus households are substantially below those of the surplus households in the terminal year. As mentioned earlier, a number of these households do not have their own carabao, but rent them from other persons on a sagod basis, whereas others have a cow instead of a carabao, sometimes also on a sagod basis. The livestock assets for the young non-surplus households declined due to the sale of cows, whereas livestock assets slightly increased for the middle-aged non-surplus households. Also for the surplus households, livestock assets remained fairly constant, showing a slight increase for the middle-aged and old households and a slight decrease for the young households. For all households, farm assets remained fairly constant during the investment period, indicating that investments were mainly used for the replacement of old equipment. Both young surplus and middle-aged non-surplus households show a substantial increase in consumer durables. whereas also the young surplus households substantially increased the value of their houses through maintenance and extension.

Due to a decline in outstanding debts, on average the increase in net worth of households (total asset holdings minus debts outstanding) of 32% (or 60% when including investments in education) is above that of the increase in total asset holdings. The increase in net worth (including investments in education) is highest for the middle-aged households with 103% and 86% for the surplus and non-surplus households, respectively, followed by the old and young surplus households showing both an increase of about 50%. As the only household category, the young non-surplus households show a decline in net worth of 4%.

Risk sensitivity

Given the above asset holdings and the earlier determined minimum income requirements, it is now possible to define more precisely the risk sensitivity of the various categories of households. For assets to serve as a hedge against unexpected shortfalls in income, they must be easy and quick to liquidate and must not seriously affect the capital integrity of the farm holding. The latter aspect refers to the importance of an asset's income-generating role. Liquidation of current assets, like inventories, are part of the household's usual operation. Their effect on the total asset value is reflected directly in its balance sheet. In contrast, liquidations of other assets such as farm implements, machines or working animals deplete the farm household's income-generating capacity and may reduce the production capacity of the farm by more than the asset's value. Assets become less liquid as their potential sale reduces the firm's value by more than their expected sales' value.

Except for current assets, rice in stock and cash on hand (as far as could be established households do not avail of jewelry or any other luxury items that can easily be liquidated), all other assets can be considered to have a low liquidity value. Apart from human capital assets (i.e., education) which have no direct liquidity value whatsoever, the sale or pledging of land, livestock assets (mainly consisting of working animals), and farm implements would seriously affect the production capacity of the farm holding, apart from the fact that pledging or sale of land requires the cooperation of other family members. The sale of houses obviously affects the functioning of the household, which also applies, to a lesser extent, to consumer durables. Although fixed assets such as land and working animals will be mortgaged or sold as a last resort, they are not considered a hedge for periods of low income by farmers and are thus not considered as part of the risk taking capability against which risky prospects are evaluated. Positive financial assets, comprising outstanding cash and kind loans, are by nature difficult to liquidate. They mainly constitute loans in the consumptive sphere given to closely related persons making it difficult to enforce loan repayment.

Thus, in assessing the household's risk sensitivity only the current assets 'rice stocks and cash savings' are taken into account. Apart from these liquid assets, a second determinant of risk sensitivity will be the expected surplus income. Instead of employing the earlier defined surplus production capacity of the farm holding, the actual surplus income is now used. This income is defined as the realized average household income above minimum income requirements during the three year observation period of 1979-81, thus also including income derived from wage labour and self-employed non-agricultural activities as well as remittances from children. It should be noted that this actual surplus income figure likely overestimates the 'average' surplus income earning capacity of households as two years out of the three-year observation period experienced very good agricultural production conditions. It will certainly overestimate the surplus income earning capacity at the start of the observation period due to changes in agricultural technology. Further, the household's capacity to borrow funds from external sources has to be considered. It will be assumed that this is negatively associated with the level of outstanding debts and positively correlated with the level of surplus income and outstanding loans. Based on these considerations, the <u>risk sensitivity index</u> is defined as

$$\frac{(Ac + Ys) - (D - L)}{MIR}$$

where Ys is surplus income, Ac current assets, (D - L) the net debt position (debts outstanding minus loans outstanding), and MIR the minimum income requirements of the household. Table 6.3.7 shows this index for the various categories of households both at the start and end of the observation period. It should be noted that the index defines risk sensitivity solely in financial terms. The risk reduction effect of ample availability of family labour is not accounted for.

Basically, this more accurate calculation of the household risk sensitivity does not change the picture of differences in risk sensitivity between households as earlier presented in Section 5.3 (2). It is clear that both non-surplus household categories show a high sensitivity to income risk compared to other household categories both at the start and at the end of the observation period. Although the young non-surplus households show a substantial improvement in the risk sensitivity index (despite an increase in minimum income requirements) due to an increase in the current asset position and a decline in outstanding debts, they

Table 6.3.7 Determination of the household's risk sensitivity index ($)

		- Non-surplus -		- - - Surplus - - -		
	Mean	young	medium	young	medium	old
April 1979						
(1) Liquid asset holdings a)	160	48	70	175	177	328
(2) Expected annual surplus income b)	378	75	143	401	620	652
(3) Expected liquidity situation (1+2)	538	123	213	576	797	980
(4) Net debt position c)	82	75	89	-9	207	50
(5) Minimum annual income requirements d)	380	320	467	232	552	328
Risk sensitivity index ((3-4)/5)	1.37	0.15	0.27	2.52	1.07	2.84
March 1982						
(6) Liquid asset holdings	302	78	115	553	407	356
(7) Expected annual surplus income	378	75	143	401	620	652
(8) Expected liquidity situation (6+7)	680	153	258	954	1027	1008
(9) Net debt position	3	39	112	-39	59	-158
10) Minimum annual income requirements	381	384	416	264	544	296
Risk sensitivity index ((8-9)/10)	2.03	0.30	0.35	3.76	1.78	3.94

a) Liquid assets include product inventories and cash on hand.
b) Average annual surplus income realized during the period 1979-82.
c) Debts minus outstanding loans with other households.
d) Calculated minimum income requirements based on 'number of consumer units * $80'.


Young non-surplus households
($)
200
0
-200
lean month period
Apr '79
Apr '80
Apr '81
Middle-aged non-surplus households
Apr '79
Apr '80
Apr '81
Legend
c. liquid asset position (a+b)
b. cash on hand
a. rice stock
net liquid asset position (c-f)
f. net debt position (d-e)
e. loans outstanding
d. debts outstanding

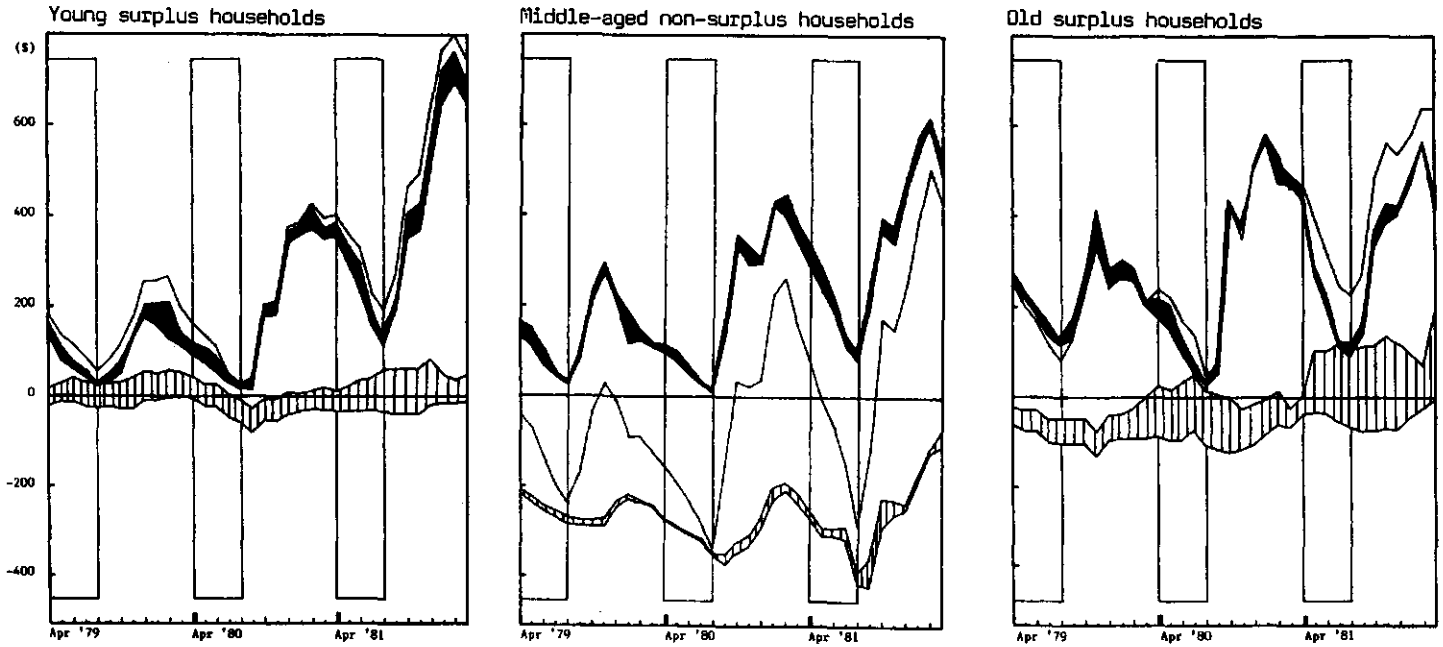


Fig 6.3.3 Seasonal pattern of the household's liquid asset position and level of indebtedness; monthly recordings for the period of April 1979 to March 1982

still have a very limited capacity to overcome poor production years or unexpectedly high expenditures. It should also be noted that this improvement in short-run risk sensitivity occurred at the expense of the sale of livestock assets. The middle-aged non-surplus households also show a slight improvement due to a stronger increase in current assets compared to the increase in outstanding debts. All surplus household categories show a relatively low sensitivity to income risk at the start of the observation period and a further decline in risk sensitivity during the observation period. However, relative to the young and old households in this category, middle-aged households are in a much weaker position.

Figure 6.3.3 shows the seasonal pattern in net liquid asset position (rice inventory and cash on hand) as well as net indebtedness level (outstanding debts minus outstanding loans) by month for the period April 1979 until March 1982. It appears that especially for young non-surplus households it is virtually impossible to accumulate sufficient reserves to serve as a hedge against low incomes. Despite a high overall rate of family labour utilization, the household income is low relative to the minimum household income requirements, because of a relatively unfavourable worker-consumer ratio. Forced by short-term subsistence pressures, these households have to employ their scarce labour resources in activities that provide immediate income during the lean month period, notably through wage labour activities. As a result they are less able to devote their labour resources and attention to the management of self-employed agricultural production compared to other household categories causing - together with a low level of complementary input use - low returns on a per hectare basis. Moreover, a substantial part of the surplus income realized in good production years is paid to interest on loans acquired in poor production years.

With a more favourable worker to consumer ratio, middle-aged non-surplus households are in a much better position to devote family labour to self-employed agricultural activities while at the same time providing for short-term income requirements through wage labour activities. In fact, these households appear to face serious problems in finding remunerative employment for their labour resources. Still, compared to the young non-surplus household category, these households are able to realize a substantial surplus income. This income, however, is not used to create reserves to overcome short-term income deficits, but instead is invested - and thus immobilized for the short-term - in the education of children. The utmost importance attached to investments in human capital is understandable within the context of long-term security. Given the limited opportunities to expand the agricultural operation as well as limited possibilities for investments outside self-employed agriculture, the only way to improve the standard of living and provide for a source of living for the children is to aim at employment in the qualified job market outside the village economy. From a risk point of view, the implication is that these households take substantial short-term risks both in terms of keeping low reserves and restricting investments in agricultural inputs to safeguard long-term survival, whereas in themselves these long-term investments are by no means without the risk of a low pay-off. As a result also the middle-aged non-surplus households are in a very tight budget situation. Since, investments in education primarily occur during the months of April or May, thus at the start of the growing season, it further weakens the financial basis of the household at the time investments are required for agriculture.

The same (but more pronounced) seasonal pattern in the net liquid asset position is shown by the middle-aged surplus households. Because of a much lower level of risk sensitivity, these households can afford a much higher absolute level of indebtedness to finance education and are able to create a substantial liquid asset reserve at the end of the study period, i.e, after two good production years (Figure 6.3.3). Compared to the other households, both the young and old household categories show a very low level of risk sensitivity. Throughout the study period, these household categories show a positive net liquid asset balance.

Summarizing, it is clear that households differ substantially in their ability to take risks as well as the capacity to improve upon their risk taking ability. With a disposable income barely above minimum income requirements, the expenditure pattern of both non-surplus household categories is more or less fixed by pure subsistence requirements such as rice consumption and other daily household needs and the necessary expenses for education. In sharp contrast with the surplus households, there is hardly any room for creating reserves or for cutting back on household expenditures for non-surplus households. Although the local credit market, in particular lending between closely related persons, provides for a good external buffer against periods of low incomes, it is an expensive form of household sustenance. The necessity to use credit to sustain food requirements and education expenses directly affects the ability of poor households to invest in productive activities. Households may not use all available credit resources but keep certain credit reserves in anticipation of possible shortfalls in income. In addition, interest payments on these loans usurp a large part of the surplus income that is left after subsistence needs are covered, putting additional restrictions on the capacity of non-surplus households to invest in production activities and to increase their surplus income earning capacity. Further, households have to be careful in loan acquisition and debt management in order to limit the risk of a spiralling debt accumulation. Because of these factors, non-surplus households are highly sensitive to variations in income and, specifically, surplus income. Even minor cash investments in agriculture such as fertilizer or the loss of seeds due to drought, especially during the early stage of the growing season, represent substantial financial risks.

7 INTENSIFICATION OF LAND USE: CROP ACTIVITY CHOICE AND INNOVATION RISK

The case study presented in this chapter deals with the issue of intensifying land use through the intensification of rice crop production. Given the limited scope for increasing income through activities outside agriculture as well as from non-crop activities in agriculture, land use intensification is an important means of increasing household income. Chapter 4 presented a brief history of the introduction of the so-called HYV technology in the study village. It was indicated that farmers through own experimentation played an active role in the adaptation of this technology to rainfed conditions. This chapter is primarily concerned with the second stage of farmers' adaptation of the HYV technology, i.e., double rice cropping in rainfed fields.

Through the introduction of very short-maturing HYV varieties in the mid 1970s, farmers had the opportunity of growing two consecutive rice crops in rainfed fields, provided these fields had access to some supplementary sources of irrigation. For fields fully dependent on rainfall, the technology of double rice cropping with the employed crop establishment methods of transplanting or direct seeding in wet soil conditions proved to be marginal, because of the high incidence of drought for the second rice crop. Subsequently, farmers attempted to advance the establishment date of the second rice crop to an earlier date by employing dry seeding of the first rice crop. This practice proved to be so successful that five years after it was first attempted (1977), about half of the total rice area was grown to double rice crops.

Against this background of land use intensification through multiple rice cropping, an attempt will be made to conceptualize, structure, and analyze the risk factor in crop planning decisions. The introduction of double rice cropping in the course of the study period provides an excellent opportunity for analyzing the possible effect of risk on adoption behaviour. This technology requires a basic change in crop production planning and management as it involves the incorporation of an entirely new cropping pattern into the existing cropping system. Emphasis will be placed on the possible effect of resource-induced risk aversion by comparing adoption behaviour of surplus and non-surplus households.

As an introduction to the risk factor in rice production, Section 7.1 provides a detailed description of crop management and risk control in rice cultivation focusing on the way in which farmers perceive risks and risk management. This largely qualitative assessment of risk factors will form the basis for the selection of two cases for which a quantitative risk assessment will be attempted: in this chapter rainfall-related risks of double rice cropping and in Chapter 8 the overall risk involved in fertilizer use. The complexity and problems encountered in adequately assessing cropping pattern risks will be discussed in Section 7.2 and limitations to risk assessment will be indicated. Subsequently, in Section 7.3 the process of double rice cropping introduction will be discussed and factors explaining differences in adoption behaviour will be identified. The effect of the new rice technology on increased stratification in the village will be assessed.

7.1 Risks and risk control in rice crop production

Environmental instability has a major impact on the management and outcomes of agricultural production processes. Due to the variability in such environmental factors as rainfall, temperature, winds, solar radiation, the incidence of weeds, and the occurrence of pest and disease infestation, the required inputs and outcomes as well as the timing of agricultural activities and operations within activities are, to some extent, uncertain. In various ways farmers have adapted agricultural practices to environmental instability. Below the various risk factors in rice crop production will be discussed and farmers' practices to control such risks will be reviewed.

7.1.1 Land preparation and crop establishment

Agronomically the best - also according to farmers - and traditionally the most widely used method of establishing rice crops is transplanting seedlings (_tanum_) from an earlier established nursery. Nursery preparation may either occur during the early onset of the rainfall season in which case ungerminated seeds are broadcast in dry soil conditions (_sabod-samara_) or at the start of the main rainfall season in which case pregerminated seeds are broadcast unto a puddled soil (_sabod sabati_). Before transplanting, the field is usually thoroughly ploughed followed by one or two rough harrowings. Alternative and inferior methods of transplanting, previously used in transplanting far-away fields or other fields in case of insufficient labour for land preparation or land tenure uncertainty, include the so-called _lahos_ and _loya-loya_ methods. The _lahos_ method consists of one ploughing followed by a furrowing and planting of seedlings in the furrow and the _loya- loya_ method involves just a furrowing of the field before transplanting. Both methods allow a hilling-up about one month after transplanting employing a steel-pointed wooden plough to control weeds. They were also popular during the Second World War, when the security situation did not allow the farmer's presence in the area for a long time.

The obvious disadvantage of transplanting rice crops is the large labour requirement for pulling of seedlings and transplanting. Further, in case of a very late onset of the rainfall season, the establishment of nurseries may get seriously delayed or may not be possible. Thus, in order to cut back on production costs or to quickly establish rice crops, farmers employ various methods of direct seeding rice. A distinction can be made between direct seeding methods in dry and in wet soil conditions. The technique of seeding rice in dry soil conditions has been in use with farmers for a long time. With the introduction of the BE-3 rice variety, farmers started to use an establishing technique known as palay-ang. This seeding technique involves broadcasting of ungerminated seeds in dry soil conditions before the start of the rainfall season. Seeds remain in situ until the first rains allow germination. To facilitate early seedbed preparation, the field must be ploughed at the start of the dry season in January or the beginning of February. At the end of March or April, after a light shower (the soil clods must be slightly wet to prevent carabaos from hurting their feet) the field is ploughed for a second time, followed by seeding and incorporation of seeds through a third ploughing/harrowing. An alternative to broadcasting is to place the seeds in furrows (paray-paray) which allows weed control through hilling up.

For weedy fields, farmers also employed a method known as sabog-samara, which involves the seeding of ungerminated seeds in slightly moist soil conditions allowing germination to start directly after seeding. This establishment method is essentially the same as the dry seedbed establishment of nurseries for transplanting. With the introduction of short growth duration IR-varieties farmers increasingly started using this method for dry seeding fields in order to facilitate double rice cropping. The advantage of this method is that it allows farmers to assess the weed infestation after the first ploughing and that germinated weeds are ploughed under during the preparation of the field.

Apart from these dry seeding methods, farmers have for a long time also employed direct seeding methods in wet soil conditions. Similar to the wet seedbed nursery establishment technique, the usual method of wet seeding rice fields involves two to three ploughings followed by an intensive puddling of the soil through a large number of harrowings. After the field has been levelled, it is drained and pre-germinated seeds are broadcast unto the puddled soil. With the introduction of the BE-3 rice variety, this so-called sabog-sabati method (sabati literally means many harrowings) became less popular. According to farmers, in contrast to the dry seeded and transplanted BE-3 crops, the root system of the wet seeded BE-3 crops did not penetrate deep enough into the soil to give the relatively tall crop enough anchoring to withstand strong winds. As a result wet seeded BE-3 crops often lodged. With the introduction of short-statured IR-varieties (IR30 and IR36, both with an excellent seedling vigour and good tillering capacity, the wet seeding of rice crops has become popular again. In fact, as mentioned earlier, this method rapidly replaced transplanting as the main method for rice crop establishment.

For loamy soils, farmers employ an alternative method to sabog-sabati. According to farmers, the large number of harrowings required for this method results in a very compact soil layer in this type of soils causing problems in root development of seedlings. Instead, farmers employ a crop establishment method known as minongo. Fields are ploughed at the start of the dry season, ploughed again with the ponding of water in the field (the water must be slightly warm) after which pregerminated seeds are broadcast into standing water. After seeding, the field is harrowed once and drained after one day. A similar method using ungerminated seeds is known as palusot. Fields are ploughed twice, followed by a rough harrowing. The water is not drained, but the ungerminated seeds are broadcast into standing water. The field is drained three to seven days after seeding. According to farmers, this is an inferior establishment technique which should be used in case rapid crop establishment is required. An advantage is that floating weed seeds will either be removed with the drainage of the field or concentrate along the bunds of the field.

A wet seeding method particularly aimed at controlling grassy weeds is known as palagbung. Similar to the sabog-sabati method, the field is thoroughly ploughed, harrowed and levelled. After levelling, water is allowed to enter the field until a depth of about one foot. Pregerminated seeds are broadcast in standing water and after ten days, the field is drained until the tips of the seedlings become visible. Because the seedlings are very weak, the water level in the field must gradually be raised with the growth of the seedlings. The field is not allowed to drain earlier than three weeks after seeding. Clearly, this method requires a sufficient water retention and drainage capacity of fields. Also, the fields cannot be too large as the seedlings may otherwise be destroyed by water currents caused by winds.

7.1.2 Water management and related risks

Some of the major problems experienced in rainfed rice production relate to insufficient availability and control of water in rice fields. Optimal water conditions, indicated by farmers as a shallow water depth and preferably a slow constant in and outflow of water, are often difficult to attain. Because of irregular rainfall and landscape patterns, rice plants may suffer from alternating periods of water shortages and oversupply of water.

The principal way in which farmers control the water level in their fields is through the opening and closing of levees (bunds) surrounding the fields. During periods of intermittant rainfall proper water control requires close supervision of bund opening and closing. For far-away fields this may be difficult and it is common that levees are left open for sustained periods. From a social and organizational point of view, water management is best characterized as a 'first come-first served' system. Although, certain behaviour codes are established, farmers are more or less at the mercy of water management decisions made by farmers managing adjacent, higher positioned fields. They are allowed to block water flows or to drain water at any time it is deemed necessary. Damage due to uncontrolled drainage - especially a problem for newly wet seeded crops - cannot be claimed. A good social relationship with neighbouring farmers is thus an important pre-requisite for proper water control management.

Underhand opening of levees of other farmers' fields, however, appears to occur quite often and may lead to social tension between families in the village. Stealing of water may be a particular problem for fields located far from the village, especially when these fields are surrounded by fields farmed by persons from other villages. There are instances that water was diverted from one field to another through a number of other fields. Poor water control in far-away fields is often cited as a reason for growing the relatively tall-statured BE-3 variety and maintaining a low level of overall crop management.

Seedling stage

Water management risks during the seedling stage of crop growth differ substantially between direct seeded and transplanted crops. All risks associated with stand establishment of direct seeded crops - particularly dry seeded crops - are non-existing for transplanted crops. For dry seeded rice crops, four crop establishment risks were identified.

First, uneven and poor germination may result from insufficient germination rains after the rice is seeded. The risk of uneven germination and poor stand establishment is increased with poor land preparation prior to seeding and poor seed incorporation after seeding as well as the use of poor quality seed. Uneven germination causes staggered harvests with short maturing varieties. This latter problem does not occur with the existing, photo-sensitive varieties. In case of stand reduction or an uneven stand replanting may be required and, in severe cases, whole fields may have to be pulled followed by transplanting of seedlings to other fields. To reduce the risk of thin stands and facilitate transplanting in case of uneven germination, farmers generally use high seeding rates for dry seeded rice crops.

Second, stunted growth of rice seedlings due to drought shortly after seed emergence is a major risk which cannot be controlled by farmers. Depending on the duration of the drought period, severe stand reduction or complete crop failure may result. The extent to which such drought may occur depends on the seeding date and whether seeding is carried out under dry or slightly moist conditions. With the former method seed emergence depends on sufficient germination rains which are estimated to be in the range of 50 to 125 mm (Furoc *et al*, 1978).

Third, seed damage due to submergence of seeds caused by an early ponding of water in the field may be a severe problem with late dry seeded rice crops, but may also be a problem with early dry seeded crops in case germination rains are late and heavy. Although drainage may solve the problem to a certain extent, continuous rains may prevent effective drainage, particularly in waterway fields. Submergence of ungerminated seeds will generally result in a complete stand loss. For this reason, seeding under slightly moist conditions (sabog-samara) is usually preferred at later seeding dates in order to enhance direct germination to reduce the risk of submergence of seeds due to early water accumulation.

Fourth, sudden ponding of water in a dry field with young rice seedlings (without necessarily sustained seedling submergence) may result in stunted growth and yellowing of leaves, a condition which is locally known as naga-puras. This condition results from the sudden change from dry to flooded soil conditions. In this process, various chemical reactions take place that may retard root development, inhibit nutrient absorption, and cause root rot. According to farmers, this condition can be remedied by the application of fertilizer.

Two water management risks specifically relate to wet seeded crops. First, insufficient moisture conditions during the seedling stage are also common for wet seeded rice crops, because prior to seeding drainage to field capacity is required. However, in contrast with soils of dry seeded rice crops, puddled soils can become very compacted (bagtik) in the process of drying and may remain in such condition even after the field is flooded again. According to farmers, this has an unfavourable effect on growth and the only remedy is to immediately fertilize the crop after sufficient water is available in order 'to make the soil soft' (hagpok).

Second, unexpected heavy rainfall can flood wet seeded rice fields prematurely causing damage by floating the seeds, covering pre-germinated seeds with mud, or washing out barely emerged seedlings. Concentration of seeds on the lower parts of the field may cause a pattern of scattered groups of rice seedlings that requires replanting at the start of the vegetative growth stage. Shallow ditches in the field are commonly used to drain lower spots in the field as well as to channel water from higher fields through the field in an orderly way. The use of peripheral ditches along the bunds is less common.

Finally, sustained submergence of young rice seedlings is a major water management related risk to both dry- and wet seeded rice crops. Water requirements are low at the seedling stage. If seeds are submerged for a sustained period, the development of radicles (primary roots) is affected by a lack of oxygen supply (De Datta, 1981). This effect is locally known as dar-os, which literally means 'damaged by water'. It is characterized by farmers as stunted growth and yellowing of leaves due to sudden submergence of seedlings. They distinguish it from naga-puras because it cannot be remedied with fertilizer applications. This makes sense as submergence hinders the root development of seedlings ('you should wait one or two weeks with the application of fertilizer').

For transplanted rice crops, no early water management related risk factors are present, except a delay in transplanting which may occur due to insufficient moisture conditions at the time of transplanting. Depending on the period between seedbed establishment and transplanting, such delay may seriously reduce yields of short maturing varieties or may cause loss of seedlings.

Vegetative growth stage

Following the seedling stage, a shallow water depth facilitates tiller production and promotes firm root anchorage in the soil. Excessive water at the vegetative growth stage seriously hampers rooting and decreases tiller production. Leaf blades and leaf sheaths of the submerged plants become weak, turn pale green, and break easily (De Datta, 1981). The risk of submergence of rice seedlings remains during the early vegetative growth period, but will gradually cease as the plant gains height. However, due to poor surface drainage of the lower part of the rice plain, submergence risk remains present for crops planted in this area.

The effect of drought during the vegetative stage is considered severer for wet seeded or transplanted crops compared to dry seeded crops. As indicated earlier, puddled soils become very compacted after drying and crack easily. Low hydraulic conductivity due to very fine textured soils may lead to moisture stress of rice during periods of low water supply. While enough available moisture may remain in the interior of the clods of these dry soils, it is too slowly released to adequately supply the rice roots.

Sudden flooding of a soil near the cracking stage (bagtik soils) is observed by farmers in the area to cause stunted growth without the leaves of the rice plant turning yellow. Locally this effect is known as nakusgan. This condition does not occur in reasonably wet, fully cracked or non-puddled soils. Farmers consider application of fertilizer after rainfall to be an effective method of remedying this condition.

Stunted growth of rice plants may also occur in fields which are strongly deficient in internal drainage. The negative effect of prolonged and complete waterlogging on crop performance may result from phosphorus deficiency and is demonstrated by alleviating such conditions. Improvement of drainage, even temporary, will cause most nutritional disorders to diminish or disappear. Nitrogen availability may also be low in permanently or semi-permanently waterlogged rice lands. Under such conditions, mineralization of soil nitrogen is restricted and nitrogen deficiency may occur, even when the nitrogen content of the soil is high (Moorman and van Bremen, 1978). Locally, this condition is known as lus-on and is associated with fields that are located near springs.

Reproductive growth stage

Reproductive growth starts when maximum tillering is completed. It includes the panicle primordia development, booting, heading, and flowering stages. A large amount of water is consumed during the major part of the reproductive growth period, which explains why rice is particularly sensitive to moisture stress during reproductive growth. Drought at this stage causes severe yield damage, particularly when it occurs from the panicle initiation to the flowering stages. Matsushima (1962) reported that rice is most sensitive to moisture stress from 20 days before heading to 10 days after heading. Increased panicle sterility, caused by impeded panicle formation, heading, flowering, or fertilization, occurs if the amount of moisture is insufficient. Clearly, depending on the planting date, second rice crops have a much higher chance of drought stress during the reproductive growth stage compared to rice crops planted at the beginning of the growing season. Excessive water is also a limiting factor at the reproductive stage, particularly at the booting stage, which may cause a decrease in culm strength and increase lodging.

After the reproductive growth stage, little water is needed for ripening. Hence, no yield damage will occur due to drought at this stage. However, heavy rainfall, high winds, and strong water currents may cause lodging of rice which may damage the grain quality, result in germinating seeds and an increase in labour requirement for harvesting. A specific post-harvest problem related to first HYV crops concerns the drying of grains either for sale or for own storage. Because these crops are harvested during the height of the rainy season, farmers sometimes encounter difficulties in applying the traditional method of sun-drying grains on mats.

7.1.3 Incidence of weeds and weed control

Weeds in cultivated fields reduce rice yield and quality by competing for space, nutrients, water, and light. Weed competes with rice plants especially for water and nutrients. Competition for water is more serious in rainfed rice than for irrigated rice because moisture is often limiting, especially for direct seeded rice crops during the early stage of crop growth. In competing for nutrients, weeds will absorb as much or more than the crop plant. Furthermore, the damage caused by weeds during the early growth stage of the rice crop is more serious compared to competition during the later growth stages (De Datta, 1981). Weeds may also intensify the problem of diseases, insects, and other pests by serving as their hosts, and may interfere with agricultural operations and reduce the efficiency of harvesting. The importance of weed control in rice crop production as well as the labour intensity of the weeding operation is best indicated by the fact that the local word for farmer '<u>mangunguma</u>' literally means 'weeder'.

Crop competition from weeds varies with the time of weed infestation, the type of weeds and their density and the stage of the growth of weeds. Weeds are classified as grasses, broadleaf weeds, and sedges. A number of weeds considered important by farmers are given in Appendix IV. The most serious competition is from grasses alone since they make almost the same demand upon the environment because of similar growth habits as rice in terms of root growth and foliage characteristics. They are also more difficult to control compared to the other two weed types.

The extent to which weeds can be considered a risk factor depends on the degree to which weed incidence is predictable as well as the extent to which an actual weed infestation can be controlled. With respect to the first factor, farmers give the impression - and observation tends to confirm this - that they are quite able to predict weed incidence for specific fields. Such prediction is based on their knowledge with respect to the weed and crop history of their fields as well as the previous year's weed incidence and level of weed control. However, the actual degree of infestation is still largely dependent on the actual rainfall pattern and water conditions in the field during crop development. Certain weed species will only germinate under particular moisture and temperature conditions and may stay in situ in the soil for prolonged periods. For instance, many weeds (e.g. grasses) will not germinate under flooded field conditions and when germinated will be killed when submerged for some time. Due to poorer water control conditions, higher positioned fields are considered to be more susceptible to weed infestation compared to low lying fields where continuous flooding is possible. The worst weed infested fields are found just below the upland fields where substantial amounts of weed seeds are deposited from uncontrolled weed growth in upland areas as well as in fields situated at the end of waterways where stagnant water also results in a depositing of weed seeds.

It is also a common observation that fields, where carabaos are allowed to graze during the dry season, are more infested with weeds compared to fields where carabaos do not enter. This is probably due to the presence of weed seeds in livestock manure. It is not possible to refrain other farmers from grazing their animals in fields once they are harvested. The only possible way to protect one's field is to have either another crop following rice or to plough the field shortly after harvesting.

The continuous cultivation of dry seeded BE-3 crops is known to result in an increase in weed population. Because of its tall stature, weed control is not required at the later stages of crop growth allowing weed plants to mature and produce seeds. The continuous cultivation of dry seeded BE-3 also results in poor levelled fields with the associated problem of poorer water control and an increase in weed infestation in certain parts of the field. Hence, every two or three years dry seeded BE-3 crops have to be alternated with transplanted BE-3 to allow field levelling and reduce weed infestation as well as to facilitate easier handweeding. This is usually no problem in dry seeded HYV crops as such crops are followed by a second wet seeded rice crop.

The replacement of the tall BE-3 variety with the semi-dwarf HYV varieties has initially resulted in increased weed problems in fields planted to these latter varieties. The traditional variety has droopy leaves; the semi-dwarfs are shorter in stature and have erect leaves. Therefore, more light penetrates the crop canopy, and more weeds emerge and survive. However, double cropping with these semi-dwarf varieties is observed by farmers to have a weed reducing effect due to the mid-season incorporation of weed plants during soil puddling for the second crop and the idea that certain late maturing weed species cannot produce seeds during the short growth duration of the modern varieties. On the other hand, the increase in cultivation of HYVs and double rice cropping has aggravated weed problems due to the strong increase in the occurrence of Echinochloa crus-galli (paray-paray), a grassy weed species which is difficult to control.

Early control of weeds is important for obtaining high yields. Timely weed control is more important and also more difficult in direct seeded crops than in transplanted rice. Weed incidence is most serious in dry seeded crops since the initial dry field conditions favour the germination and growth of grasses. Because fields are not submerged during the seedling stage of the crop, grassy weedseeds find the right conditions to germinate and grow together with the rice seedlings. Because of their vigorous growth characteristics, these weeds may easily outgrow and suffocate the rice seedlings at an early stage. In case of a heavy weed infestation, such a condition is difficult to control. As will be indicated further on, weeding a newly emerged rice crop is often impossible without causing substantial damage to the crop. Thus, a good level of weed control is a pre-requisite for successful dry seeded rice crops.

Farmers will, therefore, hesitate to grow dry seeded crops unless they expect a relatively weedfree seedbed or have sufficient resources at their disposal to control an unexpected high weed infestation. For instance, the crop season of 1979-80 was particularly dry during the later growth stage of the BE-3 crop which stimulated weed growth. As a reaction, farmers planted a much smaller area to dry seeded BE-3 crops in the following year replacing them with transplanted BE-3 crops. Furthermore, for dry seeded rice crops, it is common to wait with seeding until weedseeds have germinated after the first ploughing. Thus, by observing weed emergence after the first ploughing, farmers may change their farm plans on the basis of the observed early weed incidence. Wet seeded rice crops are less susceptible to weed infestation because weeds are incorporated into the puddled soil prior to crop establishment. However, the level of early weed control attained in wet seeded rice crops is far less compared to transplanted crops, because fields have to be drained before seeding which favours the germination and development of grasses.

Other practices to reduce weed infestation include the use of clean rice seeds. Seed selection and harvesting are usually carried out before the main harvest, often by panicle with the use of the finger blade harvesting knife (kayok). Cutting of weeds on the levees of rice fields is considered important to reduce weed infestation. The relatively high seeding rates farmers use in direct seeded rice crops (around 130 kg/ha) may in part be considered a weed control practice. For wet seeded rice, Moody (1977) reported less weed competition as seeding rates increased in the range of 80 to 200 kg/ha.

Apart from the above cultural practices to limit weed incidence, direct control practices consist of a number of physical and chemical control methods. Physical methods include proper land preparation, hand weeding, burning crop residues and weed plants during the dry season, and flooding and smothering of weed plants. Hand weeding of direct seeded crops usually starts two or three weeks after seeding. Earlier weeding may cause serious damage to the young rice seedlings. Because the seeds are randomly broadcast, it is difficult to enter the field without physically damaging the rice seedlings. Moreover, at their seedling stage, certain grassy weed species so much resemble rice seedlings that even experienced farmers have difficulty in recognizing them. Hand weeding may not always be possible due to unfavourable field conditions. Moist field conditions prevent hand weeding because the soil is too sticky and entering the field would result in substantial damage to the rice plants. Also the pulling of weed plants would be impossible without simultaneously pulling of rice seedlings. Due to the soil structure, weeding in dry conditions is possible in dry seeded crops, but not in wet seeded crops where soils become compact after drying. In severely weed infested dry seeded rice crops, rice seedlings may have to be pulled and, after ploughing, replanted to another part of the field.

Mechanical weed control with rotary weeders - popular in transplanted irrigated rice - cannot be employed in direct seeded rice crops due to the random distribution of rice seedlings. Smothering of weed plants with a wooden, tooth-spiked harrow (suyod) was a common weed control method in the traditional rice crops and until today is still used by some farmers in the BE-3 crops. In 1980, farmers started to adapt this method for use in HYV crops. Instead of employing a harrow pulled by a carabao, they use a broadly spiked, wooden handharrow to control weeds with long rizhomes. Although such method may not be considered ideal, they effectively minimize the detrimental effect weeds have on crop growth (De Datta, 1981).

The use of herbicides is not widespread and is limited to applications of 2,4-D (2,4-dichlorophenoxy acetic acid). This systematic, post-emergence herbicide is used in liquid form and applied as a foliar spray with the use of knapsack sprayers. Farmers find 2,4-D effective against sedges and broadleaf weeds. Farmers do not apply pre-emergence herbicides such as butachlor which are recommended as a control method against early weed infestations in dry seeded rice crops. Application of chemical herbicides (butachlor) immediately after seeding when the soil is still slightly wet, or immediately after a germinating rain, followed by one handweeding usually adequately controls weeds. Although farmers are aware of the existence of pre-emergence herbicides, they have not yet attempted to use them because of the large cash outlay involved and the obvious risk that such investment may prove to be useless in case the crop fails at an early stage. That is, the investment has to be made before the farmer can be reasonably sure that the crop will develop well. At the recommended level, the application of pre-emergence herbicides entails a cash cost of approximately $34 per hectare. This expenditure is incurred in a period when the household's reserves are low and expenditure requirements are high. Especially for the non-surplus households there is a need to conserve cash for inputs for which labour cannot be substituted (e.g. fertilizer). Thus, although the use of pre-emergence herbicides reduces the yield risk of dry seeded rice it may substantially increase the net return risk of the crop (at least it does so in the eyes of the farmers), especially when the opportunity cost of cash in the period of investment is taken into account. Thus, instead of risking the investment of an expensive pre-emergence herbicide application, farmers try to reduce the risk of a heavy early weed infestation as much as possible by locating dry seeded rice crops on fields with a good level of weed control. They also take into account the level of weed infestation in advance of crop establishment and control weeds as much as possible through proper land preparation.

Due to its dependence on the rainfall pattern, weed incidence has an uncertain influence on rice crop production. However, it can be argued that it is not a yield risk factor <u>per se</u> since, in principle, it is almost always possible to control weeds. On the other hand, to the extent that farmers do not have sufficient resources at their disposal to adequately control an unexpected severe weed infestation, the potential damage due to weeds may still be considered a risk element. Such risk enters production decisions primarily from the cost side of production rather than from the output side. In case of a severe weed infestation, the amount of labour required to properly weed a field is substantial and often exceeds the labour availability of the individual household. Since weed control costs are stochastic, it will depend on the resource position ('fire-fighting capability') of the household whether it can mobilize the extra investment required to control an unexpected severe weed infestation. Yield risk due to weeds is thus not resource neutral and will differ across household categories.

7.1.4 Pest and disease control

In the usually warm and humid habitat of the rice plant both pest and diseases are considered major risk factors that - if not controlled - may substantially reduce the output of crop production activities. The general problem of rapid pest build-up and spreading of diseases requires timely and adequate control on the part of the farmer. The degree to which farmers can be expected to control pest and disease infestations will depend on their understanding of pests and diseases, their familiarity with control techniques, and the availability of resources for implementing them. On the other hand, the degree to which farmers want to control pest and disease damage will depend on the perceived benefits as well as the possible negative effects associated with the use of control methods (e.g. pesticides). From discussions with farmers it was clear that they were most concerned with damage caused by insect pests. The damage caused by other pests such as birds and rodents was considered minor, at least in recent years. The limited importance farmers attach to damages caused by diseases is likely due to the fact that they do not recognize leaf damage as caused by diseases.

Recognition of insect pests is a requirement to their effective control. Employing an open-ended questionnaire and photographs of pests and pest damage, farmers were asked to indicate what pests they considered important; how the pest was diagnosed in the field; what its effect was on general crop growth; the percentage of damage in terms of yield loss caused by a light, medium, and severe infestation; when and under what conditions the pest normally develops; and methods and timing of pest control. In total eight insect pest species affecting rice crop production were identified by the majority of farmers (Appendix V). Four pest species are considered of minor importance: mole crickets (Gryllotalpa africana), leaf folders (Cnaphalocrocis medinalis), rice caseworm (Nymphula depunctalis), and army-worm (Mythimna separata). They either occur early in the growth cycle of the rice plant so their effect on crop growth can still be remedied or pests that are relatively easy to control with commercial pesticides. Four insect pests are considered of major importance: stemborers (e.g. Scirpophaga incertulas, Tryporyza innotata), brown plant hopper (Nilaparvata lugens), green leaf hopper (Nephotettix spp.), and rice bug (Leptocorisa oratorius). They may either inflict damage throughout the growth cycle of the rice crop or attack during the sensitive grain filling stage of the rice plant. They are generally more difficult to control than the above described early season defoliators.

In contrast with the conclusion reached by the study of Litsinger et al (1978) for a nearby research site, farmers appear to be quite capable of identifying various insect pests (Appendix V). In fact, they recognize the pests which were indicated by the IRRI-cropping system team as being the major pests in the area that need to be controlled. Although, the local nomenclature may lack precise words to distinguish between related insect species such as leafhoppers and planthoppers, on the basis of colour differences farmers identified three different species of planthoppers and distinguished between plant and leafhoppers. Furthermore, farmers appear to have a good apprehension of the development cycle of insects and of the circumstances under which they tend to develop.

Insect control

Methods employed by farmers to control insect pests consist of cultural practices and application of commercial pesticides. Traditional methods of pest control have almost disappeared since the introduction of pesticides in the mid 1960s.

Cultural control methods include early timing of crop establishment in order to be ahead of a serious pest build-up; clean bunds around rice fields (weeds are considered host plants for certain pests); planting of long-maturing rice varieties in between fields planted with short-maturing varieties (and to lesser extent vice versa) is considered dangerous in terms of an increased chance of pest infestation derived from adjacent fields; transplanted BE-3 crops are considered to be more susceptible to brown plant hopper infestation because these insects like to stay in the decayed leaves of the newly transplanted rice seedlings; dense crops are considered to be more susceptible to pest incidence; certain farmers indicated that heavy fertilized rice is more prone to pest damage because 'fertilizer makes the stem soft'. There is no agreement among farmers whether the new varieties are more resistant to pests than the existing varieties. Certain farmers maintain that IR36 is as susceptible or even more susceptible to insect pests as BE-3, despite the alleged pest resistance of the former variety.

For chemical control, farmers generally use sprayable formulations of relatively inexpensive broad-spectrum pesticides such as methyl-parathion and endrin. The majority of farmers does not spray according to a pre-determined schedule, but decide upon the occurrence of the pest whether to spray or not. Although historically, extension with respect to pest control has stressed the importance of fixed spraying calendars, most farmers do not consider such a strategy 'necessary'. They argue: 'Every year is different. Certain years you have to spray a lot and other years you do not (panu igon). But it is very important to always have some cash on hand, so you can buy chemicals if necessary. It can be very dangerous to delay spraying!'.

The decision to spray generally depends on the time of occurrence, the type, and the degree of pest infestation. As indicated above, early season defoliators are not considered to be real threats to final yields ('the crop can recover'), and if an infestation becomes serious, farmers find it easy to control. Even an early infestation of stemborers is considered of minor importance since 'the rice plant can produce new tillers'. However, the closer the crop growth is towards the flowering stage, the more serious farmers become with respect to insect pest control. At this stage, stemborer and brown planthopper infestation are viewed by farmers as serious yield reducing factors. Spraying against these pests has a high priority, 'then it is very important to spray. If I do not have money I borrow it for that purpose. You better use some money meant for fertilizer than not to spray'. Control of rice bugs during the milking stage of rice is considered even more important.

It is difficult to evaluate whether farmers achieve recommended levels. Litsinger et al (1978) found that, although farmers generally followed the recommended amounts of pesticides per sprayer load (bottle cups or table spoons per litre) as stated on the containers, they used far too few sprayer loads on a hectare basis to achieve recommended levels. However, calculations on a per hectare basis may often be erroneous because farmers commonly apply spot treatments or spray only certain 'boxes' of a parcel.

Although farmers will generally not agree with the idea that they use sub-lethal doses of pesticides, attitudes towards the need and level of spraying given a certain pest incidence differ substantially among farmers. There is a minor group of farmers that sprays irrespective of the degree of incidence. One such farmer when asked why he always used such high level of pesticides: 'I really had a good control against pests, but this year there are only few pests. I really cannot stop myself from spraying. If I see insects, I have to spray! I am used to it because of my father. But I observed that one farmer near my parcel only sprayed once during the flowering stage, and it was enough. He had a good yield'. This group of 'heavy users' functions as a kind of early warning antenna for the majority of farmers who do not spray unless there is a serious level of pest incidence: 'This year there is no real pest problem, but still certain guys are spraying a lot, because they are used to it. Like my neighbour, he sprayed like crazy and still had the same yield I had. It was not really necessary to spray a lot'. Finally, there is a third group of farmers which only sprays when other farmers are spraying: 'Farmers on the other fields were spraying too, so I had to spray'.

To evaluate farmers' own feelings with respect to pest damage control, they were asked to assess the expected yield loss (in terms of the number of bags of rice out of twenty) under heavy, medium, and mild pest incidence with and without pest control for the pest complex taken as a whole, as well as the number of years out of ten such infestation would occur. These questions were asked for three different types of rice crops. In contrast with the 'Litsinger survey', farmers at this location indicated that in terms of expected yield loss the first HYV rice crop is more susceptible to pest infestation compared to the second HYV crop (Table 7.1.1). The susceptibility of the long-maturing BE-3 variety is roughly equal to the second HYV crop. The probability of occurrence of an infestation in the first HYV crop is somewhat lower compared to both other types of crops, however, farmers indicated that the effect of such infestation is severer in terms of the expected yield loss. Further, from Table 7.1.1 it also appears that farmers expect a reasonable degree of pest damage control with their present use of insecticides. For all crop

Table 7.1.1 Farmers' assessment of per cent yield reduction due to pest incidence for three levels of pest infestation, with and without insect pest control; all sample farmers

Type of variety	Mean yield reduction	Heavy (a)	Heavy (b)	Medium (a)	Medium (b)	Light (a)	Light (b)
		probability of occurrence of three pest infestation levels (b) and attached % yield reduction (a)					
Without insect pest control							
HYV (1st crop)	26.6 (.27) 1)	45.0 (.24)	23 (.35)	29.0 (.33)	33 (.29)	16.9 (.41)	44 (.29)
HYV (2nd crop)	19.2 (.21)	30.9 (.26)	26 (.33)	19.4 (.31)	38 (.30)	19.7 (.32)	36 (.32)
BE-3	20.1 (.32)	33.4 (.32)	25 (.37)	22.1 (.33)	35 (.32)	12.3 (.36)	40 (.42)
With insect pest control							
HYV (1st crop)	15.3 (.29)	27.5 (.31)	39 2)	16.3 (.32)	44	9.2 (.38)	46
HYV (2nd crop)	10.6 (.21)	17.9 (.28)	42	10.7 (.25)	45	5.4 (.26)	50
BE-3	11.4 (.35)	19.0 (.37)	43	12.1 (.32)	45	6.9 (.42)	44

1) Figures in parentheses are coefficients of variation (25 respondents).
2) Percentage reduction in % yield reduction due to insect pest control.

types, expected yield loss due to pest damage is reduced by over 40% when insecticides are applied. However, it is also clear that most farmers do not perceive full control of pest damage possible. With present pest control practices, farmers still expect a yield loss of over one-fourth of the gross yield of the first HYV crop if this crop is severely pest infested. The expected yield loss over all pest damage states for the same crop type is about 15%, whereas for both the second HYV crop and the BE-3 crop the expected yield loss is about 11%. Most farmers mention that the cost attached to high pest control levels is in excess of the benefits. According to them, the potential benefits of high levels of pest control are too easily nullified by other - non-controllable - environmental factors such as drought at the reproductive growth stage.

From the above it is concluded that, although farmers are quite confident about the level of pest control they can achieve, yield damage due to pests and diseases remains a serious risk factor in rice production. It should be realized that it is very likely that damage due to diseases is confounded with pest damage. Hence, it is possible that part of the above indicated 'non-controllable pest damage' is in fact due to damage caused by diseases. Farmers may (quite rightly) not follow all recommended pest control practices. The majority of farmers does not use pest specific insecticides, whereas only few farmers use prophylactic applications against early infestations of stemborers and case worms. Given the minor importance farmers attach to the yield damage caused by these early season pests, prophylactic applications are in their view not economically attractive. Furthermore, economic thresholds utilized in determining recommended control practices for leaf folders, rice bugs, case worms, and stemborers may not differ very much from the rules-of-thumb presently employed by farmers.

7.1.5 Risk control and crop production planning

Apart from the above risk control measures in crop management, risk control is also an inherent element of the farmers' crop production planning process. This element of risk control is a built-in characteristic of the two principal ways by which farmers simplify the crop production planning problem. First, they usually do not drastically alter farm plans from one year to the next. Second, they break up the planning of crop activities in a number of consecutive stages that are solved sequentially.

Clearly, cropping strategies and farm plans followed by farmers are the result of a long process of experimentation and adaptation carried out by farmer himself or based on the experience of predecessors. These patterns have proven to be viable given the local climatic and socio-economic circumstances as well as the resource endowments of individual households. Thus, the attitude of most farmers is to be cautious in changing existing cropping strategies. As will be discussed in the next sections, changes in cropping strategies are the result of a gradual insertion of new crop activities. In this process farmers assess how such new activities fit in with the existing cropping system. The pressure to change farm plans may result from changes in the decision making environment (e.g. prices, new technology, changes in the behaviour of other farmers) or from internal pressures within the household, e.g. due to changes in the resource base or expenditure requirements.

Another feature of farmers' plans is that they are expressed in terms of a conditional 'if'. When asked, farmers readily present their plans for the coming season, however, with the usual remark 'if the weather permits'. When subsequently asked what kind of alternatives they consider when the weather does not allow the implementation of the plan, they clearly have in mind what kind of alternative crops or cropping patterns to follow (fall-back strategies). As will be discussed below, for this village the initial onset pattern of rainfall critically determines the sequence of crop establishment and subsequently management throughout the season. Due to a late onset of the growing season planned crop production activities may not be feasible, thus requiring the farmer to completely change his farm plan.

Farmers' planning is neither based on some sort of average rainfall pattern nor on rainfall conditions that occur most frequently. Instead, they take into account various possibilities regarding the onset and termination of the rainfall season. Thus, farmers plan in terms of cropping strategies based on possible rainfall scenarios rather than in terms of fixed cropping patterns based on an average rainfall pattern. Such strategies include options how and where to start and what to do if a certain situation develops during the initial phase of the growing season. In formulating strategies, farmers concentrate on those decisions that are 'nearby', i.e., what crops to plant first, where to start ploughing, how much fertilizer is required for the first few months (i.e. until the next rice/dagmay harvest), but also taking into account possible crop options and management problems during the mid and the end of the monsoon season: the possibility of second rice crop establishment, planting of mungbeans or cowpea after BE-3 in December or early post-monsoon upland crops in lowland areas following rice (e.g. squash). In the actual management and adaptation of farm plans, farmers often make use of rules-of-thumb based on past experience such as cut-off dates for crop plantings, field priority for crop establishment in relation to water availability, fertilizer levels, etc. In the case of new production activities, farmers gradually tend to develop such rules-of-thumb through experimentation (Section 7.3).

7.2 Double rice cropping: Profitability and riskiness

The potential for crop intensification in rainfed wetland areas through double rice cropping is determined by rainfall and the position of fields in the toposequence. The normal rainfall distribution in the study area is marginal for double-cropping of rainfed rice. However, due to surface and sub-surface moisture enrichment standing water in relatively low-lying fields often extends substantially into the dry season. To reduce the risk of second crop failure, an early establishment of the first rice crop is required.

As indicated by the farmers' assessment of water availability for the various land units (1) (Figure 7.2.1), the potential for double rice cropping using direct seeded rice in dry soil conditions is particularly relevant for fields that lie in between the highest and lowest landscape positions. For sideslopes with good internal and surface drainage, a single rice crop can be grown in most years, either preceded by a dryland crop (usually maize) or followed by a dryland crop (e.g. squash, tomatoes). However, for sideslope fields without a supplementary source of water, growing conditions for rice are marginal and it is not uncommon to grow dryland crops instead of rice (dagmay). For partially irrigated areas, moisture conditions are such that double cropping with wet seeded rice crops is possible in almost all years.

The assessment of the feasibility and performance of double rice cropping patterns is complicated due to the year-to-year variation in rainfall pattern and associated risk factors. Since the

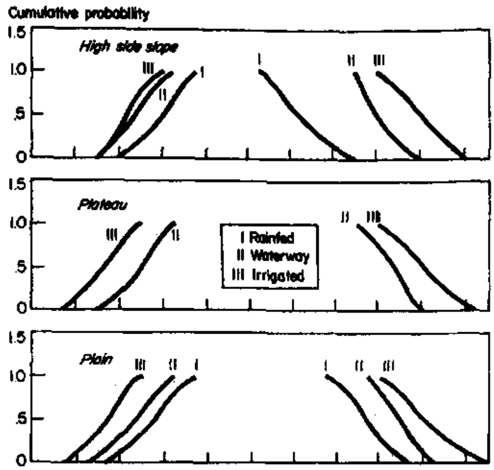


Fig. 7.2.1 Farmers' assessment of water availability in lowland fields, expressed in terms of the cumulative probability of fields being flooded (Week 1 = 1-7 Jan.)

'dry seeded - wet seeded rice' (DSR-WSR) pattern requires a favourable rainfall pattern, i.e. early onset and late decline of the growing season, it may frequently occur that a DSR-WSR pattern cannot be executed. In such a case, farmers change to different crops and different cropping patterns. In determining the profitability and riskiness of double rice cropping (and as a matter of fact for most other cropping strategies) such adaptation of initial plans based on actual rainfall conditions should be taken into account. In fact, omission of the possibility of cropping plan adaptation may result in a grave overestimation of the riskiness and underestimation of the profitability of double rice cropping.

In order to assess the performance of cropping patterns taking into account rainfall variability, the following steps have to be taken. First, it has to be established what kind of alternative crop options farmers may follow when a planned pattern cannot be executed, either because rainfall conditions do not allow the establishment of the first crop of such pattern or because the first crop fails at an early growth stage. Second, the likelihood that the planned pattern will be successfully executed has to be determined as well as the likelihood of successful alternative patterns, in case the intended pattern can not be realized. Third, an assessment must be made of the level and variability of cost and returns of individual crops within these patterns. Fourth, based on the likelihood of occurrence of the various cropping patterns and their economic returns, the profitability of the cropping strategy must be determined relative to the profitability of alternative strategies for the landscape. Fifth, the 'fit' of the cropping pattern in the cropping system has to be analyzed on the basis of its competing requirements for land, labour and cash vis a vis the returns that can be expected relative to the returns of alternative patterns.

7.2.1 Cropping pattern strategies

The various types of rice-based cropping strategies considered by farmers for the crop season of 1979-80 are shown in Figure 7.2.2. First crop options for lowland fields include dry seeded HYV or BE-3 rice crops; the establishment of corn crops; continue with a standing dry season crop; or wait for rainfall that allows the establishment of wet seeded or transplanted rice. If early rainfall conditions are insufficient for dry seeded rice or corn, farmers may switch to an early establishment of wet seeded HYV rice crops in June in case of early ponding of water or may have

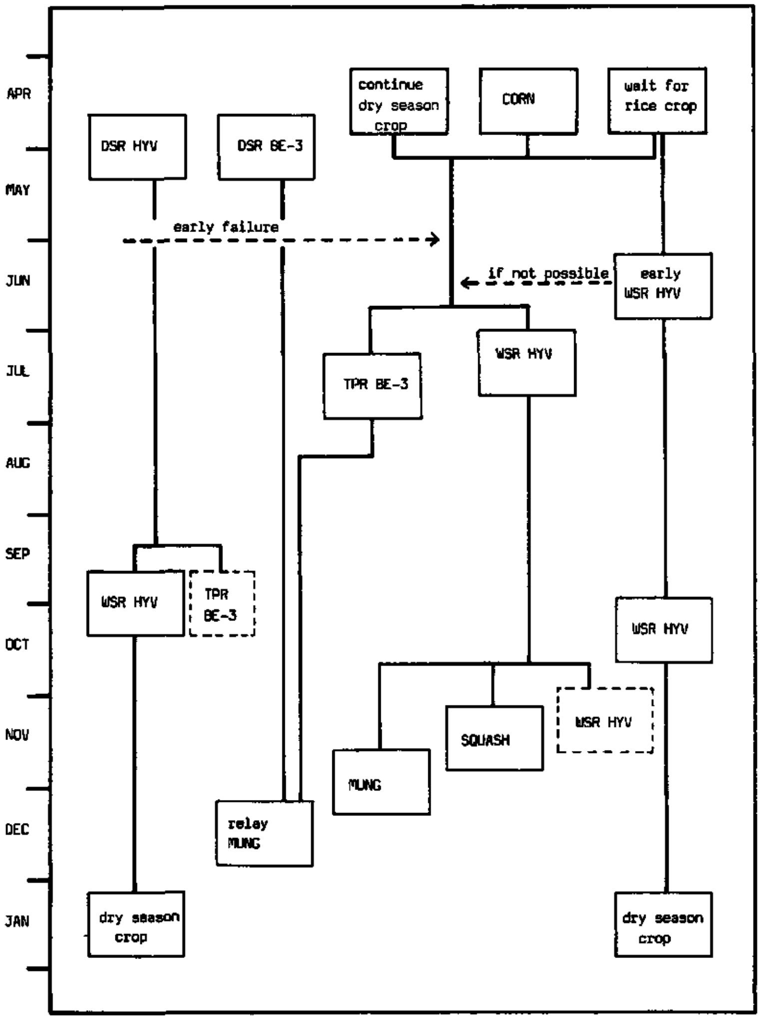


Figure 7.2.2 Rice-based cropping patterns

to wait with crop establishment until July. Farmers planning to have a dry seeded BE-3 rice crop may switch to transplanted BE-3, provided they have enough money to finance the transplanting operation. In case such financial means are not available, farmers may be forced to establish a wet seeded BE-3 or wet seeded HYV rice crop.

Both dry seeded and early wet seeded HYV crops can usually be followed by a second wet seeded or transplanted HYV crop as well as by a transplanted BE-3 crop. As it turned out in the course of the 1979-80 season, even the relatively late wet seeded HYV crops (established at the beginning of July) were still followed by a late establishment of a second rice crop. However, for 1979, such late second crop planting was certainly not considered an option in the cropping plans of farmers. The usual crop options following medium or late wet seeded HYV are crops such as squash or mung. For BE-3 crops, options after the harvesting of these crops in December include mung or cowpea (or a mixture of these two crops) relayed into the rice stubble.

In order to reduce the effect of rainfall-related crop establishment risks, farmers employ various cut-off dates before and/or after which the establishment of the crop becomes too risky. From an interview held in September 1979, it appeared that these cut-off dates are rather well defined. Farmers showed a a high degree of concensus concerning these dates, although some minor variations across land units occurred. The cut-off date for a <u>palay-ang</u> rice seeding or corn crop establisment is considered to be the end of April or the first week of May. Planting after that date is thought to be too risky because the chance of heavy rainfall in May, damaging the ungerminated seeds, is considered too high. The cut-off date, or rather the planting window for <u>samara</u> seedings is from the first week of May until the end of the month, but preferably before the third week of May. <u>Samara</u> rice seedings before that date are considered too risky due to the possibility of a dry period after the pre-germinated seeds have emerged. Seedings after the end of May are too risky because of the possibility of heavy rainfall causing ponding and submergence of the emerged rice seedlings. Thus farmers perceive a very narrow planting window for <u>samara</u> seedings. Also for second rice crop seedings, farmers largely agree about the final date before such seedings should take place. For the somewhat drier land units 'plateau rainfed' and 'plain rainfed' (Section 5.3), the final establishment date is considered to be mid-October. For the land units 'plateau waterway' and 'plain waterway', second rice crop establisment is still considered possible until the end of October. The seeding window for mung crop establishment following a wet seeded HYV crop on fields with adequate drainage is from late October until the third week of November. The latest date for seeding mung or cowpea after BE-3 is considered to be from the third week of December until the end of that month.

Except for second rice crops, the pattern of crop establishment for the crop season of 1979-80, was in close conformity with these cut-off dates. In fact, farmers who did not plant corn or dry seeded rice, used these cut-off dates (among other things) to explain that they were too late in preparing their fields to safely establish these crops. However, as became apparent from planting decisions made by farmers in 1980 and 1981 (Section 7.3), cut-off dates are not as rigid as the term implies. They are generally used as reference dates before or after which crops can be relatively safely planted, whereas perceived risk of poor crop development or crop failure increases the later or earlier the crop is planted. Moreover, cut-off dates change as farmers gain more experience with a new type of technology. For example, initial cut-off dates for dry seeded HYV crops were based on the farmers' experience with dry seeded BE-3. These cut-off dates turned out to be rather conservative. In the absence of a second rice crop possibility, there was no real pressure with BE-3 to establish the crop as early as possible.

7.2.2 Cropping strategy performance

What cropping pattern will be realized in any particular season depends on the rainfall pattern in that season as well as on the first crop farmers are planning and able to establish. To assess the performance of the above cropping strategies in terms of the likelihood that the planned pattern can be realized or that a switch has to be made to an alternative pattern, the influence of variations in the rainfall pattern on cropping pattern feasibility needs to be analyzed. A water balance/cropping pattern simulation model (Bolton and Zandstra, 1980) was used to mimic the variability in the onset and termination of the rainfall season, employing a time-series (16 years) of actual rainfall data from a nearby rainfall station. For the various land units, this model allows an assessment of whether rainfall and/or soil moisture conditions are sufficient for land preparation and establishment of the first and second rice crops as well as corn and mungbean crops. It determines the emergence date of dry seeded rice crops and generates data on the incidence of drought stress or premature flooding of established crops. The simulation model also includes the various cut-off dates for crop establishment as indicated by farmers as well as a yield prediction routine for second rice crops based on the incidence of water stress (Bolton, 1980).

The results of the cropping pattern simulation model for testing the technical feasibility of a DSR-WSR pattern for the land units 'plateau rainfed' and 'plain rainfed' are presented in Table 7.2.1. The planned DSR-WSR pattern is realized on the plain and plateau fields, in 31% and 44% of the years respectively. On both land units, the establishment of dry seeded HYV crops is possible in roughly three years out of four. However, because of a more rapid water accumulation in plain fields, dry seeded rice crops often fail due to flooding of the field before seed germination. For the plain fields, more than half of the dry seeded crops fail due to early drought or premature flooding of the field. For the

Table 7.2.1 Simulation of the performance of the cropping pattern strategy DSR-WSR; 16 years rainfall (0.20 ha plot)

	Plain	Plateau
	Patterns realized (%)	
DSR	6	6
WSR - Mungbean	25	31
Total single rice	31	37
DSR - WSR	31	44
WSR - WSR	37	18
Total double rice	68	62
	Pattern failures (%)	
DSR early failures	40	20
2nd crop failures	36	50
Successful double rice cropping	44	31

plateau fields, the risk of early crop failure is substantially less, with crop failures in two years out of seven. Hence, for plain fields wet seeding often replaces dry seeding, in such a way that a 'wet seeded - wet seeded rice' (WSR-WSR) pattern is realized in 37% of the years. A double rice cropping pattern, irrespective of the planting method, is planted in more than 60% of the years on both land units.

However, the simulation model predicts a substantial number of second crop failures. For the plain fields roughly one-third of the second rice crops has yields less than 300 kg per hectare, whereas for the plateau fields half the number of second crops failed. Because of their late planting date, these failures particularly occur for second crops that are preceded by a wet seeded crop. When these second crop failures are subtracted from the total number of double rice crops, the model predicts successful double rice cropping in 44% and 31% of the years for the plain and plateau fields, respectively.

The technical feasibility of the alternative cropping pattern strategy 'corn - wet seeded rice → mungbean' is presented in Table 7.2.2. This strategy includes the possibility to switch to a second rice crop planting (instead of mungbean) in case such is feasible. In both plain and plateau fields, early season corn plantings occurs in 25% of the years. For a similar number of years, the planned pattern is realized for the plateau position, whereas for the plain fields this occurs in 19% of the years. The percentage of double rice crops realized with this cropping strategy is substantially below that of the above discussed pattern with dry seeded rice as first crop option. For the plain position, a double rice cropping pattern occurs in 44% of the years, which is about one-third less compared to double rice crops realized with dry seeded rice as first crop option. For the drier

Table 7.2.2 Simulation of the performance of the cropping pattern strategy Corn-WSR-Mung; 16 years rainfall (0.20 ha plot)

	Plain	Plateau
	Patterns realized (%)	
WSR	6	6
WSR - Mungbean	31	38
Corn - WSR - Mungbean	19	25
Total single rice	56	69
Corn - WSR - WSR	6	
WSR - WSR	38	31
Total double rice	44	31
	Pattern failures (%)	
Corn early failures	25	19
Second crop failures	43	40
Mungbean failures	25	12
Successful double rice cropping	25	19

plateau position, the number of double rice crops with corn as first option is half of that with dry seeded rice as a first crop option. Successful double rice cropping (i.e., after subtracting the second crop failures) occurs in 25% and 19% of the years for the plain and plateau fields, respectively.

From the above, it can be concluded that having a dry seeded HYV as first crop planting option substantially increases the chance of a successful double rice crop compared to having corn as a first crop option. For rainfed plain fields, the model predicts an increase in successful double rice crops from 22% to 44%, whereas for rainfed plateau fields, the chance of a successful double rice crops increases from 19% to 31%.

7.2.3 Economic returns to cropping strategies

Based on the cost and returns of individual crops within cropping patterns and given the chance of occurrence of each of the various cropping patterns associated with following a certain cropping strategy, it is now possible to determine the economic returns to cropping strategies. The profitability of the various cropping strategies will be assessed in terms of the gross margin to family factors. That is, all paid-out cost are subtracted from the gross return, except for the landrent payment. Further, since the main question is whether double rice cropping allows a remunerative absorption of family labour, it is assumed that all crop operations are carried out by family labour, except for those operations that require a high labour input in a short period (transplanting and harvesting). In aggregating the cost and returns of individual crops for each of the occurring cropping patterns, possible carry-over effects between crops must be taken into account, e.g. land preparation for the first rice crop is highly reduced if such crop is preceded by a corn crop or a failed dry seeded rice crop. Further, to the extent that inputs incurred with failed crops cannot be considered beneficial as inputs for the succeeding crop (e.g. seeds, labour for crop establishment), the cost of these inputs must be included in the total cost of the cropping strategy.

Table 7.2.3 presents the level of paid-out cost and the gross margin to family factors per hectare as well as per labour hour for individual crops and cropping patterns. The presentation of data is restricted to the rainfed plain position. Apart from the two cropping strategies discussed above, also the cost and return of the two BE-3 based rice cropping patterns are included. The gross return figures for rice crops are derived from a fertilizer response function and yield simulation study which are discussed in detail in Chapter 8. They represent gross return levels for normal fertilizer inputs. The gross return estimates for the non-rice crops are based on crop production data obtained during the three year period of 1978-1980. Also the labour input and material cost figures are based on the 1978-80 production data. For the labour input, a distinction is made between labour supplied by the household and hired labour. The hired labour input is limited to the transplanting and harvesting of rice. Power cost includes the payment of mechanical rice threshing. The material input figures

Table 7.2.3 Cost and return of individual crop activities, cropping patterns, and cropping strategies; rainfed plain fields

	Gross return ($)	Family labour input (hrs)	Hired labour cost ($)	Power cost ($)	Material input cost ($)	Total cost ($)	Gross margin to family factors ha ($)	hr ($cts)
Individual crops								
DSR HYV	450	335	50	25	53	128	322	0.96
WSR HYV (1st)	450	266	50	25	51	126	324	1.22
WSR HYV (2nd) 1)	310	168	34	17	45	96	214	1.27
WSR HYV (2nd) 2)	183	168	24	12	35	71	112	0.67
DSR BE-3	423	350	47	23	42	112	311	0.89
TPR BE-3	423	215	87	23	40	150	273	1.27
Corn	58	115			1	1	57	0.50
Mungbean	49	78			13	13	36	0.46
Patterns								
DSR(HYV)-WSR(HYV)	760	503	84	42	98	224	536	1.07
WSR(HYV)-WSR(HYV)	633	434	74	37	86	197	436	1.01
Corn-WSR(HYV)-Mungbean	557	459	50	25	65	140	417	0.91
WSR(HYV)-Mungbean	499	344	50	25	64	139	360	1.05
Corn-TPR(BE-3)-Mungbean	530	408	87	23	54	164	366	0.90
DSR(BE-3)-Mungbean	472	428	47	23	55	125	347	0.81
Strategies								
DSR(HYV)-WSR(HYV)	629	476	70	35	92	197	431	0.91
Corn-WSR(HYV)-Mungbean	567	414	62	31	73	165	402	0.97
Corn-WSR(HYV)-Mungbean 3)	510	381	51	25	63	139	372	0.98

1) Second WSR crop following DSR as first crop.
2) Second WSR crop following WSR as first crop.
3) Without option to establish a second WSR crop instead of mungbean.

represent averages for the three year period and include seeds, fertilizers, pesticides and herbicides.

The first part of Table 7.2.3 shows the cost and return of rice crop activities and of the two major upland crops that either precede (corn) or follow rice crops (mungbean). The indicated yield level for dry seeded and first wet seeded HYV crops assumes normal crop growth development and a good level of weed control. In calculating the cost and return of cropping strategies, it is assumed that an early failure of dry seeded HYV will be replaced by a wet seeded crop. Except for the higher labour input for weeding, other input factors for dry seeded HYV are assumed to be similar to wet seeded crops. In computing the cost and return of second HYV crops, a distinction is made between second rice crops following dry seeded rice and second crops following wet seeded rice. The former can be established, on average, one month earlier, thus experiencing a much lower risk of drought stress during the reproductive growth stage (Chapter 8) and, consequently, shows a higher gross return level. The gross return levels of BE-3 crops are very similar to those of the HYV crops. At normal fertilizer dosages the BE-3 crops yield somewhat lower than the HYV crops, but the market price for BE-3 is somewhat higher. The labour input for dry seeded BE-3 is roughly similar to the labour input required for dry seeded HYV. Although BE-3 stays in the field for a much longer period, the presence of standing water and the height of the plant are usually sufficient to control weeds at the later growth stage of the plant. Transplanted BE-3 has the lowest family labour input requirement. Similar to dry seeded BE-3, the weed control cost is low and transplanting is assumed to be carried out by hired labourers.

The second part of Table 7.2.3 shows the cost and return of cropping patterns employing a simple aggregation of costs and returns of individual crops. Of these cropping patterns, the DSR-WSR pattern is the most attractive both in terms of the returns to family factors per hectare and per labour hour. Compared to the alternative HYV pattern 'corn - wet seeded rice - mungbean', the gross margin to family factors per hectare of the DSR-WSR pattern is about 30% higher. The incremental return per labour hour of this pattern relative to the 'corn - wet seeded rice - mungbean' pattern is above the ongoing wage rate. This implies that the DSR-WSR pattern is economically attractive both for households with ample family labour resources that attempt to maximize output per unit of land and for households with limited labour resources that attempt to maximize output per labour hour. The BE-3 based cropping patterns are clearly the least profitable. However, the returns per labour hour of the transplanted BE-3 pattern are similar to those of the HYV patterns.

The differences between these cropping pattern activities become much less pronounced when the chance is considered that such patterns may actually be realized as well as take into account possible switches to other patterns in case such is not possible.

In the third part of Table 7.2.3, the costs and returns of cropping strategies are presented based on the probability weighted mean of the costs and returns of the various cropping patterns realized through these strategies. From these calculations, it can be concluded that it does not make much difference in returns per hectare and per labour hour whether the DSR-WSR strategy is followed or the alternative 'corn - wet seeded rice - mungbean' strategy, in case the latter allows the planting of second rice crops when such is possible. Even compared to a 'corn - wet seeded rice - mungbean' strategy that does not consider second rice crop plantings, the benefits of the DSR-WSR pattern are much less pronounced.

Of course, the question arises whether statistical means of outcomes of strategies, that consider the outcomes of activities in the long term, have any meaning within the context of farmers' decision making. Based on the evidence concerning the adoption of the DSR-WSR cropping pattern presented in Section 7.3, it appears that cropping choices of farmers are guided by relatively simple economic return calculations such as presented in the second part of Table 7.2.3, whereas in assessing the risk attached to such cropping patterns they think in terms of the above cropping strategies. The implication is that farmers have a rather positive assessment of the benefits of cropping pattern activities and perceive a much lower return risk as strict adherence to one particular cropping pattern would indicate.

7.2.4 Cropping strategy risk

Risk in terms of the output variability of cropping strategies results from two different sources. The first source comprises the variability due to the occurrence of the different crops or cropping patterns actually realized caused by differences in the year-to-year rainfall pattern. The second source comprises the output variability of individual crops in the cropping pattern.

Based on the above information regarding the performance of the cropping strategy, it is straightforward to determine the variability caused by the occurrence of different cropping patterns resulting from variations in the rainfall pattern. The real problem lies in determining the output variability of individual crops within cropping patterns. This is due to difficulties in assessing (1) the incidence of the earlier discussed risk factors affecting crop growth (e.g. weed incidence, pest infestation), and (2) whether such risk factors actually adversely affect crop growth. As was discussed in Section 7.1, final yield risk is the result of a great number of individual risk factors that occur at different stages of the growth cycle of the crop and that may or may not be controlled by farmers. By intervening in the production process, farmers will attempt to reduce the effect of these factors on crop growth as they occur in the course of the growth cycle of the crop. Final return risk of individual crop activities will thus be a function of the influence of uncontrollable risk factors such as drought stress during seedling stage and risk factors that are potentially under the control of farmers but for some reason cannot be controlled, e.g. due to labour constraints. Controllable risk factors, such as weed incidence, essentially cause uncertainty with respect to the anticipated cost of production.

In Chapter 8, the various methods to quantitatively assess crop activity risk will be discussed. Regarding the risk of cropping pattern strategies, the analysis will be confined to a qualitative assessment. Based on the various aspects of DSR-WSR rice cropping considered above, the main risks attached to this pattern as compared to single HYV cropping can be descriptively summarized as follows: First, due to an early failure of dry seeded rice, the farmer faces the loss of seeds and labour investements. The risk of seed loss ($25/ha) may loom large especially for non-surplus households having insufficient seed stocks and rice for consumption. The risk of a loss of labour investments ($38/ha) is particularly relevant to households that have to hire labour for crop establishment. Second, excessive weed growth in dry seeded rice may require a heavy labour input for weeding and possibly replanting. Farmers with insufficient labour may have to plough the crop and incur the same losses as discussed above. Third, farmers may not be able or otherwise may get seriously delayed in the establishment of the second rice crop in case of low family labour availability combined with a tight wage labour market. Fourth, because seeding of the second rice crop occurs at the height of the rainy season, farmers may face the risk of seed or seedling loss due to uncontrolled flash floods washing out newly seeded fields. Fifth, depending on the seeding date, farmers face a substantial risk of second crop failure due to drought stress during the reproductive growth stage. The loss incurred is much higher compared to an early failure of dry seeded rice. Apart from the labour investment ($50/ha) and seeds ($18/ha), farmers also lose the fertilizer investment ($30/ha). Again, risking the labour investment is particularly serious for farmers who have to hire labour for crop establishment.

A possible way of reducing yield risk of second crops is to use transplanting as an establishment technique rather than wet seeding. When the seedbed is prepared well in advance of the planting date of the second crop, transplanted crops may have a headstart of about 2 - 3 weeks over wet seeded crops. This clearly reduces the risk of crop failure due to late drought stress. Moreover, it is not necessary to drain the field completely as is the case with wet seeded crops. Thus, apart from the other agronomic advantages associated with transplanted rice crops (Section 7.1), the 'dry seeded - transplanted rice' (DSR-TPR) cropping pattern has a substantial higher chance of success than the DSR-WSR pattern (Bolton, 1980).

However, as will be shown in the next section, the DSR-TPR pattern is not adopted for the following reasons. First, transplanting a second crop is no guarantee for early crop establishment. Because of the possibility of a dry spell following the harvest of the first crop, land preparation and crop establishment may get delayed, possibly resulting in overgrown rice seedlings in the seedbed. In the worst case, after seedbed establishment, it may not be possible to establish a second rice crop at all. Second, and probably more important, because of the restricted wage labour market in the village, it can be a serious problem to find hired labour for transplanting. At the time labour is required for this operation, other and better paying wage labour activities are competing for labour, such as rice harvesting, land preparation for the second crop, and hauling of rice from far-away fields. Again this may cause a delay in crop establishment. Third, transplanting involves a high investment early in the growth cycle of the rice crop, whereas the returns on this investment are highly uncertain. Thus, the combined effect of high initial investment cost associated with transplanting (including the time required in organizing a hired labour group) and the possibility that transplanting may get seriously delayed, essentially makes the transplanting of second rice crops a high risk venture in terms of net returns to family factors.

7.2.5 Cropping strategy fit

The final step in evaluating the attractiveness of double rice cropping should concern the 'fit' of the cropping pattern in the overall cropping system. The degree of 'fit' of a strategy considers its competing requirements for land, labour and cash *vis a vis* the returns that can be expected relative to the resource requirements and returns of alternative strategies. For example, such analysis takes into account the opportunity cost of family labour determined by the benefits foregone when labour is used in alternative activities. Such analysis should also consider the opportunity cost of cash affecting both input prices and the perceived benefits of activities. For example, for poor households the perceived benefits of an early corn crop harvested during the lean period may lie substantially above the market price. Corn substitutes rice that otherwise has to be borrowed at the local credit market against a steep interest rate.

A standard technique usually employed in economics to analyze such problems is linear programming. This technique allows a quantitative assessment of the importance of constraints (e.g. resource limitations) in limiting the feasibility of activities and thus the output derived from the production system. In the usual application of this technique to choice problems involving risky activities, resource constraints as well as input requirements are considered fixed, i.e., there levels are predetermined. Risk is usually confined to activity returns. The non-stochastic character of the linear programming model is thus largely retained. Such models are inadequate to analyze the cropping strategy fit in the overall cropping system because both the resource constraints and input requirements of such strategies land and labour resources can be used effectively depends on the uncertain onset and decline of the growing season, whereas labour requirements for replanting or weeding depend on the early season rainfall. In turn, cropping strategies interact with uncertain resource constraints and input requirements of other cropping strategies. When we further add to the choice problem the uncertainty with respect to the availability of wage labour opportunties, credit availability, etc., it will be clear - without going into further detail - that such analysis becomes very tenuous, data demanding as well as time consuming and at best may provide a reasonable approximation to real production circumstances. Although economic choice models exist that take into account some of the above indicated uncertainties, these models are difficult to apply in actual practice. More importantly, it is questionable whether the results from such an exercise are of any use to farmers or, otherwise, can help to explain farmers' behaviour. This point will be taken up again in Chapter 9.

7.3 Process and pattern of double rice cropping introduction

Based on the above type of analysis - which considers long-run expected cost and returns of cropping pattern strategies - to many outsiders the DSR-WSR double rice cropping technology would seem to be too risky from a production point of view: the first crop faces a severe risk of failure due to drought during the beginning of the growth cycle, whereas the second crop faces a severe drought risk during the latter part of the growth cycle. When these risks are considered within the context of the relatively low additional returns that can be expected from this pattern in the long-run, it would *a priori* not have appeared a viable alternative to existing patterns. It is thus rather surprising that farmers themselves started to experiment with this technology.

Below, the process by which double rice cropping was introduced and gradually adopted by farmers will be analyzed. The adoption situation differs from the usual situation. The innovation was not introduced from outside the village by an extension service or other organization, but was developed from within the farmers' community, without any substantial support or pressure from outside. A number of valuable lessons can be learned from studying this adoption process, particularly regarding the manner in which farmers gradually change farm plans and deal with innovation risk. Thus, before discussing what categories of households adopted double rice cropping, a brief chronological account will be given of the adoption process during the period of 1978 until 1982. In describing this process, a distinction will be made between, on the one hand, the kind of cropping patterns farmers were planning to implement and, on the other, the cropping patterns they actually realized (2). For the 1978-79 cropping season, information about farmers' crop production planning is lacking, thus only actual management patterns are discussed.

7.3.1 Farmers' experiences with dry seeded rice and double rice cropping

The first attempt to dry seeding an HYV crop occurred in 1977 with the IR30 rice variety. The experiment was undertaken by a farmer (a respected opinion leader) on a partially irrigated sideslope area where he usually cultivated dry seeded *Camoros*. This non-photosensitive reddish grain variety has a growth duration of about 4 months. Farmers' previous attempts to grow a second transplanted HYV crop after a dry seeded *Camoros* failed because of its late planting date. The *palay-ang* IR30 crop proved to be successful. However, the second crop, a transplanted IR36 was a failure because of very poor post-monsoon rainfall conditions.

Rice crop management 1978-79

Apparently, based on the favourable experience with dry seeded HYV in 1977, a few other farmers started experimenting with dry seeding HYVs in 1978. The early onset of the pre-monsoon rainfall facilitated the establishment of dry seeded crops. Of the five farmers, two established dry seeded IR30 (of which one had a portion mixed with IR29) and three farmers established dry seeded IR36. These dry seeded HYV crops occurred on relatively small areas covering about 5% of the total rice area of the sample farmers. All farmers had obtained experience with double rice cropping in previous years. Four of them belonged to the middle-aged household category, two of whom to the non-surplus and two to the surplus households. One farmer belonged to the old household category. The results obtained with the dry seeded HYV crops were mixed, depending mainly upon the level of weed infestation and weed control. Yields per hectare ranged from 0.9 tons/ha to 4.1 tons/ha. Average yields were in the order of 2.3 tons/ha, a level well below the average yields obtained with wet seeded HYV crops.

The rainfall pattern in 1978 also favoured the establishment of second rice crops. More than half of the sample farmers (63%) established a second rice crop covering 19% of the total rice area, of which 25% was preceded by a dry seeded HYV crop. In this year farmers were still in the process of finding the best type of crop establishment technique and rice variety as was indicated by the diversity in the types of double rice cropping patterns and rice varieties used. As it turned out in the next season, this year essentially marks the final stage in the transition from double rice cropping patterns based on transplanted rice as second crop to patterns based on direct seeded crops. This year also marks the oncoming dominancy of IR36. Apart from the DSR-WSR pattern covering 19% of the double rice crop area, the largest area of double HYV rice crops consisted of a wet seeded - wet seeded rice' (WSR-WSR) pattern (54%), still including such rice varieties as IR26, IR30, IR1561, and IR29. Other double HYV rice cropping patterns were composed of 'transplanted - wet seeded rice' (TPR-WSR) (12%) and 'dry seeded - transplanted rice'

(DSR-TPR) (6%). Two double rice cropping patterns were observed to have transplanted BE-3 as the second crop, i.e., WSR-TPR (8%); TPR-TPR (10%). The post-monsoon rainfall was not particularly favourable for crop development. A number of late planted rice crops failed due to drought stress. The average yield of second crops following dry seeded rice was 2.3 tons/ha, ranging from 1.8 tons/ha to 2.6 tons/ha. Second crops following wet seeded or transplanted rice crops had a substantial lower yield of 1.2 tons/ha on average.

Rice crop planning 1979-80

The area planned to be double cropped with a DSR-WSR pattern increased substantially for 1979 compared to the actual area planted to this pattern in 1978. The area roughly tripled covering 13% of the total rice area, whereas the percentage of farmers planning to have DSR-WSR increased from 17% to 33% (Table 7.3.1).

Management 1979-80

The crop season of 1979-80 experienced excellent initial conditions for the establishment of dry seeded crops. Rainfall in April was sufficient to allow a first ploughing of fields (bungak) not yet ploughed in the dry-season. Weed seeds could germinate and rainfall in mid-May allowed for a second ploughing after which the fields were dry seeded in slightly moist conditions (samara seeding). Because the rainfall pattern facilitated a bungak ploughing in April, after which farmers could assess the weed infestaton in their fields, a substantial number of farmers that had not planned to have dry seeded HYV still decided to establish

Table 7.3.1 Planned and realized double rice cropping patterns as percentage of total rice area and total number of sample farmers (in parentheses)

	1978	1979	1980	1981	1982
DSR - WSR					
planned		12.8 (33)	13.7 (38)	23.9 (61)	26.2 (61)
realized 1)	3.5 (17)	10.6 (42)	13.4 (42)	20.4 (48)	
DSR - TPR					
planned					
realized	1.1 (8)	1.4 (4)		1.8 (9)	
WSR - WSR					
planned		15.2 (42)	24.0 (67)	22.6 (61)	21.8 (57)
realized	8.6 (29)	8.9 (29)	25.0 (79)	23.6 (61)	
Other					
planned		3.6 (13)	0.1 (8)	1.2 (9)	
realized	5.8 (21)	0.1 (4)	2.7 (13)	2.2 (9)	
Total					
planned		31.6 (75)	38.5 (83)	47.6 (87)	48.0 (87)
realized	19.0 (63)	21.3 (63)	41.1 (79)	48.0 (83)	

1) Realized patterns exclude early failed dry seeded rice crops, but include failed second rice crops.

this crop, whereas a number of other farmers decided not to establish a dry seeded HYV crop because of anticipated weed problems. The percentage of farmers actually establishing a dry seeded HYV crop increased from 21% in 1978 to
69% (!) in 1979, whereas the area roughly quadrupled, covering - two years after the first farmer started with dry seeded HYV cropping - 17% of the total rice area. It is interesting to note that during this year farmers attempted to intercrop corn with dry seeded rice based on their experience with the existing intercrop of dry seeded Camoros and corn. The effort, however, was not successful and not repeated during the study period.

Rainfall conditions after seeding did not favour crop development. The germination rains were not enough to sufficiently penetrate the soil resulting in poor and incomplete germination. After the seeds had germinated, a dry spell of about 3 weeks almost killed the young rice seedlings. The drought problem was aggravated by a severe attack of mole crickets. Because of these two problems, a large part of the planted rice crops failed. Roughly one-third of the area planted to dry seeded HYV area failed and had to be entirely re-seeded, effecting 46% of the farmers. Of the remaining area, a substantial number of crops was heavily infested with weeds requiring in part pulling of seedlings after which the field had to be ploughed again and subsequently replanted. Households with insufficient labour to weed the DSR crops had problems in finding wage labourers. The surviving dry seeded HYV crops recovered fairly well. If anything, it showed the drought tolerance of this rice variety which turned out to be at least as good as that of the BE-3 variety.

Due to the uneven germination of the rice crop, farmers encountered a new problem with dry seeded HYV crops: uneven maturity and staggered harvests. Because of the dry spell in May, after part of the seeds germinated, rice plants in one and the same field differed 3 weeks in maturity, causing severe problems with harvesting. Some farmers had to use the old fingerblade knife for panicle harvesting, whereas others employed spot harvesting. Because of the photo-sensitivity of BE-3, the problem of uneven maturity following uneven germination does not occur in this crop. Uneven germination was due to the rather rough way of seedbed preparation, simply using ploughs as usually employed with BE-3 crops, causing seeds to be positioned at different depths in the soil and leaving large soil clods preventing the light rains to penetrate underneath. Based on this experience, farmers started to employ a better type of seedbed preparation the following year, consisting of two ploughings followed by a harrowing. The average yield of harvested dry seeded HYV crops was around 2.3 tons/ha, ranging from 1.0 tons/ha to 3.3 tons/ha. Poor yields were especially due to non-controlled weed infestations resulting from non-availability of labour to carry out the weeding operations, whereas good yields were obtained with crops that were pulled and replanted.

After the harvest of the first rice crop (for most farmers in the second week of September), soil moisture conditions did not allow land preparation for the second crop. Utterly frustrated, farmers had to wait until the first week of October before they could start ploughing their fields. The first farmer harvesting dry seeded rice had to wait one month after the harvest of the first crop before he could start preparing the land for the second crop. Obviously, due to this dry period, the benefit of advancing the establishment date of the second rice crop through dry seeding the first crop entirely disappeared.

However, as depicted in Figure 7.3.1, for this particular year the establishment of two rice crops on rainfed fields would not have been been possible without the use of dry seeding. Of the total area of double rice crops, more than half was preceded by a dry seeded HYV crop. The remaining area of double rice crops was, for a large part, established in partially irrigated fields. Of the total area planned with second rice crops following wet seeded rice as a first crop, 40% was actually not established at all.

Similar to the 1977 season, late season rainfall conditions were disastrous to crop development. From the second half of October - thus right after the fields had been drained for the wet seeding of rice - until the last week of November hardly any rainfall occurred. Roughly 60% of the area planted to second rice crops failed due to drought stress during the vegetative growth stage. Only crops in partially irrigated areas survived this drought period, yielding 1.8 tons/ha on average.

Planning 1980-81

Despite the poor results obtained in the previous season with the

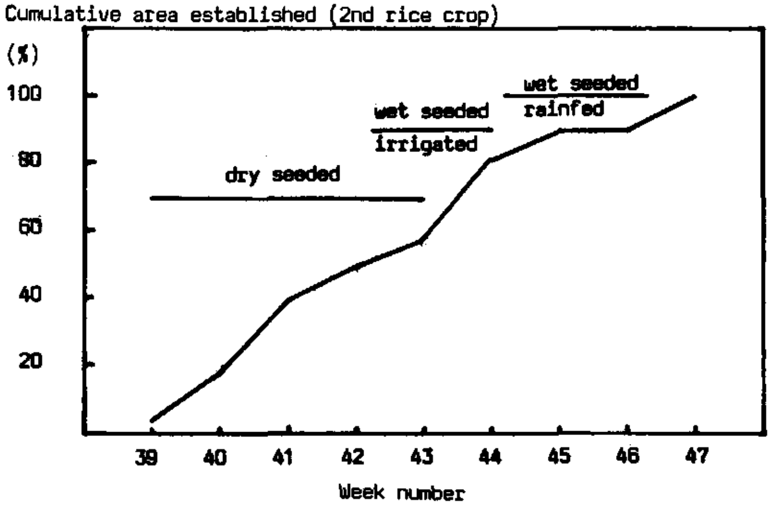


Fig. 7.3.1 Cumulative area established with second rice crops by week; cropping season 1979-80 (Week 1 = 1-7 Jan.)

DSR-WSR pattern, for the season of 1980-81 a somewhat larger area was planned to be double cropped with this pattern compared to the planned area in the previous season. Also the percentage of farmers planning to have double rice cropping with DSR-WSR slightly increased from 33% in 1979 to 38% in 1980. However, compared to the actual areas planted to dry seeded HYVs in 1979, there was a reduction in both the area and the number of farmers. The area declined with 12%, whereas the percentage of farmers decreased with 16%.

In contrast to the more or less stable area planned to be cropped with DSR-WSR, the area planned to be double cropped with WSR-WSR shows a dramatic increase of 58% compared to the planned area in 1979, whereas the percentage of farmers planning to have such a pattern increased from 42% to 67%. Compared to the actual area planted to WSR-WSR in 1979, the increase was even more dramatic, from 9% of the total rice area in 1979 to 24% in 1980, whereas the percentage of farmers increased from 29% in 1979 to 67% in 1980.

These figures indicate a strong determination among farmers to continue with double rice cropping but a reserved attitude towards dry seeded rice cropping. This determination resulted not in the least part from the low household incomes realized in the previous season. As discussed in Section 6.3.3, the debt position of most households had substantially increased. Households simply needed a good level of crop income for economic survival and hoped for a favourable rainfall season. However, it is still interesting to note that in spite of the generally poor results obtained with double rice cropping in 1979, a larger number of farmers apparently evaluated the feasibility and profitability of double rice cropping more positively. Interviews revealed the strong demonstration effect of a few successful double rice crops during a poor rainfall year. The majority of farmers attributed the previous year's failure to the exceptionally unfavourable rainfall pattern and not to the technical infeasibility of double rice cropping given normal rainfall conditions. More importantly, because of the poor growing conditions in 1979 farmers became aware of the drought tolerance of the IR36 variety. A number of dry seeded IR36 crops had successfully survived a sustained drought period during the seedling and early vegetative growth stage, whereas a number of second wet seeded IR36 crops still had reasonable yields despite very dry soil conditions during the late reproductive stage.

The general impression gained from discussions with farmers was that they had become more confident in the feasibility of a WSR-WSR cropping pattern on waterway fields. Although most farmers agreed that dry seeding rice was a sound strategy to obtain successful second rice crops, the risks associated with dry seeded rice clearly outweighed the benefits expected from this crop in terms of advancing the planting date of the second crop to an earlier date. Further, most farmers (especially those who did plan to have dry seeded rice) had encountered severe problems with crop management. Heavy labour inputs were required for weeding and replanting the dry seeded rice crops at the time land preparation and establishment of other rice crops had the highest priority. In 1979, it was generally difficult to find wage labour to carry out such tasks.

For a considerable number of households, another important reason for not planning dry seeded rice was that they simply could not risk the seed loss associated with dry seeded rice because of an extremely tight rice stock situation and a high debt position. For similar reasons, a large number of farmers gave high priority to corn plantings in February and March - facilitated by an unusual occurrence of scattered rainfall in these months - instead of leaving the field vacant for dry seeded rice in April or May. Moreover, farmers observed a high level of weed infestation (grasses) in their corn crops, probably caused by the extended periods of non-flooded fields during the previous season.

Management 1980-81

Both pre-monsoon rainfall conditions and field conditions in the 1980 season differed substantially from those in the previous season. In contrast to 1979, a large number of lowland fields were cultivated with corn crops. An unusually heavy rainfall at the end of March allowed land preparation in early April, after the top soil had been sufficiently dried out. A few farmers - all of the middle-aged surplus household category - made use of this condition to establish a palay-ang HYV crop. A few other farmers - all of the middle-aged household category - ploughed the field in-between the standing corn crop in preparation of a samara HYV crop in May. However, in contrast to 1979 season, the pre-monsoon rainfall pattern in 1980 did not favour the establishment of samara rice seedings. From the beginning of April until the last week of May, no significant rainfall occurred. When finally a number of days of mild rainfall occurred at the end of May, farmers planning to have dry seeded rice still established this crop in the first and second week of June. They exceeded the earlier indicated cut-off date for dry seeded rice establishment with two to three weeks, thereby taking a substantial risk of an early crop failure due to premature flooding of the field. However, such a condition did not occur and rainfall conditions after emergence were favourable for further crop development. The harvest of the dry seeded rice crops occurred in the third week of September. The palay-ang rice crops were harvested at the same time as the samara crops. Although the former crops were established one and half month earlier, insufficient rainfall caused seedling emergence at the same time as the latter type of crops. Yields obtained with the dry seeded rice crops were excellent with an average yield of 3.9 tons/ha, 70% higher than the average yield obtained in 1979. Lowest yields were as high as 2.5 tons/ha, whereas the highest yield reached 6.0 tons/ha.

Mid-season rainfall conditions were very favourable for the establishment of second rice crops. Rainfall conditions allowed wet seeding of rice from the end of September throughout the month of October. Thus, right after the harvest of the first dry seeded rice crops land preparation for the second crop could start. However, because of the large increase in the area of second rice crop plantings - roughly twice the area of second rice crops established in the previous year - a number of farmers encountered severe problems in finding labour for land preparation. In fact, farmers had to offer different kinds of incentives (e.g. higher wages in the form of rice payments, good meals and ample drinks) to attract sufficient labour - for a large part from outside the village - for timely crop establishment.

Also late season growing conditions were very favourable for crop development. Yields of second rice crops reached a high average level of around 2.3 tons/ha, ranging from 1.2 tons/ha for the late plantings to a high 4.0 tons/ha for early plantings following dry seeded rice. For a partially irrigated rice field, a yield of 5.2 tons/ha was recorded.

Planning 1981-82

This season shows a sharp increase in the area planned to be double cropped with the DSR-WSR pattern. The area increased with 75%, whereas the percentage of farmers increased from 38% to 61%. As will be discussed in Section 7.3.2, this increase in dry seeded area mainly came from non-surplus households. The young non-surplus households again planned to have a DSR-WSR pattern on a small portion of their fields (15%), whereas the middle-aged non-surplus housholds more than doubled the area under this pattern from 19% in 1980 to 46% in 1981. The area planned to be grown to a WSR-WSR pattern appears to stabilize. Both the number of farmers and the area decreased somewhat, especially when compared to the actual area and actual number of farmers growing this pattern in 1980. This levelling off indicates that all irrigated fields and favourable waterway parcels are now definitely planned to be cropped with a WSR-WSR rice pattern.

Management 1981-82

Pre-monsoon rainfall conditions in 1981 were very similar to the 1980 season, with the exception that it rained during the third week of April. This rainfall was just enough to allow land preparation for palay-ang rice, provided the field had been ploughed in January. A few farmers immediately established this crop, whereas the majority of farmers planning to have dry seeded rice ploughed the field for the second time but waited for the rains in May to establish a samara rice crop. In May, it rained several times but the amount and intensity were not enough to allow for the preparation of samara rice seedlings. Instead of waiting for sufficient rainfall as they did in the previous season, a substantial number of farmers still employed the palay-ang establishment method during the second half of May. In doing so, farmers again exceeded an earlier established cut-off date, i.e., no establishment of palay-ang rice after the end of April. A heavy shower during the last day of May finally allowed land preparation (bungak) on fields that had not yet been ploughed during the dry season. After these fields had sufficiently dried out, the second ploughing was carried out immediately followed by a harrowing and samara seeding.

Both the farmer's risk taking in establishing late palay-ang crops and the attempts of farmers to establish samara rice crops under sub-optimal soil conditions in June (normal cut-off date third week of May because of the risk of premature flooding), shows that farmers were very determined to have a double rice crop and did anything they could to enhance the success of this pattern. Despite poor conditions for dry seeded rice crop establishment, almost all farmers planning to have the DSR-WSR pattern actually did so in an area slightly less than planned (see Table 7.3.1). It further indicates that the dry seeded rice technology is employed much more flexible by farmers than they themselves indicated in 1979. This season also shows the dramatic impact dry seeding rice had on advancing the planting date of the first rice crop. Figure 7.3.2 shows that without this crop establishment technique, planting of rice crops in rainfed fields could not have started before the third week of July. Because of the use of the dry seeding technique, more than half of the rice area (excluding sideslope and irrigated fields) had actually been planted by that date!

A severe weed infestation developed in most dry seeded rice crops due to the occurrence of an intermittent type of rainfall pattern locally known as buro-balangtang, meaning 'it is continuously raining but it is not enough for standing water in the field'.

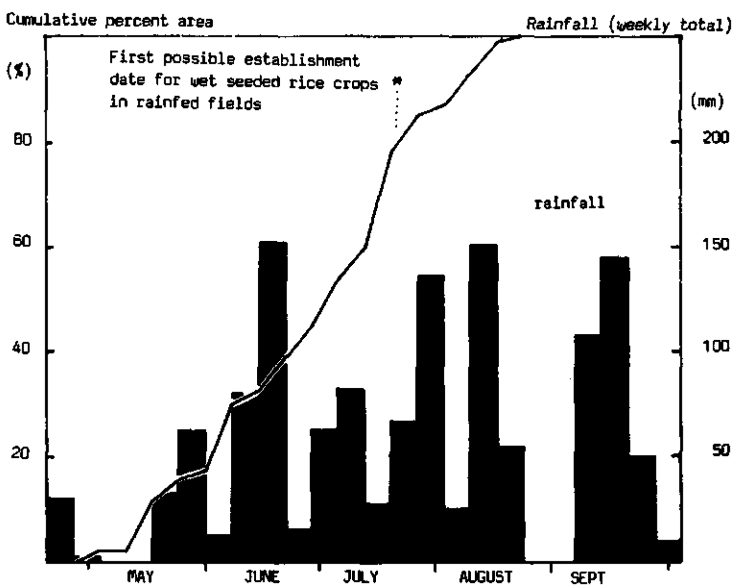


Figure 7.3.2 Cumulative area established with first rice crops by week (1981-82)

Similar to 1979, a number of fields had to be pulled and replanted. For the first time, farmers started to use small tooth-piked handharrows to control weeds. This weeding method is an adaptation of the earlier described weeding technique used in dry seeded BE-3 crops. Despite the weed problem, yields obtained with dry seeded rice in this year were as good as in the previous year. Again average yields were around 3.9 tons/ha, ranging from 2.5 tons/ha to 4.7 tons/ha.

Similar to 1980, rainfall facilitated the establishment of second rice crops right after harvesting the first crop. However, for the first time, farmers encountered problems in finding labour for the popular and relatively well-paid rice harvesting and rice hauling activity during mid-October. This resulted from the simultaneous harvests of both the large area established with dry seeded rice crops -that due to late rainfall germinated late - and early wet seeded rice crops. As shown in Figure 7.3.2, a large area of second rice crops (58%) was established in a period of two weeks. The problem in finding labour for hauling rice and land preparation of the second crop was further aggravated by a severe cash shortage that occurred in the village due to low dagmay prices and the lack of buyers for the newly harvested rice (3). For households with a limited supply of family labour, both problems affected timely establishment of second rice crops. Similar to 1980, late season rainfall was favourable for crop development. Second crop yields were somewhat lower compared to the previous season with an average of 2 tons/ha, ranging from 0.4 tons/ha to 4.4 tons/ha.

Planning 1982-83

The adoption of double rice cropping appears to consolidate in the season of 1982-83. The area planned for WSR-WSR again slightly decreased in favour of a minor increase in the area planned for DSR-WSR. The total area planned to be doubled cropped with rice crops appears to stabilize around a level of one half of the total rice area. Of this area, the largest part (55%) is planned to be grown to a DSR-WSR pattern. The total number of farmers planning to have double rice cropping on some part of their land also stabilizes. Similar to 1981, 87% of the farmers plans to grow a double rice crop, of which 35% opts for a DSR-WSR pattern, 30% for a WSR-WSR pattern, and the remainder for a combination of these patterns.

7.3.2 Risk and adoption

From the above description of the adoption process of double rice cropping, it will be clear that, similar to agronomic research, experimentation is a major tool of farmers to reduce uncertainty regarding the performance of a technology with regard to its performance in specific fields and its overall fit in the cropping system. Once technology has been in use for some time, farmers gradually get a better notion of the profitability and risks involved in the technology and will be better equipped to evaluate the advantages and disadvantages of activities including the risks attached. In the previous section, it was indicated that at least a number of farmers are quite able experimentors. It is a fallacy to think that farmers only obtain one experiment per season, and that consequently farmers' experimentation is a long time affair. The heterogeneity of land and water resources in this environment, together with rainfall variability, allows multiple observations in a rather short time span. Technologies for which the innovation risk is low are distinguished from high innovation risk technologies in that they allow experimentation on a small scale. The ability to experiment with new technology will primarily depend on whether the technology requires cash outlays and/or whether it is divisible. Thus, a distinction should be made between new technologies that are bulky and require relatively large cash outlays (e.g. tractors) and technologies that do not (e.g. improved seeds). With respect to the former, wealth status is likely to be a primary determinant for differences in innovation and adoption behaviour because poor households simply lack the financial means or access to credit sources to venture into such activities. For example, investments in the limited number of rice mills, threshers and rice blowers in the village were all made by the richest group of farmers.

A second factor determining innovation risk is whether new technologies link up with the knowledge base of farmers. Perceived innovation risks will be highly reduced in case farmers are capable of assessing the feasibility of new technologies on the basis of their experience with factors directly influencing the performance of the technology. In this respect, the above described cropping pattern technology differs entirely from technologies such as artificial fertilizers or pesticides. In perceiving the possibility of new cropping patterns, farmers can draw upon their intimate knowledge concerning rainfall patterns and the micro-ecology of fields. Based on this knowledge, they are able to interpret the results of experiments conducted with these patterns. As discussed above, because of this knowledge, farmers were not dejected after the initial poor results with the DSR-WSR pattern and did not conclude that the technology was infeasible. Although, as will be discussed in Chapter 8, farmers also experiment with fertilizers they essentially lack the basic knowledge regarding fertilizer technology to adequately interpret the results of such experiments. Despite the farmers' long experience with fertilizer technology as well as their intuitive grasp of how to use it, the basic elements of this technology are not part of the farmers' knowledge base: in essence, farmers use it but do not understand it (see also Goodell et al, 1982). This may not be a problem as long as the technology works and is simple enough to be applied. However, if the performance of the technology changes for whatever reason, farmers face a serious problem in terms of adapting the technology to such a new situation.

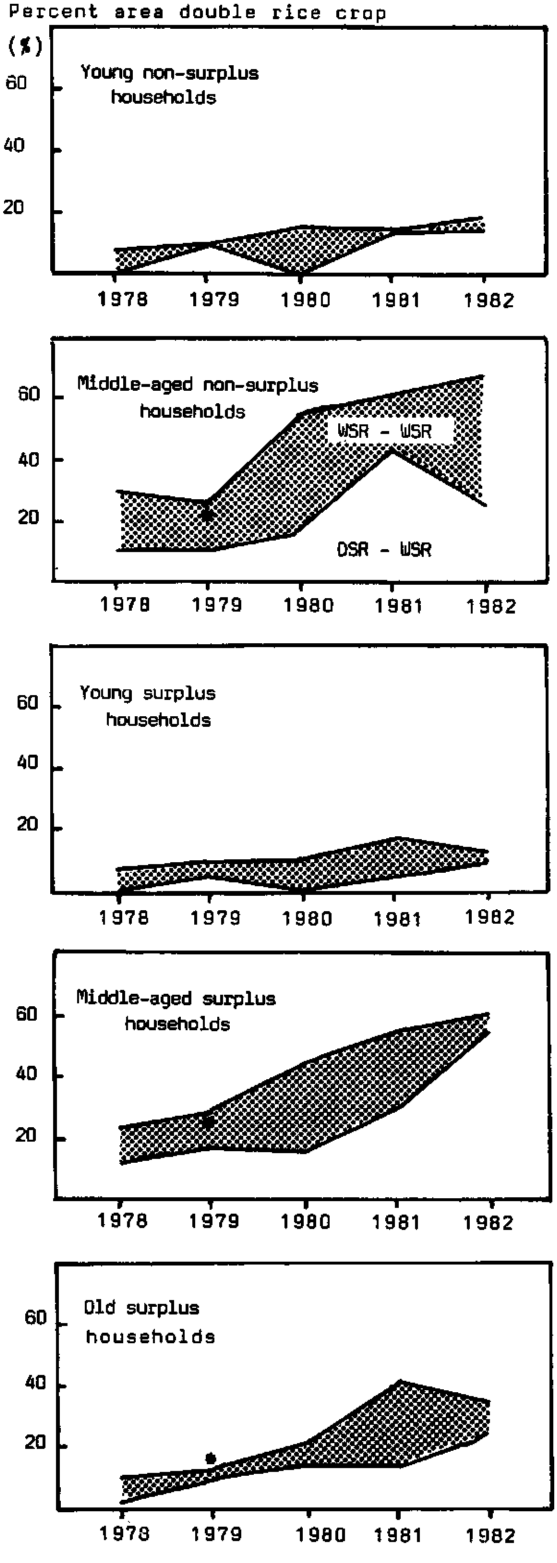


Fig. 7.3.3 Percentage of double rice crops of total rice area; average per household category (1978-82); 1982 is area planned)

Adoption pattern

Figure 7.3.3 shows the area double rice cropping as percentage of the total rice area for the various household categories for the period of 1978-82, excluding partially irrigated fields. Except for the last year, these figures represent realized double cropped areas, irrespective of second crop failure. Because of the large number of dry seeded crop failures in 1979, also the total area established with dry seeded HYV crops is shown for that year in order to indicate the intended area to be double cropped with DSR-WSR.

The consistent differences in the rate of adoption of double rice cropping between the young and middle-aged households is striking. Differences between these categories immediately start at the early stage of the adoption process and remain throughout the observation period. In 1978, the middle-aged non-surplus households cultivated the largest area under double rice cropping, on average roughly 30% of their total rice area, followed by the middle-aged surplus households with 23%. Both young household categories show a low level of double rice cropping with 8% of the total rice area. Of the double rice area, the middle-aged surplus households have roughly half planted to the new DSR-WSR pattern, compared to 37% of the middle-aged non-surplus households. Of both the young household categories almost the entire area of double rice crops consisted of the WSR-WSR pattern. Also the old household category has a small area under double rice crops some part of which with the DSR-WSR pattern. It should be noted that the choice for a dry seeded HYV crop as first rice crop in a double rice cropping strategy is indicative of the farmers' determination to aim at a double rice crop.

In 1979, the area under DSR-WSR increased for all household categories. Also both young household categories have some area under DSR-WSR, with the non-surplus households having the largest area. When the failed dry seeded HYV crops are considered as being intended for DSR-WSR cropping and added to this cropping pattern (indicated in Figure 7.3.3 by an asterix), the area meant to be planted to DSR-WSR substantially increases for the middle-aged and old households.

When compared to the area intended to be double cropped with DSR-WSR (i.e., including early failures of dry seeded HYV crops), 1980 shows a decline in double cropping with DSR-WSR for all household categories. Both young household categories do not plant any dry seeded HYV crop. The middle-aged and old categories show a slight decline. Due to the favourable rainfall pattern for second rice crop establishment, the area planted to double rice crops increases or remains stable for all household categories because of the larger area planted to the WSR-WSR pattern.

The season of 1981 shows a substantial increase in DSR-WSR cropping for non-surplus households, apparently supported by an improved risk taking capacity resulting from the good production season of 1980. Especially the middle-aged non-surplus households show a sharp increase in the area planted to DSR-WSR, from 17% of the total rice area in 1980 to 43% (!) in 1981. In fact, considering the decline in the area the following year, it appears that these households moved too fast in adopting the DSR-WSR pattern. Except for the old households, also the other household categories show an increase in DSR-WSR cropping in 1981. The old household category shows a sharp increase in the area cultivated with the WSR-WSR pattern.

For 1982, especially the middle-aged surplus households plan a substantial expansion of the area under DSR-WSR cropping, largely at the expense of the area under WSR-WSR, whereas the opposite occurs for the middle-aged non-surplus households. For the other household categories, the area DSR-WSR either remains stable or increases somewhat.

Since land type is a major determinant of the feasibility and profitability of double rice cropping, Figure 7.3.4 shows the adoption pattern of household categories for two major land unit groupings for which double rice cropping is feasibile but risky, i.e., rainfed and waterway fields, excluding the dry sideslope and partially irrigated fields. The adoption pattern by land unit group clearly shows the farmers' preference for locating double rice cropping patterns on waterway fields. As can be expected, waterway fields show a mixture of DSR-WSR and WSR-WSR cropping patterns, whereas the DSR-WSR pattern dominates on the rainfed fields. As first household category, middle-aged non-surplus households reach a full coverage with double rice cropping on waterway fields. From 1980 onwards, in order to increase the rate of double rice cropping on their farms, these households were forced to increase the rate of double rice cropping with the DSR-WSR pattern on the more risky rainfed fields. In 1981, also the middle-aged surplus household category almost reached full coverage with double rice cropping on waterway fields and was forced to move towards the rainfed fields. Both the young and old household categories still have ample room to increase the rate of double rice cropping on waterway fields.

The overall conclusion that can be derived from the above adoption pattern is that both middle-aged household categories played a major role in introducing the DSR-WSR pattern in the village and continued to have the largest area planted to this pattern during the study period. Despite their low risk taking capability, the non-surplus households in this category showed a considerable perseverance in increasing the area under DSR-WSR as shown by the large area under this pattern in 1981. In sharp contrast, both young household categories show low adoption rates throughout the study period. However, again the non-surplus households appear to be the most serious in implementing double rice cropping as indicated by the comparatively large area under double rice cropping with dry seeded rice as first crop. The old household category takes up a position in between. Similar to the middle-

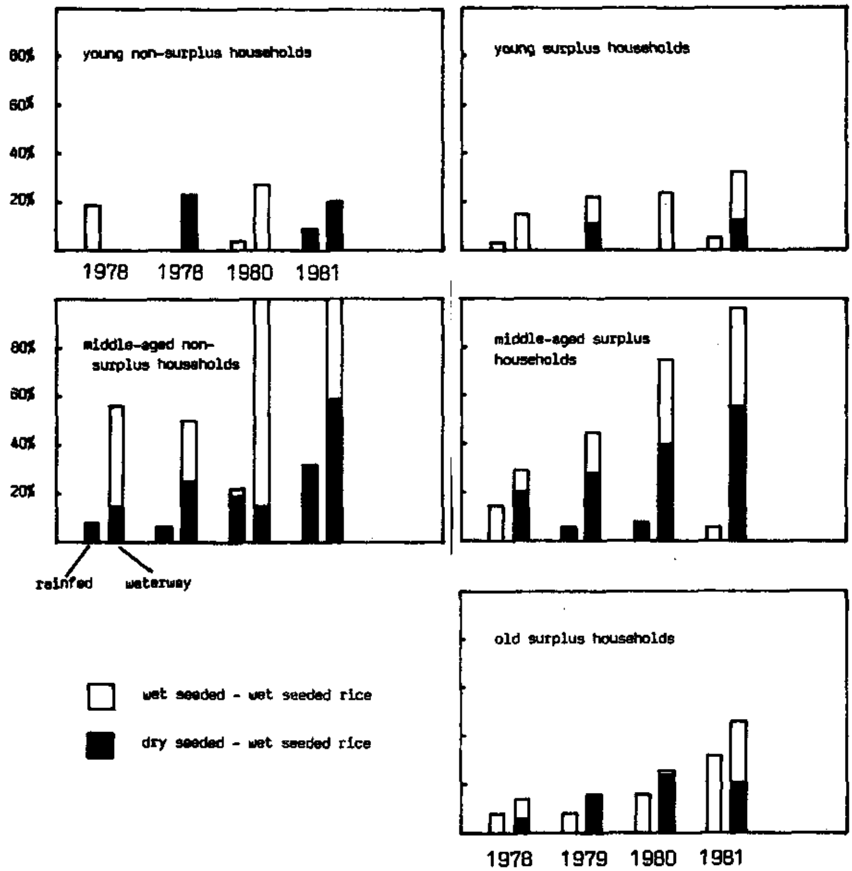


Figure 7.3.4 Percentage double rice crops in rainfed and waterway fields; average per household category (1978-82)

aged households, they show a gradual increase in the area under DSR-WSR and WSR-WSR, but at a substantially lower pace.

What are the underlying variables causing this sharp difference in adoption behaviour? Adoption studies have historically stressed the importance of wealth as a major factor determining differences in adoption behaviour. However, as indicated by DeWalt and DeWalt (1980), one should be careful to assume a direct relationship between wealth and innovation adoption. They discuss four different theoretical models that have appeared in the literature regarding the relationship between these two variables. The <u>first</u> model asserts a strong similarity in adoption behaviour among small farmers. The asumption on which this so-called <u>homogeneity model</u> is based is an apparent homogeneity in socio-economic status among relatively small agricultural producers. It also follows from the earlier mentioned studies that viewed small farmers as uniformally conservative and resistant to change (e.g. Foster, 1965; Rogers, 1969). From numerous studies and again supported by findings from this study, it will be clear that income and wealth differences - even within an apparently homogeneous group of small farmers as presently studied - are substantial. Further, the above description of the adoption process underlines the fact that conservatism or resistance to change cannot be considered a general behaviour mode of small farmers.

The second model postulates a simple positive relationship between wealth and adoption rates. This so-called linear model asserts that within any community the wealthier households are likely to be the first, or principal, adopters of new technology. They have better access to information and have a higher economic risk taking capability. This model is intuitively the most appealing. However, the above adoption pattern supports neither the view that wealth determines the rate at which innovations are accepted, nor the idea that experimentation is a prerogative of relatively wealthy farmers. The adoption pattern clearly shows that very poor households are willing and do take innovation risks. Despite their limited risk taking capability, the middle-aged non-surplus households were very active in the initial stage of experimenting with dry seeded HYV crops and thus carried a large part of the innovation risk.

Apart from wealth, the third model includes the notion of social risk taking. This so-called middle-class conservatism model asserts that people of very low wealth status and people of very high wealth status are likely to be the main and first adopters of innovations because these groups do not put their social status in the community at risk when adopting innovations. In contrast, middle-class groups tend to behave in conformity with established behaviour patterns in order to safeguard their present social and economic status. In other words, the social risk taking capability of this latter group is much smaller compared to high and low status groups. The validity of this model is difficult to test with the present data set because - for reasons mentioned earlier - the small group of rich farmers in the village is not represented in the sample. However, the middle-aged surplus households can be considered to represent what could be called the middle-class of farmers in this community. From the adoption pattern of this group, it is clear that their behaviour is not in conformity with this model. Both low and middle-class farmers are among the early adopters of the innovation. In fact, the group with the highest per capita income, i.e., the young surplus households, are the slowest adopters. Further, similar to the finding by DeWalt and DeWalt with respect to fertilizer adoption rates, the adoption of the new risky DSR-WSR technology by poor households is not simply behavioural idiosyncrasy, i.e. low status people behaving as nonconformists: it is a matter of economic survival.

The fourth, so-called modified middle-class conservatism model combines the ideas of the linear and middle-class conservatism model. It has been advanced by Cancian (1967) and tested for several different situations (Cancian, 1980). Cancian's model follows the linear model in regarding the lowest economic class as unable to invest in new opportunities, whereas the wealthiest group is most likely to adopt innovations because of their secure economic position. For the middle-class group, Cancian distinguishes between an upper and a lower rank. The former group shows innovation behaviour in conformity with the middle-class conservatism model, whereas the latter group is willing to take risks in adoption behaviour because of a greater desire to upward mobility. For similar reasons as discussed for the middle-class conservatism model, it is difficult to test the validity of this model, but it is also unlikely to be applicable to the present case.

Apart from the weakness of the above adoption theories in not differentiating between types of innovations based on differences in innovation risks, a critical variable lacking in the above models is the life cycle stage of the household. This variable does not only determine the labour availability and income requirements of the households, it may also explain cyclical dynamics in adoption behaviour, i.e., the idea that when households move to a new life cycle stage they gradually change their management orientation and management pattern.

The above adoption pattern clearly indicates underlying differences in management pattern between households in different life cycle groups. Households in the first life cycle stage (i.e. the young household categories) tend to choose for the relatively easy to manage single rice-based cropping patterns mainly consisting of BE-3 crop activities. For the surplus households in this category, this is primarily due to their limited availability of family labour. They consider the risk of not being able to control an early weed infestation in dry seeded HYV crops too high because of the difficulties they expect in finding wage labour when such a situation occurs. In effect, their 'fire-fighting capability' - the capacity to timely remedy poor crop conditions - is insufficient to allow DSR-WSR cropping. Moreover, the advantage of early rice crop establishment does not appeal to them because they expect similar problems in finding labour for second crop establishment and thus are not certain whether they will be able to timely establish a second crop. Also, since these young surplus households have more than enough rice production capacity with single BE-3 rice crops, they do not have to take the potential management risks associated with DSR-WSR cropping. Instead of taking what they call 'the hassle of double rice cropping' they invest much of their own labour in upland crop activities. During the rice growing season they concentrate on dagmay (as earlier discussed a low risk, highly profitable crop requiring, however, large cash outlays for fertilizer early in the season), whereas during the post-monsoon season they give priority to squash which is a labour intensive crop with potentially high returns, but with a high price risk level.

For young non-surplus households, the need to satisfy daily subsistence requirements with limited labour resources and meagre financial reserves has a major impact on their management pattern. To avoid heavy borrowing for consumption purposes, thus reducing the availability of credit for investments in agriculture, these households often have to engage in wage labour activities early in the cropping season. Given the limited and uncertain availability of such wage labour opportunities (Section 5.2.5), wage labourers have to be available when such opportunities arise. Protecting one's position as a wage labourer in the personalized wage labour market of the village implies that 'one should never say no' when another farmer asks you to work on his farm. Hence, in order to reduce the risk that own crop activities may be delayed, poor households with limited labour resources tend to choose self-employed crop production activities that do not require heavy labour investments during the period that wage labour activities are available (ploughing, transplanting, weeding); that are flexible enough to allow postponement of crop operations; and that have a cash input profile requiring cash inputs later in the season. Therefore, it is not surprising that these households also grow relatively large areas of BE-3 crops. On the other hand, these households are more pressed to grow HYVs and double rice crops because of their low income position and the advantage of having an early rice harvest with HYV crops for consumption purposes.

In contrast with young households, households in the second life cycle stage (i.e., middle-aged households) have both ample availability of family labour and a high level of household expenditures in terms of rice requirements and cash requirements for the schooling of children. Because these households have the labour resources as well as the reason to intensify land use, it is not surprising that particularly middle-aged households started experimenting with the DSR-WSR pattern. Apart from the benefit of increasing the returns per hectare without any increase in the paid-out cost of rice production, cultivating part of the farm with DSR-WSR also reduces the chance that labour must be hired for land preparation due to its spreading effect on the overall labour input profile. It does not only allow a more effective use of land resources, it also facilitates a more effective use of the fixed family labour resources. Land preparation and establishment of dry seeded rice crops occurs during a period when usually only corn or dagmay are planted.

Given the differences between these two life cycle groups, it can be expected that when young households move towards the end of the first life cycle stage, the management orientation of these households will gradually change as food requirements increase and children gradually start participating in crop production activities. Especially the risk of low production due to weed infestation of dry seeded HYV crops declines as weeding is an activity typically carried out by children. In this situation, surplus households are likely to start concentrating more of their own labour on rice crop production in order to intensify rice cropping at the expense of non-rice crop cultivation. Non-surplus households, because of their smaller farm areas, are likely to continue to be engaged in wage labour activities but will, at the same time, intensify rice crop production. The above adoption pattern also supports the view that when households move towards the third life cycle, they are likely to reduce the area under intensive rice cropping. For households at this life cycle stage, rice consumption requirements and cash requirements for schooling will decline because children have finished their education and are leaving the household.

Of course, given the multitude of other factors determining the choice of crop activities, the above representation of factors determining adoption behaviour is somewhat schematic. Furthermore, the number of households per category is very small. However, the consistency with which certain categories of households are or are not inclined to employ double rice cropping strongly supports the idea that - apart from wealth - the life cycle has a strong impact on the adoption behaviour and crop activity choice of households. Because of their low man-land ratio, young households face a much higher management risk than middle-aged households. Although, young non-surplus households are hard pressed to intensify rice crop production, they clearly face the highest management risks. They have both insufficient family labour and insufficient resources to hire labour to remedy adverse crop growth conditions. Young surplus households may encounter problems in finding hired labour during a tight wage labour market situation and, given their income position, find much less reason for intensifying rice crop production.

8 THE IMPORTANCE OF RISK IN FERTILIZER DECISIONS FOR RICE PRODUCTION

In the previous chapter, it was shown that adaptation of farm plans is a key aspect of farmers' decision making and risk reduction strategies. Adaptation occurs in the course of years as a result of changing technology, life cycle stage of the household and overall socio-economic conditions as well as within years in response to actual environmental conditions. Through 'adaptive planning' farmers attempt to obtain the best output from a crop production system which depends on uncertain rainfall and a variable growing season duration. Sequential crop choice and flexible cropping pattern strategies were observed as the main elements of successful planning and adaptation to uncertain environmental conditions.

This chapter specifically deals with decisions related to the use of fertilizer inputs in rice crop production. Since the introduction of fertilizer responsive rice varieties, artificial fertilizers have become an important means to increase crop production and sustain land productivity. To some extent, the use of fertilizers and associated crop inputs has become a prerequisite for meeting household consumption goals (Chapter 4). It is, however, a common observation that there still exists a wide gap between what yields are presently considered possible in rainfed areas and what farmers actually do obtain. Insufficient use of fertilizers has often been indicated as a major factor explaining this discrepancy. Empirical studies have invariably shown that farmers who adopt 'modern' varieties apply fertilizer at a much lower rate than that predicted by economic theory, given prevailing market prices and experimental response (David and Barker, 1978). In the literature, various hypotheses have been put forward explaining the discrepancy between actual and optimal fertilizer rates:

First, experimental and on-farm fertilizer response may differ substantially reflecting the highly controlled conditions under which fertilizer response is measured in experiments. Further, the within and between farm variation in the quality of land and water management may be substantial - particularly so in rainfed areas - resulting in a range of optimal fertilizer levels rather than one single optimum.

Second, insufficient attention may have been paid to cash constraints at the farm level. Imputed cost of inputs based on ongoing interest rates may poorly reflect real opportunity cost of capital in case of imperfect capital markets. Specifically, poor farmers may have limited access to credit.

Third, institutional arrangements such as share tenancy may reduce optimal fertilizer levels relative to those predicted for fixed rent contracts.

Fourth, insufficient or ineffective use of other inputs in rice crop production may reduce the yield response to fertilizer. Resource poor farmers may apply less fertilizer due to constraints on the level of application of other inputs.

Fifth, farmers' perception of fertilizer response may differ from empirical findings. This may in part be due to limited information and/or understanding of fertilizer technology as well as associated crop production technology.

Sixth, farmers may not aim at maximum profits. It is a common observation that - under conditions of diminishing returns - nearly optimal conditions are indeed very nearly optimal. Farmers may employ simple rules-of-thumb, such as a conservative benefit-cost ratio, to arrive at such nearly optimal conditions.

Finally, more recently increased attention was paid to risk as an additional factor explaining sub-optimal use of crop inputs. It is hypothesized that farmers' concern with adverse environmental conditions affecting agricultural production may lead to risk averse behaviour and insufficient use of yield increasing, but not necessarily risk neutral technology such as fertilizer.

Although this chapter primarily deals with the risk aspect of fertilizer use, an attempt is made to approach the issue from the broader perspective of the above indicated hypotheses in order to reduce the danger of a possible bias in research orientation towards what Roumasset (1979) calls 'the identification of apparent risk aversion'. That is, to attach importance to identified risk, whereas in fact, other non-identified variables are (part of) the underlying cause for underinvestment in fertilizer, or that underinvestment in fertilizer actually does not occur for the simple reason that optimum fertilizer levels are wrongly specified. Hence, apart from assessing fertilizer response and optimum fertilizer application levels under local production conditions and socio-economic circumstances, attention is paid to the issue of how and to what extent it is possible to isolate the effect due to risk from the effect of other variables affecting fertilizer decisions.

This section presents a brief introduction to the micro-economic theory concerning the choice of crop input levels. Farmers' perception and use of fertilizer technology in rice production are discussed in Section 8.1. An assessment of the response to fertilizer under on-farm conditions for IR-varieties and BE-3 rice crops is presented in Section 8.2, followed by an assessment of the risk of fertilizer use in Section 8.3. Section 8.4 deals with the issue whether farmers' perceptions of fertilizer response differ from empirical estimates and how they perceive the risk of increasing fertilizer use. In the same section, an attempt is made at quantifying farmers' willingness to take risks. This chapter will be concluded with an assessment of the relative importance of the farmers' ability versus willingness to take risk.

Economic theory related to input use in crop production
The micro-economic theory concerning the choice of crop input levels in agricultural production activities is well established and is discussed in detail by Heady (1952) and in a more recent contribution by Dillon (1977). This theory provides a 'mechanistic' choice model that consists of a set of normative decision rules that - given production constraints and input and output prices - determines in an unequivocal way the best solution to choice problems. As such, it does not address the issue of how decision makers arrive at choices.

Underlying the economic analysis of input use is the biological relationship between crop output and farmers' controlled and non-controlled inputs. This so-called production function or input response relation sets a limit on the quantity of a crop which can be produced with a given combination of inputs. In this production function, apart from the farmers' management input, three different input categories can be distinguished (Section 3.2.1): decision inputs (e.g. labour, fertilizer), fixed exogenous inputs (e.g. soil type, natural fertility), and uncertain exogenous inputs (e.g., rainfall, pest and weed incidence). In the conventional economic theory, it is not common to account for the influence of the uncertain exogenous inputs on production. It is assumed that yield response to inputs is instantaneous as well as that the output is known to the decision maker, i.e., prices and yields are known when the farmer makes his decision on the levels of inputs he intends to use. Further, the analysis is usually based on the assumption that there exists a continuous smooth relationship between inputs and output and that diminishing returns prevail to each input factor, i.e., additional output from increasing units of each input becomes less and less.

Within this framework, assuming one particular output Y, the decision rule employed to arrive at the economic optimum input choice is to maximize profits ($\mathfrak{p}$) given the profit function:

$$\mathfrak{p} = Py * Y - \sum_{i=1}^{n} Pxi * Xi - FC \qquad (1)$$

where Y = f(X1,X2, .. ,Xn) represents a the response function relating physical output to variable input factors (X1, .. ,Xn) given fixed factor cost FC, and Py and Pxi are prices of Y and Xi, respectively.

The optimal combination of variable inputs depends on the nature of the crop response function and the ratio of input to output price, and ratios of input prices, but not on the level of inputs assumed to be fixed in the production process. However, differences in fixed inputs may affect the shape of the response function and thus the optimal level of variable inputs. If interaction between input variables exists, optimal input levels will be dependent on the levels of the other inputs.

When unlimited funds are available, the profit maximizing input level is found by equating the first derivatives of the profit function (dp/dXi, $i=1,2, n$) to zero. This is often stated by the profit maximization rule of 'equate the marginal product of each input variable factor to its inverse price ratio'. For the more common case that the total budget for investment in crop production inputs is limited, the above decision rule should be modified to the more general rule of equating the net marginal returns from investments from all variable factors for all crop activities.

In a formal sense, such budget limitation is conveniently handled by using so-called 'Lagrange multipliers' that proportionally increase the price ratios of the variable input factors to such an extent that the budget is exhausted. If cash expenditures per hectare are limited to some level C, equation (1) is modified to:

$$p = Py * Y - \sum_{i=1}^{n} Pxi * Xi + L\left(\sum_{i=1}^{n} Pxi * Xi - C\right) \qquad (2)$$

where L is the Lagrange multiplier. Then, given that $\sum PiXi$ cannot exceed the restriction C, the constrained optimum is defined by differentiating equation (2) with respect to Xi and L, equating the (n+1) derivatives to zero and solving simultaneously

$$Py\ (dY/dXi) - Pxi + L * Pxi = 0$$

$$\sum_{i=1}^{n} Pxi * Xi - C = 0$$

Constraints on other variable inputs may require the introduction of additional Lagrange multipliers. For example, labour required for rice crop production may be limited by the amount of family labour available. The analysis can be further extended by considering multiple activities (Dillon, 1977).

A less formal approach of taking into account budget constraints is to employ a reasonable, predetermined rate of increase in the cost of variable inputs. Such opportunity cost considers the foregone benefits in terms of the marginal net return from alternative investment opportunities and is based on the same principle that is involved in the use of the Lagrange multipliers. Fixed opportunity costing of cash inputs is valid if good credit facilities are available. In such a case, the lowest value for the opportunity cost of cash may be taken as the local, ongoing interest rate on short-term production loans.

Optimal input use is further influenced by input factors that are costed proportional to the output obtained. For example, land rent may be paid as a proportion of the final harvest (share tenancy), similar to the payment of harvesting labour. Such input factors proportionally decrease the marginal value product or, alternatively, increase the price ratio with the inverse of the share factor. In a similar way, percent yield losses due to post-harvest processing (threshing, drying, hauling, storing, etc.). to the extent that they are not taken into account in the response function, should be included. Cost incurred in the application of variable inputs that vary according to the level of application do have an additive effect on the input factor cost.

Equation (3) shows how the various factors influence optimum input levels.

$$Py\ (dY/dXi) - ((1 + R)/SF))(Pxi + AC) = 0 \qquad (3)$$

where R is the interest rate on local loans, SF is the share factor, and AC are input application costs.

The introduction of risk substantially complicates the analysis of response efficiency (Chapter 3.2). The _first_ problem relates to the estimation of the technical production relationship in which the influence of uncertain exogenous factors on production outcomes is explicitly accounted for. In particular for input choice problems that allow sequential decision making, the measurement of response uncertainty of individual crop inputs is difficult. _Second_, risk is, to some extent, not independent of the resource availability of farm households. Certain risk factors may be fully (e.g. weeds) or partly controlled (e.g. pest incidence) by farmers. _Third_, with risk subjective elements (risk perceptions and attitudes) are introduced into the analysis which prevent the determination of a single, optimum input level. Because of these elements of subjective judgement, the best operating conditions that would be appropriate for one person may be quite different for another (Dillon, 1977).

In modelling crop input choice problems, most studies have abstracted from the influence of time on decision making and treat response risk as not being subject to sequential control by the farmer. In fact, the most commonly employed choice models are simple extensions of the above described deterministic model. For example, Anderson _et al_ (1977) show how the _expected utility maximization_ rule may be incorporated in the first order conditions to derive at subjective optimal solutions. In a simplified form, the first order condition for maximizing utility is given as

$$E(MVPi) = MFCi + RaIr,\ i=1,\ ..\ ,n \qquad (4)$$

where E(MVPi) is the expected marginal value product of input i, MFCi is the (non-stochastic) marginal factor cost of input i, and RaIr is a risk adjustment factor. E(MVPi) will be determined by the expected value of the uncertain environmental factors inasfar as they interact with input response. Ra is the farmers' local risk aversion parameter as derived by one of the earlier described methods and Ir is the marginal contribution to risk of additional input use. This decision rule implies a positive risk adjustment if both Ir and Ra are positive, i.e., a risk averse farmer will stop short of equating E(MVP) to MFC. For a derivation of this rule, see Anderson _et al_ (1977).

Safety-first rules are less easy to incorporate into the first order conditions for optimization because they do not assume a continuous trade-off between expected return and risk. Under strict application of this rule optimal solutions are affected only to the extent that a predetermined income level cannot be attained, either at a given fixed probability level or based on the rule that the probability of falling below such fixed income is minimized. It is possible, however, to approximate the safety-first rule as a standard deviation rule (1) which then allows for a similar decision rule specification as utility maximization.

8.1 Farmers' perception and use of fertilizer technology in rice production

Before an attempt is made to quantitatively assess the response to fertilizer under farmers' conditions and the effect of risk factors on fertilizer response, this section will deal with the issue of how farmers approach soil fertility management for rice crop production. Such understanding is needed to appreciate and interpret farmers' behaviour with respect to fertilizer use.

8.1.1 Types of fertilizer used by farmers

Farmers generally recognize the beneficial effect of various sources of organic fertilizers. Livestock manure is considered beneficial to crop growth, but is hardly used in rice crop production. Apart from the fact that the collection of manure can be a laborious activity (the main source of manure being carabaos that are not permanently stalled) as well as that it does not seem to be socially feasible, the main reason for not using manure appears to be the potential danger of increased weed infestation in manured fields. In a number of cases deluted pig manure is used for upland crop production (e.g. dagmay).

Farmers mention the beneficial effect of leguminous crops on soil fertility. Both cowpea and mung are indicated in this respect and are used in rotation with other crops on the upland areas or follow rice in lowland areas. However, these crops are not used as green manure. Farmers grow them for bean production and do not incorporate residual green matter into the soil. Incorporation of rice crop residues, particularly the stubble, at the start of the crop season is common practice, but the use of the sickle and short-statured varieties does not leave much residue after harvesting. Moreover, it is common to burn rice fields during the dry season in order to reduce weed infestation. The piles of rice straw left after threshing are partly used for carabao fodder or burned to facilitate a quick establishment of a second rice crop. It is not common to spread rice straw over the field, although farmers are aware of the beneficial effect on soil fertility. This can be observed by vigorously growing rice plants in places where in the previous season rice straw was piled and burned.

By far the most important source of fertilizer used in rice production are artificial fertilizers. Farmers have gained substantial experience in using of fertilizers. They were introduced as early as the mid-1960s together with the gradual replacement of the tall, traditional varieties with the (then) modern, fertilizer responsive variety BE-3. With the introduction of the M-99 programme early in the 1970s (Appendix II.1), the level of fertilizer use increased considerably. During the short M-99 period, a number of farmers experimented with the recommended high fertilizer rates. However, it was common to distribute the fertilizer received over all crops in the farm. After the M-99 programme, most farmers reduced fertilizer inputs to a more economic level, partly caused by tight budgets due to M-99 loan repayments.

At present, farmers consider artificial fertilizers a prerequisite for successful rice crop production. Probably due to the earlier described crop intensification process starting with (non-fertilized) corn in lowland fields in the early 1960s, much of the natural fertility of the original rich clay soils has been depleted. Soils are considered lamgud which means that inherently good soils lack fertility. There are instances of farmers renting out (tenanted) land because they cannot finance fertilizer inputs due to debt induced credit constraints.

8.1.2 Farmers' knowledge of artificial fertilizers

Much of the knowledge farmers have acquired over the years has been gained through own experience. Extension has traditionally stressed the importance of fertilizer rates rather than to inform farmers about the function of fertilizer and fertilizer management. Although, based on own experience, farmers appear to have a good intuitive grasp of fertilizer technology, such experience may become less useful when environmental conditions change. It may be safely assumed that after a number of years farmers will adapt their practices to such new conditions. However, an adequate extension service may reduce both the period and the cost of such transition.

The most common types of fertilizer used are urea and ammonium sulphate. More recently, farmers started to switch to other types such as ammonium phosphate due to problems encountered with the use of the above nitrogen-based fertilizers. In general, farmers are familiar with differences between types of fertilizers in terms of nutrients present. However, they lack knowledge about the various concentrations of these nutrients. Instead of employing these concentrations, farmers evaluate fertilizers on the basis of the following three aspects:

- their visual effect on crops in relation to the inherent fertility of the soil;
- the price of fertilizer per bag;
- the amount of fertilizer in volume terms.

Farmers generally consider urea the best type of fertilizer for rice crops. They especially appreciate the immediate effect of urea (tambok) on the colour of the leaves shortly after application. In contrast, according to farmers, ammonium phosphate 'takes a long time to release'. On the other hand, this latter type of fertilizer is evaluated positively because 'it stays long', which observation may be partly related to the favourable effect of phosphate on the use efficiency of available nitrogen given the generally phosphate-deficient soils in the area. Ammonium sulphate is considered a cheap but inferior fertilizer which is only used in case farmers do not have enough money to purchase the more expensive urea or ammonium phosphate ('it's no good because it cannot reach 40 days, then the rice becomes yellow again').

Lack of available phosphate in rice fields due to the continuous use of urea and ammonium sulphate and the general increase in cropping intensity is a widespread problem in the area of which most farmers are not aware. The effect of this deficiency is clearly visible in fields where during the dry season squash or watermellon were grown. These crops are usually fertilized with ammonium phosphate or compound fertilizers such as 14-14-14. The residual availability of phosphate at regular spots in the field has a very marked 'dotted' effect on the following rice crop, particularly at the early stage of crop growth. Furthermore, farmers increasingly start to have problems with the use of urea which does not seem to be absorbed by the plant. They complain about 'rice not eating urea' which some farmers attribute to the poor development of the root system of the plant. Although, these effects are not directly attributed to phosphate deficiency, farmers tend to solve the latter problem by changing to other types of fertilizers that usually contain phosphate.

Farmers' knowledge of fertilizers substantially differs between farmers with and without experience with phosphate containing fertilizers. As one farmer explained: 'how could the crop take urea, the soil is already 'sour' (aslum). The soil lacks phosphate, but they still continue to use urea without knowing that there is no phosphate in the soil. Nitrogen is really cold and phosphate makes the soil warm. Is that true?'. The latter part of this remark seems to indicate some notion of the need for a nutrient balance in soils required for good rice production. However, it also appears that phosphate deficiency is confused with the wider held notion among farmers that soils get acid after continuous use of fertilizers (aslum).

Other observations made by farmers using phosphate containing fertilizers through mere experience include such remarkably accurate findings as: 'urea is good for the tillers and 16-20 (ammonium phosphate) is good for the fruits (panicles)', 'when you apply 16-20 the leaves are not so wide and green (lampano), but the fruits are good', 'with urea the crop grows vigorously, but the grains are small and not well-filled (huyos)'. Finally, one farmer indicated the beneficial effect of ammonium phosphate on dry-seeded rice: 'In dry-seeding we use a high seeding rate. And if you have a dense stand it is no good to have urea, only for the second dressing you apply urea. If you use urea for the first dressing, the stem will become soft (due to the high crop density) so it will be more susceptible to pests and also more susceptible to flooding'.

Apart from fertilizer type and prices, certain farmers attach importance to the size of the bag. Although, all fertilizers come in bags of 50 kg, they substantially differ in size. Bags of ammonium phosphate are about 30% less in volume compared to bags of urea, and because of that farmers consider the former 'kul-ay', which term is commonly used for situations in which something appears more than it is or less than expected. Since farmers assess dosages in terms of volume applied rather than the amount of kg applied, they reason that to apply the same amount of fertilizer more bags of fertilizer are required and, therefore, the cost per application is considered to be higher.

8.1.3 The amount of fertilizer applied

The manner in which farmers tend to determine the minimum amount of fertilizer needed for rice production is simple but effective: keep the rice crop green until the grain filling stage. Similar to other inputs, fertilizer is primarily seen by most farmers as a control input in the sense that it is a necessary input to keep the crop green and give it a healthy appearance (hitsura, literally meaning face) as well as to control the stand (density) of the rice crop (tindog).

In general, crops with a low stand density (nipis) receive relatively high dosages of fertilizer to induce tillering, whereas on high density crops (gutok, literally crowded) less fertilizer is applied to avoid weak, elongated tillers (barriri). Apart from stand establishment, crops are evaluated on the basis of even height and colour (sarama). In case certain parts of a field develop poorly they may receive a spot fertilization ahead of the main application. Crops that remain green during the growth cycle of the plant may not receive any fertilizer at all. Extra high dosages of fertilizer (gintapat) may be applied after weeding heavily weed infested fields in order to give the crop - as farmers call it - a sudden boost (nagulpihan, literally to frighten the crop).

Soil quality, referred to by farmers as 'the capacity of soil' (capacidad sang lupa), is another factor influencing fertilizer applications. Farmers are critically aware of these differences in soil quality and observe them by looking at the change in leaf colour during the early growth stage of the plant. The sooner the leaves turn yellow after crop establishment the less fertile the land is considered to be. Land is considered fertile if two weeks after germination the leaves still look 'pal-ay' (healthy).

Apart from soil texture - fine-textured soils (pug-a) are considered more fertile than coarse-textured soils (baras-barason, buga) - differences in fertility of soils/fields are attributed to the beneficial effect of soil deposits of higher positioned fields (lay-on) as well as to the inflow of artificial fertilizer nutrients from higher positioned fertilized fields. Generally, less fertile land in a similar water management group receives higher dosages of fertilizer at an earlier stage in crop growth, whereas less fertile parts in a field receive an extra dose of fertilizer through spot application.

Generally, farmers do not apply fertilizer until the crop is fully established and a first weeding (if required) is carried out. Except for a very few isolated cases, mainly in transplanted rice crops, basal dressings of fertilizer do not occur. The absence of this - through the extension service - strongly recommended practice is understandable in view of the predominance of wet seeded rice crops in the area. Since fields have to be drained prior to seeding, weed infestation may be considerable and applied fertilizer may induce weed growth. Moreover, due to drought after drainage fertilizer may be lost. However, in certain cases, e.g., after sudden flooding of dry-seeded rice crops (nagapuras), an early dressing may be required.

Fertilizers are mainly applied in one application, but two applications sometimes occur. Since the first weeding is commonly carried out two to three weeks after seeding, the first fertilizer application takes place three to four weeks after crop establishment. However, applications may be delayed due to such factors as postponement of weeding (e.g. due to insufficient moisture conditions), family labour constraints or short-term cash flow problems. Depending on crop growth development and cash availability, farmers may have a second application during the early reproductive stage (naga bilog-bilog). Such second application is commonly considered as 'an extra amount' over and above the regular dosage ('it's for the fruits'). It may happen, though, that a second application is necessary because the first application was not effective, e.g., due to flood conditions shortly after fertilization or because of a severe phosphate deficiency.

Among farmers there is a general consensus of the minimum amount of fertilizer required for the first dressing. It is very similar to seeding rates for wet-seeded rice crops on a volume basis (1 to 1.5 bags). This is not very surprising since fertilizer is broadcast in standing water at a similar rate as pre-germinated seeds are broadcast unto puddled soils. The maximum amount of fertilizer for the first dressing is considered to be in the range of 3 to 4 bags per hectare, whereas the total maximum amount for two applications is in the range of 6 to 7 bags/ha. The actual amount of fertilizer applied by farmers is, to some extent, sequentially decided upon, i.e., it depends on the development of the crop until the time the fertilizer is applied. However, farmers' control of risk factors prior to the application of the first fertilizer application (e.g. early drought stress, incidence of early season pests, and weed infestation) is generally adequate. In severe cases, the effect of risk factors on crop growth is usually be remedied by farmers through replanting. This may sometimes require pulling of seedlings in parts of the field followed by re-seeding. Although the level of risk control partly depends on the resource availability of farmers, early season risk factors can generally be considered to have a minor influence on the rate of the first fertilizer application. Risk control after the application of the first (and main) fertilizer application is much less due to risk factors such as drought during the reproductive growth stage of rice plants or various types of pest infestation (Section 7.1.4).

Farmers attempt to divide inputs among crops in such a way that all crops grow well (ekonomia). However, in certain cases crops may - as farmers call it - be abandoned (pabay-an), i.e., they just leave the crop as it is without any further care. For instance, this may occur after a heavy weed infestation. Furthermore, farmers may favour certain parcels (usually those close to the homestead) which are more intensively managed (buylohan). Apart from economizing across crops, farmers also appear to have a general economizing attitude towards the use of fertilizer, particularly in case fertilizer has to be financed with borrowed money. Local expressions such as 'patas sa gasto' (the returns just cover the expenses) or 'patas man gihapon' (two options that give the same result or there is no winner) are frequently used when farmers explain why they do not apply higher rates of fertilizer

8.2 Measuring the response to fertilizer under farmers' conditions

In this section, an attempt will be made to estimate the yield response to fertilizer of the newly introduced varieties IR36 and BE-3. Section 8.2.1 reviews approaches and problems in assessing stochastic response functions. Combining two existing approaches, an improved method of estimating stochatic response functions is suggested. Problems encountered in estimating response functions using non-experimental data are discussed in Section 8.2.2. A description of the employed fertilizer response model is given in Section 8.2.3, followed by a discussion of the estimated response functions (IR36 in Section 8.2.4 and BE-3 in Section 8.2.5).

8.2.1 Approaches and problems in assessing stochastic response functions

There are essentially two ways of assessing response variability (Anderson et al, 1977). One could be called the 'gross' approach in the sense that no attention is paid to individual risk factors causing response variability. The other approach, called analytical, explicitly measures the importance of the various risk factors prior to assessing their overall effect on yield. The diagram below shows the various methods that are suggested in the literature. It is also indicated that the method applied in this study is a combination of the analytical and 'gross' approach.

Diagram: <u>'Empirical' risk assessment methods</u>

<u>'gross' approaches:</u>	<u>analytical approaches:</u>
. cross-section analysis	. percent damage approach
. homogeneous sub-strata analysis of time series data	. crop growth simulation
. residual analysis following production function estimation	. $\boxed{\text{inclusion of risk factors in production function}}$
. $\boxed{\text{observed variability in response coefficients}}$	

method applied

8.2.1.1 'Gross' approaches

Cross-section analysis
One of the most widespread methods of estimating risk of a certain production technique is to find a secondary data source (i.e. data collected by others, usually for other purposes) on per hectare yields, and to assume that the frequency distribution of such cross-section is a good proxy for the frequency distribution of yields that a certain farmer, using the technique, faces. The obvious weakness of this method is quite serious for agriculture. No account is taken of the effect of the various decision inputs (e.g. fertilizer) on yield. Likewise there is no control on differences in fixed exogenous factors such as irrigation, soil type, terrain, and other physical characteristics of the farmer's land. Both types of inputs are likely to differ from farmer to farmer, whereas in effect, the entire variance in yields is attributed to the influence of the stochastic factors such as weather.

<u>Homogeneous sub-strata analysis of time-series data</u>
To properly control the effect on yield of inputs other than stochastic inputs, the sample of observations on crop yields has to be divided into sub-strata that are homogeneous with respect to these inputs. This implies that except for the stochastic inputs, all other inputs have similar values within each sub-stratum of observations. For the various input levels, an adequate yield risk assessment can then be obtained from such a data set, if observations cover a sufficient number of years to account for the influence of the stochastic inputs on yield. That is, all major 'States-of-Nature' should have occurred during the observation period, preferably in a pattern which closely represents the (joint) frequency distribution of occurrence of these stochastic inputs.

It will not be surprising, that in most research situations such type of data is almost non-existent. Usually time-series on crop yields are limited to a small number of years, whereas the multitude of possible combinations of inputs prevents an adequate division into homogeneous sub-strata. Such method may be employed with data derived researcher-controlled experiments, where usually discrete input levels are used and where sometimes experiments run for a considersable number of years (e.g. long-term fertility trials). However, in experimental designs, the influence of stochastic factors is commonly considered a nuisance, complicating the analysis and interpretation of experimental results. Hence, a maximum degree of control over exogenous influences is excercised, invalidating, to a large extent, experimental data for risk assessment.

Residual analysis following production function estimation

To circumvent the problem of too small homogeneous sub-strata which may easily arise when the above method is employed, an alternative approach to control the influence of the non-stochastic input factors is to estimate a production function and assume that the residual term for individual observation captures the effect of the stochastic exogenous inputs. The behaviour of the error term can be investigated for different input intervals or the function can be tested for heteroscedasticity, i.e. whether the residuals show a systematic change in variance with either increasing or decreasing input use. It is obvious, however, that not only the influence of the stochastic inputs is represented in the residual term, but also errors due to variable measurement and function specification.

Observed variability in response coefficients

Recently, Young and Mount (1979) suggested a method of estimating yield variability that may overcome some of the above problems. They use a variant of the random coefficient regression (RCR) model (Swamy, 1970) to estimate the intra-year variability in the response coefficients of the decision input variables. They interpret this variability as being mainly the result of non-specified stochastic input variables interacting with these decision input variables. The estimated variability of the coefficients of the decision inputs can thus be used to assess the variability in response due to these inputs. A specification of the RCR model is presented in Appendix VI.

The clear advantage of the above 'gross' methods is that recorded observations on the stochastic variables, often unavailable, are not required. However, a weakness is that variability in yield - conditional on the decision and fixed exogenous input variables - is entirely attributed to unknown stochastic effects. Variation due to possible errors of observation and measurement, as well as due to the non-measured effects of omitted decision and/or context variables are confounded with variability due to real stochastic effects. Consequently, if observations are inaccurate and/or if the sample of yield observations is not sufficiently broken down into homogeneous classes of decision and fixed exogenous variables, the approach gives not only a poor estimate of yield variability but also tends to overestimate it. Further, the 'gross' approach requires sufficient time-series data on crop yields to capture the real variability of stochastic factors present in the environment.

For all the above methods, data requirements are difficult to meet. Crop yield data over extended periods of time are usually unavailable. However, data sources for certain important stochastic input variables such as rainfall and solar radiation are often available. The analytical approach to risk estimation makes an efficient use of this information.

8.2.1.2 Analytical approaches

Percent damage approach

This approach, suggested and applied by Roumasset (1976), consists of a two-step procedure and is essentially a simplified version of the RCR model mentioned above. First, a no-damage production function is estimated using experimental data, gathered under highly controlled conditions. Second, for each important crop damage factor (k) various 'damage states' (DSi) are distinguished and their associated percent yield reduction levels are determined as well as their probability of occurrence (Pi). The stochastic production function (specified for two 'damage factors') is then defined as:

$$PiPj\ (1-DS1i)(1-DS2j) * Y(N) \equiv Uij * Y(N) \qquad (5)$$

where Uij is the random variable percent damage representing the joint probability of the combined percent yield damage factors and Y(N) is the 'no-damage production function'. Because the random variable is specified to interact with the no-damage production function in a multiplicative way, the above model specification actually implies that all input coefficients are subject to the same random variation. For the quadratic response function, this results in the unlikely situation that - irrespective of the state of the damage variable - the maximum input level remains constant, because the damage factor does not occur in the first derivative of this function. Only the response to inputs differs for different damage states. Moreover, due to the particular random factor specification, the variation in yield will automatically increase with increasing levels of input use.

Crop growth simulation

Although not further discussed here, crop growth simulation is likely to become a major tool in the assessment of crop production risks.

Inclusion of risk factors in the production function

This method also involves a two-step procedure. First, the effect of all three types of inputs on yield is estimated through regression analysis. Second, the joint probability distribution associated with the stochastic input factors is assessed. Yield variability can be directly assessed by plugging in the values of the stochastic input variables in the estimated response function.

In contrast with the gross approaches, the problem with the analytical approaches is the underestimation of yield variability. In most cases, however, it is impossible to capture all the stochastic influences that affect yield in the specified model. Usually, for some of these variables observations are unavailable or their probability distribution cannot be assessed due to lack of time-series data. To some extent, this problem can be solved when in the above mentioned RCR model important stochastic input factors are included. Such specification escapes the rigidity of the analytical approach by allowing the influence of the non-specified stochastic input factors to work through the estimated response coefficients in a random fashion. That is, the omission of risk factors from the response function is translated into intra-year, unstable regression coefficients. Because this response model employs both time-series on crop yield data and time-series on stochastic input variables, it allows for an efficient use of scarce empirical data in assessing risk. The model will be further elaborated on in Section 8.2.3.

8.2.2 Problems in estimating response functions using non-experimental data

There are a number of problems associated with input response analysis based on farmers' crop production data. First, and most important, in contrast with experimental designs, the decision input variables are not pre-selected, researcher controlled variables. Farmers decide what, how, when, and at what level inputs are applied. They determine the range of the decision input variables on which observations are available. This implies that it may not be possible to estimate the effect of certain fixed input factors. For instance, with the present data set it was impossible to estimate the squared term of the phosphate input for a quadratic response model, because of the general low level of application. Alternatively, in order to estimate the possible diminishing effect of increased input use, it is required that certain farmers deliberately apply relatively large amounts of that input.

Second, the same type of problem occurs with the estimation of interaction effects between inputs. Although for estimation purposes it is usually assumed that response is instantaneous, it should be realized that input response is a dynamic process in which inputs interact with each other in a sequential way. Of course, farmers are aware of these interactions and base their input decisions on the condition of the crop at the time they have to make the decision. For instance, farmers do not apply high doses of fertilizer on heavy weed infested fields. This sequential aspect of decision-making causes certain input combinations not to occur in 'real world data' and, consequently, their interaction effect cannot be estimated.

Third, other problems encountered in survey data are differences in the quality of similar inputs included in the same input variable due to differences in management level (e.g. method and timing of application) as well as the often inescapable need to aggregate different types of inputs into one input category (e.g. different brands of pesticides). Especially, with pest and weed control inputs quality may differ widely because of the almost unlimited number of possible combinations of different pests as well as weed control measures. Coupled with differences in the timing and way of application of these inputs as well as the differences in the degree and type of infestation when these inputs are applied, it seems that significant fixed effects of aggregates of these non-homogeneous inputs can only be obtained by pure chance.

Finally, survey data are often not specifically collected for response analyses purposes. In this case, efficient use of scarce manpower resources did not allow continuous monitoring of environmental conditions in rice fields and proxy variables had to be used to include these effects in the reponse relationship. Water stress data were generated through the water-balance simulation model mentioned earlier (Bolton and Zandstra, 1980), using on-site recorded rainfall data, actual planting/seeding and harvesting dates, and typical bund height and seepage-percolation rates for the various landscape positions. Solar radiation data were obtained from a nearby agricultural research station.

Attempts to include the effect of other stress factors through subjective estimates on yield loss were unsuccessful. Farmers had difficulty in separating the individual effects of the various sources of stress. However, since weed infestation is generally more location- specific and less unpredictable compared to other environmental factors, an attempt was made to include this factor as a fixed exogenous input variable through a subjective estimate. For all their rice fields, farmers were asked to estimate the yield loss as a percentage of the gross yield due to a heavy/normal/mild weed infestation assuming no weed control. Subsequently, they were asked how many years out of ten such infestation would occur. The expected value of these estimates was used as a proxy for an expected weed incidence index.

8.2.3 Specification of the fertilizer response model

Given the above limitation and inadequacies in variable measurement, together with the general problem of capturing a complex agricultural production process in a single response equation, the fertilizer response function cannot be expected but to be a crude approximation of the true shape of the function. Accordingly, results should be interpreted carefully. On the basis of a fertilizer response model specification by Rosegrant (1977), employed for a different research-site in the Philippines, and some preliminary analysis, the following quadratic response relationship between rice yield and fertilizer is postulated:

$$Yi = (a+a') + (b1+b1')\ SrN + (b2+b2')\ N2 + (b3+b3')\ NP + (b4+b4')\ N/(Pest+1) + (b5+b5')\ Ws + (b6+b6')\ WsN + (b7+b7')\ Wi/(Weed+1) + ui \tag{6}$$

where,

Y	: unmilled rice yield (kg/ha)
SrN (Sr*N)	: interaction solar radiation (kcal/cm2) and nitrogen (kg N/ha)
N2	: nitrogen squared
NP (N*P)	: interaction phosphorus (kg Pesos/ha) and nitrogen
N/(Pest+1)	: interaction nitrogen and pest control cost (Pesos/ha)
Ws	: water stressdays (days)
WsN (Ws*N)	: interaction water stressdays and nitrogen
Wi/(Weed+1)	: interaction weed infestation index and weed control cost (Pesos/ha)

The coeffients (bi+bi') represent the fixed response coefficient (bi) and the random term (bi') according to the model specification given in Appendix VI. The (ui) represents the error term.

Nitrogen appears quadratic as well as in interaction with solar radiation, phosphorus, pest control cost, and water stress (2). The solar radiation variable is defined as the total amount of solar energy received during the combined reproductive and ripening stage of crop growth. Following Wickam (1973), stress days are defined as the number of days in excess of three for which a field is without standing water. Initially, three stress periods were distinguished following the three growth stages of rice crops. However, both the vegetative and ripening stress variables appeared to have no effect on yield so they were not further analyzed.

The pest control variable represents an aggregated input variable in which a large number of different types of pesticides are combined through their deflated cash value. It is specified in such a way that it does not contribute directly to yield, but rather has a protective influence on nitrogen response. In a similar way, the aggregated weed control input has a protective effect on the intercept term by controlling the negative effect of the weed incidence index. Because of the effectiveness of both the pest control and - to some lesser extent - weed control inputs will depend on stochastic events, the influence of these inputs will be random. Only to the extent that a certain non-controlled infestation occurs in each season, will there be a significant fixed effect from the use of these inputs.

For the BE-3 variety, a dummy weed variable was introduced for crops established with the dry seeded method. Because of the relatively long growth duration of dry seeded BE-3, effective weed control requires a substantially higher weeding input compared to the transplanted BE-3 crops. Such a situation does not occur for the HYV variety due to the absence of transplanted crops as well as the similarity in weeding requirements for dry and wet seeded crops (3).

Unfortunately, because of the limited number of observations per period, the above specified model could not be applied to the data for the BE-3 variety. Below, first the results for the HYV variety will be discussed and, subsequently, they will be compared with the results derived for the BE-3 variety.

Table 8.2.1 Regression coefficients (OLS) of fertilizer response function for individual years and for all years

Variable	1978		1979		1980		1981		Pooled	
SrN	0.00113	(2.56)	0.00162	(5.41)	0.00152	(3.82)	0.00134	(2.59)	0.00130	(6.99)
N2	-0.1019	(1.09)	-0.2383	(3.65)	-0.1309	(1.98)	-0.2105	(2.08)	-0.1358	(3.88)
Ws	-43.08	(1.58)	-50.79	(1.72)	-47.01	(1.21)	-87.33	(2.81)	-54.37	(3.43)
WsN	-1.065	(1.99)	-0.845	(1.64)	-0.623	(0.81)	-0.455	(0.91)	-0.934	(3.24)
N/(Pest+1)	2.31	(0.51)	3.03	(0.78)	-10.81	(2.48)	-3.874	(1.21)	-3.077	(1.70)
Wi/(Weed+1)	-0.966	(1.05)	-0.413	(0.48)	-1.518	(1.54)	-2.883	(2.77)	-1.233	(2.56)
Intercept	1612	(4.10)	1322	(4.74)	1954	(4.98)	2560	(5.47)	1900	(10.99)
R2	0.69		0.49		0.40		0.53		0.50	
s.e.	611		806		1009		807		868	
No. of obs.	74		97		119		101		391	

Figures in parentheses are computed t-values.

8.2.4 Nitrogen reponse of IR-varieties

Employing the ordinary least square (OLS) regression method, first the regression coefficients for individual crop seasons are estimated. Table 8.2.1 presents the results of these individual year regressions, together with the OLS estimates when all observations are pooled. The basic relationship appears to be relatively stable in its linear term, but the quadratic nitrogen term varies substantially over years. This indicates an increase in the instability of response to nitrogen with increasing levels of nitrogen. This effect is clearly visible in Figure 8.2.1 where for mean levels of solar radiation, the basic response surfaces for the individual years are shown. Consequently, for a given level of solar radiation, nitrogen levels for maximum yield response (Nmax) differ substantially between years, ranging from 88 kg N in 1979 to 150 kg N in 1980. The pooled estimate for Nmax is around 130 kg N with a yield response of 2.2 tons/ha. The substantial effect of water stress on nitrogen response is shown in Figure 8.2.2.

The pooled estimate of the linear interaction term between water

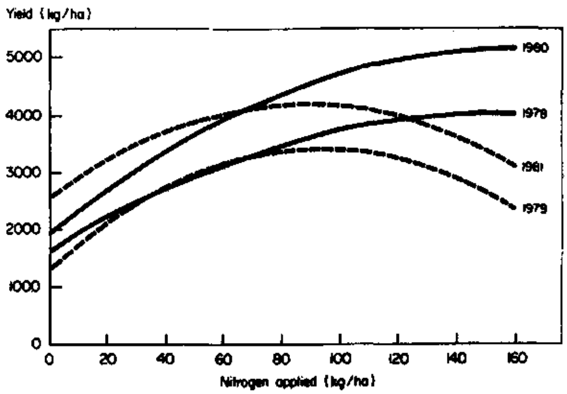


Fig. 8.2.1 Nitrogen response functions for individual years under farmers' conditions (IR-varieties)

stress and nitrogen implies a response reduction of almost 1 kg palay per stressday per kg N which - at a level of 60 kg N - amounts to 55 kg palay per stressday. Combined with the effect of water stress on the intercept yield (i.e., yield at the 0 N-level), it adds up to an overall reduction of 110 kg palay per stressday. Both water stress coefficients show a substantial variation over years. This may in part be attributed to the non-included (stochastic) effect of either the distribution of stressdays within the measurement period or to differences in periods between the application of nitrogen and the occurrence of stress.

The pooled estimates of the effect of phosphorus, pest and weed control inputs are all significant and conform to a priori expectations with regard to the sign of the coefficients. However, year-to-year variation is rather high and a number of individual

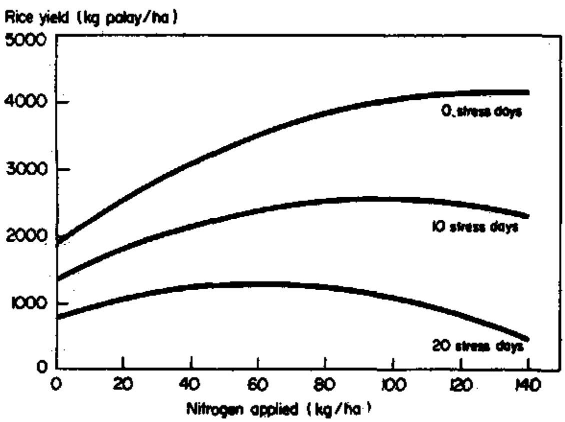


Fig. 8.2.2 Nitrogen response functions for different levels of water stress (IR-varieties)

year estimates have either the wrong sign and/or are not significant. The effect of phosphorus application is significant and relatively large for two years. Non-significant estimates occur for the other two years. In accordance with previous remarks, the effect of the pest control input is rather ambiguous. For two individual year regressions, the sign of the coefficient is positive which is contrary to expectations. Only 1980 shows a significant negative effect of some magnitude. The effect of the weed control inputs is less ambiguous. All years show the expected negative coefficient, but the magnitude of the coefficient shows a substantial between-year variation. Yield reduction for fields with a medium weed infestation index under zero weed control conditions range from 11% of the intercept yield in 1979 to 39% in 1981.

The above discussed pooled response coefficients are unbiased, but they are inefficient. To calculate an efficient estimator for the response coefficients the generalized least square (GLS) estimator must be used (Appendix VI). The results of GLS regression are given in Table 8.2.2. Both coefficients of the basic response relationship (SrN and N2) are somewhat higher compared with the OLS estimates. The higher GLS estimate for the linear nitrogen term (SrN) implies a steeper response surface. However, the stronger increase in the quadratic term mitigates this effect to a large extent and actually causes a decrease in the Nmax level from 130 kg N for the OLS estimate to 114 kg N for the GLS estimate.

Table 8.2.2 Generalized least squares estimates of the mean slope coefficients and ordinairy least squares estimates of the pooled observations

Variable	HYV varieties OLS		HYV varieties GLS		BE-3 variety OLS	
SrN	0.0013	(6.99) 1)	0.0014	(7.03)	0.0010	(2.17)
N2	-0.136	(3.88)	-0.172	(3.84)	-0.128	(1.15)
Ws	-54.37	(3.43)	-56.18	(3.41)	-71.75	(2.81)
WsN	-0.934	(3.24)	-0.780	(2.77)	0.219	(0.31)
N/(Pest+1)	-3.077	(1.70)	-2.418	(0.74)	-1.322	(0.26)
NP	0.231	(2.92)	0.197	(1.66)	0.507	(2.06)
Wi/(Weed+1)	-1.233	(2.56)	-1.391	(2.20)	-0.670	(1.15)
Wi(DSR)	-		-		-0.722	(1.53)
intercept	1900	(10.99)	1838	(6.42)	2012	(4.80)
R2	0.50				0.51	
s.e.	868				712	
No. of obs.	391		391		90	
N(max) (kg/N)	132		114		108	
Max. response (kg)	2350		2220		1485	
Max. yield (kg)	4250		4060		3500	
kg palay/kg N	17.8		19.5		13.8	

1) Figures in parentheses are computed t-values

The linear stress term is similar for both regressions, but the interaction effect with nitrogen decreases with 16% indicating a general decline in the effect of water stress in the GLS relationship. Both the pest control and the phosphorus term show a substantial drop in significance compared to the OLS level. This can be expected since both the within-year variation and the between-year variation of the coefficients are high.

Table 8.2.3 Yield response to nitrogen of HYV rice crops (irrigated fields) under farmers' and experimental (on-station) conditions

Year	Survey data (IR36)	Nmax	Nresp	Year	Experimental data (IR20) 1)	Nmax	Nresp
1978	Y = 1612 + 31.30N - 0.102N2	153	2401	1969	Y = 4989 + 55.13N - 0.285N2	97	2686
1979	= 1322 + 44.71N - 0.238N2	94	2100	1970	= 3103 + 72.00N - 0.492N2	73	2634
1980	= 1954 + 40 89N - 0.131N2	156	3191	1971	= 4039 + 31 01N - 0.180N2	86	1336
1981	= 2560 + 35.12N - 0.211N2	88	1633	1972	= 3563 + 30.66N - 0.127N2	121	1850
				1973	= 3543 + 43.10N - 0.167N2	129	2781
				1974	= 2848 + 53.59N - 0.297N2	90	2417
				1975	= 3278 + 51.45N - 0.306N2	84	2163
Mean	= 1862 + 38.01N - 0.171N2	123	2331	Mean	= 3623 + 48.13N - 0.265N2	97	2264
(c.v.)	(0.29) (0.16) (0.38)	(0.30)	(0.28)		(0.20) (0.30) (0.46)	(0.21)	(0.23)
Nresp/ Nmax (kg palay/kg N)		18.95				23.34	

1) Visayas Rice Experimental Station, Iloilo Province, Philippines. Response functions are for wet season, irrigated rice crop, IR-varieties. Nmax is the nitrogen level at which the maximum yield response is obtained and Nresp is the yield response at the Nmax level.

The estimated 'basic' nitrogen response relationship for zero water stress and optimal pest and weed control conditions is compared with experimental findings for irrigated rice crops of a nearby research station in Table 8.2.3 (4). It is rather surprising, that for mean levels of solar radiation, the mean maximum yield response under farmers' conditions (irrigated fields) is the same as the experimental response. However, the average nitrogen response over the range zero-N to Nmax is about 20% less under farmers' conditions due to a higher Nmax level caused by the combined effect of a lower linear and quadratic nitrogen term. This may indicate a generally lower efficiency in the use of nitrogenous fertilizer by farmers due to such factors as crop management, method and timing of fertilizer application, etc. However from the same table, it is clear that it is not so much the nitrogen response that causes divergence between experimental and farmers' yields, but rather the intercept yield which under farmers' conditions is about half the experimental results. This points to an overall lower level of crop management, possibly caused by a much lower degree of pest and disease control and - to a lesser extent - weed control, planting density, etc. Farmers' cost-benefit considerations with respect to input use may (in part) be the underlying reason for this lower level of input use. Higher levels of P and K in experimental designs are likely to be another major cause for the higher experimental yield intercept.

A comparison of the relative stability in the estimated coefficients reveals that both the linear and quadratic nitrogen coefficients under farmers' conditions are more stable compared with experimental results. However, their combined effect - which includes the covariance between both nitrogen terms - expressed in maximum yield response shows a higher coefficient of variation under farmers' conditions (Table 8.2.3).

8.2.5 Nitrogen response of BE-3

A substantial portion of rice land in the area is still planted to the BE-3 variety. Apart from the earlier indicated advantages this variety has over the recently introduced IR-varieties, one of the main reasons farmers continue to grow the BE-3 are the good yields that can be obtained with this variety. Most farmers argue that, under normal management conditions, the yield potential of BE-3 is quite similar to that of the IR-varieties. Results from a response function analysis tend to support this view (Figure 8.2.3).

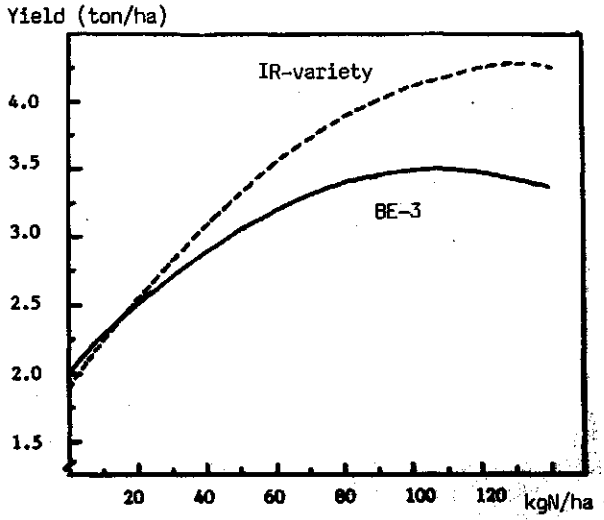


Fig. 8.2.3 Nitrogen response functions for IR-variety and BE-3

Although modern varieties are definitely more responsive to nitrogen, also under local conditions, the BE-3 variety still reaches a maximum yield of 3.5 t/ha compared to 4.3 t/ha for the modern varieties. BE-3 has a slightly higher yield when no fertilizer is applied, but mean response to the maximum N-level (108 kg N) is about 20% less compared with the mean response of IR-varieties for the maximum N-level of 132 kg N. The significant and more pronounced effect of applied phosphorus on nitrogen reponse for the BE-3 is rather unexpected, but may be due to a severer phosphorus deficiency in the plain areas where this crop is usually grown.

Varieties also differ with respect to the influence of water stress on yield. Although in both cases one would expect water stress to adversely influence nitrogen response, in contrast with the modern varieties, no significant effect of water stress on nitrogen response was found for the BE-3 variety. However, the influence of water stress on total yield is substantial as indicated by the significant coefficient of the water stress variable. The magnitude of this coefficient is substantially higher than the coefficient for the IR-varieties. This finding, however, should be carefully considered as the occurrence of water stress is rare for BE-3 crops. During the four year survey period, a severe stress situation occurred once, clearly to the surprise of farmers. In the 1979 crop season, low moisture conditions started to develop in the month of September, at the end of which month farmers usually apply fertilizer to BE-3 crops. Application of fertilizer was delayed by 3 to 4 weeks and farmers gave below normal dosages. A subsequent drought after fertilization prevented farmers from applying a second dose. Hence, for BE-3 severe water stress tends to go together with low levels of fertilizer giving rise to the non-significant interaction between water stress and fertilizer.

The negative effect on yield of the non-application of weed control inputs in transplanted BE-3 crops is about half when BE-3 is dry seeded. This shows the surpressing effect transplanting has on the level of weed infestation. For dry seeded BE-3 crops, the effect of weed control inputs is very similar to direct seeded HYV crops as indicated by the combined effect of the two weed control variables in the BE-3 response relationship. Pest control inputs appear to have less influence on yield and are not significant for similar reasons as mentioned for the modern varieties.

8.3 Assessing the risk of fertilizer use

On the basis of the above derived response relationships, it is now possible to estimate the variability in nitrogen response for any level of nitrogen given certain values for the non-nitrogen related decision input factors. The estimation procedure involves two steps. It is best understood in terms of the two components of response variability that can be distinguished in the above described response specification:

- A specific variance component comprising the response variability due to the effect of the stochastic variables (risk factors) that are included in the response relationship: water stress and solar radiation.
- A random variance component which contains the response variability due to the random variance of the regression coefficients. This variance is assumed to find its main source in unspecified risk factors influencing the fertilizer response relationship.

Yield risk due to the incidence of water stress during the reproductive growth period

The above derived response relationships indicate the profound effect water stress may have on the yield of rice crops during the reproductive growth stage. Below, the simplified response functions for HYVs and BE-3 are given. They only include nitrogen and water stress as variables. The other variables are set at their mean value. In order to allow a comparison between the GLS-function of the HYV crops and the OLS-function of BE-3, an adjustment had to made in the coefficients of the BE-3 response function. We opted for an adjusted BE-3 function, rather than to use the inefficient estimates from the OLS-regression for the HYV crops. The adjustment was made on the basis of the percent change in magnitude of the coefficients between the OLS and GLS estimates of the HYV response function.

$$\text{HYV (1st)}: Y = 1838 + 39.05N - 0.172N2 - 56.18Ws - 0.78WsN \quad (7a)$$

$$\text{BE-3}: Y = 1946 + 30.05N - 0.161N2 - 74.14Ws - 0.18WsN \quad (7b)$$

For both HYVs and BE-3 it is estimated that for a medium nitrogen level of 60 kg N for each stressday output is reduced by 100 kg palay. However, in contrast with HYVs, the effect of water stress on yield of BE-3 is much less dependent upon the level of applied nitrogen.

To determine the effect of the stochastic variables on response variability, the values of the stochastic variables have to be plugged into the response function and the associated response for selected levels of nitrogen needs to be calculated. The probability of occurrence of such 'response state' is given by the probability of occurrence of its associated 'water stress state'. In this way a probability distribution of yield response for different levels of nitrogen can be obtained.

An alternative approach is to determine a 'variance function' of response which directly relates the variance of the stochastic variables to the variance in response. Given the simplified response relationship for HYVs

$$YR(i) = 39.05\ N - 0.172\ N^2 - 0.78\ Ws(i)N + + 0.197\ NP - 2.42\ N/Pest \quad (8)$$

where YR(i) is the nitrogen response dependent upon the stochastic value of water stress 'state' (i) conditional on the input levels of nitrogen (N), phophorus (P), and pesticides (Pest), the variance of this response is given by

$$\text{Var}\ (YR \mid N,P,Pest)_{Ws} = \sum_{i=1}^{n} P(i) * (YR(i) - E(YR))^2 \quad (9)$$

where P(i) is the probability of the occurrence of the ith water stress state. Substituting (8) in (9) we get

$$\text{Var}\ (YR \mid N,P,Pest)_{Ws} = \sum_{i=1}^{n} P(i) * (-0.78\ Ws(i)N + 0.78\ E(Ws)N)^2$$

$$= (0.78\ N)^2 * \sum_{i=1}^{n} P(i) * (Ws(i) - E(Ws))^2 \quad (10)$$

Hence, the variance of nitrogen response can be directly related to the variance in the number of water stressdays and, due to the particular specification of the response equation, is functionally related to the square term of nitrogen. Of course, in a similar way, it is possible to specify any other moment of the nitrogen response distribution as a function of nitrogen and water stress.

Frequency distributions of the occurrence of different water stress states were generated by running a time-series of 54 years of rainfall data from a nearby rainfall station through the water balance simulation model mentioned earlier (Bolton and Zandstra, 1980). For both the first and second rice crops, the simulated date of planting was made conditional on sufficient water availability for land preparation and crop establishment. To determine the length of the land preparation period, similar parameters were used as for the cropping pattern simulation model described earlier. In order to investigate possible establishment dates of second rice crops, the harvesting date of the first rice crop was fixed at 3 weeks intervals The occurrence of water stress for second rice crops depends, to a large extent, on the date of planting which, in turn, depends on the date of planting of the first rice crop,. Water was drained to a level considered feasible during the harvesting operation of the first crop. Land preparation for the second crop could start after a sufficient amount of water had accumulated and continued if a certain moisture level could be maintained, followed by crop establishment.

Rice crops were considered not to yield when more than 30 stressdays had occurred. Although this may seem to be an optimistic assumption (three-fourths of the reproductive growth stage), it does not imply that the crop is under severe stress conditions during the entire period. Since water stress is defined to begin with a soil moisture condition when plants start to experience problems with extracting soil moisture, the severity of water stress will increase with the duration of a continuous stress period. Consequently, water stress is not a homogeneous input variable. However, the likelihood of a continuous stress period will increase with the duration of the stress period.

Table 8.3.1 shows the results of the water stress simulation for direct seeded first HYV crops. Except for the sideslope position, none of the rice crops run the risk of complete failure due to water stress. In the same table optimal N-levels and associated predicted yields are given derived from the earlier estimated response equations (7a) and (7b), taking into account expected water stress levels and the mean (deflated) nitrogen/palay price ratio over the four year survey period. This price ratio also includes the common harvesting share arrangement and cost of capital. The relative variation (indicated by the coefficient of variation) in nitrogen response is highest for the sideslope areas and declines as the water supply to fields improves.

Table 8.3.1 Simulated water stress levels by land unit

Land unit	E(Ws) (day)	SD(Ws) (day)	Prob. (Ws 1) (%)	Prob. (Ws 25) (%)	Nopt (kg)	Pred. yield (ton)	c.v. yield
<u>HYV (1st crop)</u>							
sideslope	12.3	9.4	13.0	11.0	63.5	2.3	0.42
plateau rainfed	6.7	7.8	33.3	3.7	76.1	3.0	0.29
plain rainfed	3.5	6.4	61.1	1.9	83.4	3.5	0.22
waterway	1.7	5.3	61.1	0	87.5	3.7	0.18
part. irrigated	-	-	-	-	91.4	4.0	-
<u>BE-3</u>							
plain rainfed	2.6	5.2	64.0	0	69.5	3.1	0.13
waterway	1.8	4.9	82.0	0	69.5	3.1	0.12

E(Ws) is the mean number of water stress days; SD(Ws) is the standard deviation; Prob. (WS 1) indicates the probability that the number of water stress days are less or equal to 1; Prob. WS 25) indicates the probability of water stress days being 25 or above; Nopt is the economic optimum fertilizer level; Pred. yield is predicted yield for the economic optimum fertilizer level; and c.v. yield is the coefficient of the predicted yield level.

Despite its later harvesting date, the risk of fertilization of the traditional BE-3 crops is relatively low. This appears to be primarily due to the weak interaction between nitrogen and water stress, probably resulting from the late application date of fertilizer in BE-3 crops. Also the incidence of water stress in BE-3 crops is low because these crops are usually grown on the lower part of the toposequence. Since early application would result in excessive vegetative growth, farmers usually apply fertilizer around the third week of September, the date of the annual fiesta of the nearby town. At this time, plants have a considerable height allowing the ponding of a substantial amount of water in rice fields which for BE-3 are usually confined to plain areas which allow relatively high bunds. If sufficient water is available at this time, water stress is not likely to occur during the reproductive stage. If water availability is insufficient, farmers may adjust fertilizer levels downwards and wait for sufficient water conditions to occur at a later stage, after which they still have the option to apply an additional dosage of fertilizer. Hence, on the basis of water availability in September, farmers may reduce return risk to nitrogen by adjusting fertilizer levels to actual water conditions at the time of fertilization, i.e., the water stress effect works primarily through the intercept term.

In contrast, early application of fertilizer in the case of modern varieties is important to induce tillering. Since application occurs at a stage when plants are still small, only a limited amount of water can be accumulated in the field. Hence, at the time of the first fertilizer application the likelihood of water stress during the reproductive growth stage is unpredictable, and consequently, adaptation of fertilizer levels does not occur as is

Table 8.3.2 Simulated water stress levels by land unit and planting date

Land unit	E(Ws) (day)	SD(Ws) (day)	Prob. (Ws 1) (%)	Prob. (Ws 25) (%)	Prob. no pl. ($)	Nopt (kg)	Pred. yield (ton)	c.v. yield
<u>week 39</u>								
rainfed	11.2	11.6	29.8	19.1	6	56.4	2.2	0.53
waterway	7.7	10.9	44.9	12.2	2	64.3	2.6	0.44
part. irrigated	4.5	8.1	59.2	6.1	2	71.6	3.0	0.30
<u>week 42</u>								
rainfed	17.8	11.3	9.3	37.2	14	41.4	1.5	0.69
waterway	13.0	12.0	24.4	28.8	8	52.3	2.0	0.59
part. irrigated	8.5	9.3	29.8	8.5	6	62.5	2.5	0.39
<u>week 45</u>								
rainfed	25.0	9.3	0	74.3	30	25.1	0.7	0.95
waterway	22.2	10.2	5.1	53.8	22	31.5	1.0	0.81
part. irrigated	17.4	11.6	4.9	39.0	18	42.3	1.5	0.56

E(Ws) the is mean number of water stress days; SD(Ws) is the standard deviation; Prob. (WS 1) indicates the probability that the number of water stress days are less or equal to 1; Prob. WS 25) indicates the probability of water stress days being 25 or above; Prob. no pl. gives the probability that second rice crops cannot be planted; Nopt is the economic optimum fertilizer level; Pred. yield is predicted yield for the economic optimum fertilizer level; and c.v. yield is the coefficient of the predicted yield level.

the case with the traditional variety.

The occurrence of water stress in second direct-seeded HYV crops largely depends on the date the crop is established. From Table 8.3.2 it can be seen that the probability that water stress occurs as well as the duration of the stress period sharply increases as the seeding date is later. The relationship between stressdays and planting date is more or less linear indicating increasing risk in terms of an increasing chance of a higher loss. A similar linear relationship between predicted grain yield and planting date was found by Bolton (1980).

The utmost importance of timely planting is due to the nature of the wet seeded method of crop establishment and the particular pattern of late season rainfall. During the initial growth period of wet seeded rice crops, the water level in the field can only be increased gradually with the gaining of height of the rice seedlings. Thus, second rice crops are very much dependent on the erratic late season rainfall mainly consisting of a number of widely scattered periods of heavy rainfall. If such rainfall cannot be stored in rice fields because rice plants are still too small, or if the root system has not been developed enough to reach the receding ground water table, prolonged periods of water stress are likely to occur.

This results in a rather peculiar shape of the frequency distribution of water stress distribution. A considerable portion of the probability weight is either found in the upper or lower tail of the distribution or in both depending on the date of seeding. Moreover, because we are dealing with a frequency distribution with two distinct end-points (i.e., zero stress and stress causing crop failure), there is of course a tendency for the probability distribution to gradually change its shape from being skewed to the left for the early seeded crops to being skewed to the right for the late seeded crops. Because of the skewness of the probability distribution of yield, representing risk of water stress with a variance measure is, to a large extent, inadequate (5).

Yield risk due to other environmental factors

As was indicated earlier, to the extent that important risk factors are not included in the response function, such uncertain variable influences are translated into unstable response coefficients over the years. On the basis of the variances and covariances of the estimated response coefficients, the remaining part of the yield risk, i.e, risk due to environmental factors other than water stress, can be assessed. The variance-covariance matrix of the response coefficients can be estimated through equation 6 given in Appendix VI. Based on the variance measure

$$\mathrm{Var}\ (YR \mid X)_{RCR} = X'\ d^2\ X \qquad (11)$$

where d^2 is the variance-covariance matrix of the slope coefficients (Table 8.3.3) and 'X' is the vector of independent variables included in the regression, we can derive a 'variance function' of response, which gives the variability in yield response due to risk factors other than water stress for any combination of independent variables. Unfortunately, this additional risk analysis can only be carried out for HYV crops. Insufficient data for BE-3 prevented the estimation of the

Table 8.3.3 Variance-covariance and correlation matrix of the individual year regression coefficients

	SrN ('00,000)	Ws	WsN ('00)	N/(Pest+1)	N2 ('000)	NP ('00)	Wi/(Weed+1)
Variance-covariance matrix							
SrN	352						
Ws	15.1	313					
WsN	153	-316	527				
N/(Pest+1)	-24.2	15	-87.6	31.2			
N2	-667	536	-547	-79.8	3120		
NP	-275	-105	-110	54.7	134	300	
Wi/(Weed+1)	4.48	14	17.1	2.67	4.19	-4.38	0.844
Correlation matrix							
Ws	0.05						
WsN	0.36	0.78					
N/(Pest+1)	-0.23	0.15	-0.68				
N2	0.64	0.54	-0.43	-0.26			
NP	-0.85	-0.34	-0.28	0.57	0.14		
Wi/(Weed+1)	0.26	0.86	0.81	0.52	0.08	-0.28	

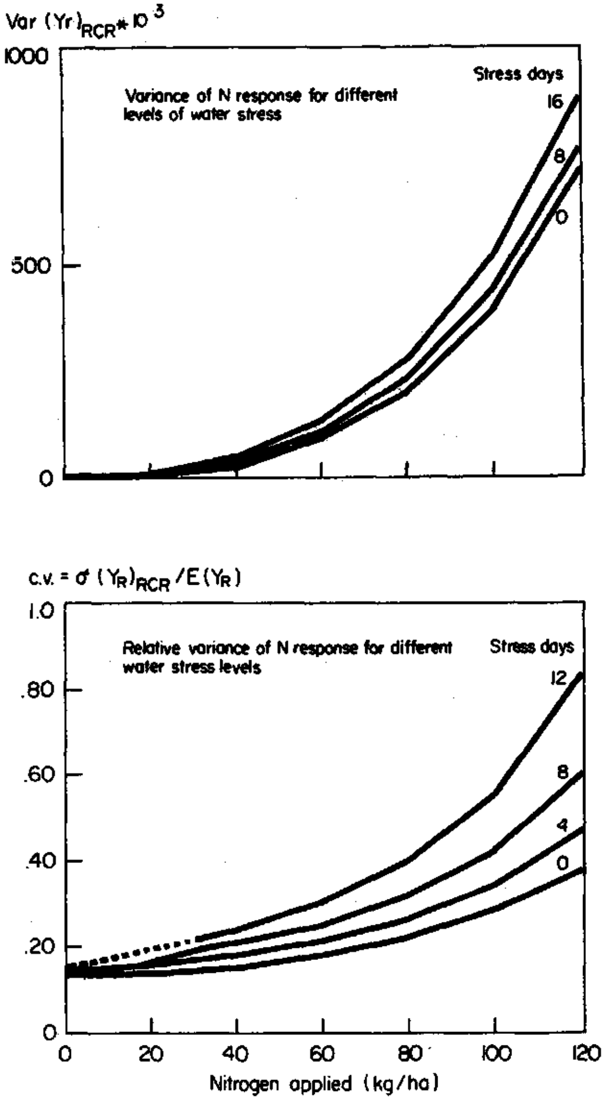


Fig. 8.3.1 The variance and coefficient of variation of nitrogen response due to the influence of water stress for different levels of water stress incidence (IR-varieties)

variance-covariance matrix of the slope coefficients.

Since we are only interested here in nitrogen response variability, we omitted from the variance function those variables having a constant contribution to variance, i.e., those variables that do not interact with nitrogen (Ws and Wi/Weed). With no phosphorus input, and the pest control input valued at its mean value, the variance function for the HYV crops can be computed through matrix multiplication (equation 11). It is given by

$$\begin{aligned} \mathrm{Var}\ (YR(i) \mid N,P,Pest)_{RCR} &= 36.09\ N + 26.99\ N^2 - 0.185\ N^3 \\ &+ 0.00312\ N^4 + (4.625\ N + 0.935\ N^2 - 0.00547\ N^3)\ WS(i) \\ &+ (-3.16\ N + 0.0527\ N^2)\ Ws(i)^2 \end{aligned} \tag{12}$$

The effect of nitrogen use on the response variance for different levels of water stress is depicted in Figure 8.3.1. It shows that the response variance due to risk factors other than water stress sharply increases with increasing levels of nitrogen, but that it is more or less independent of the water stress level. However, if the response variance is evaluated relative to the yield response (indicated by the coefficient of variation), substantial increases occur in response variability with increasing levels of water stress.

Overall nitrogen response risk

Finally, when the variance functions (10) and (12) are combined, the joint frequency distribution of nitrogen response for any rice crop/land unit combination can be determined, indicating the nitrogen response variability due to water stress and other (non-specified) risk factors (Huijsman, 1980). For two land units, the total response variability and the coefficient of variation for first wet seeded HYV crops are depicted in Figure 8.3.2. For the same land unit, cumulative density functions of net returns to nitrogen for different levels of nitrogen are given in Figure 8.3.3.

8.4 Farmers' perceptions and attitudes towards risk of fertilizer use

Above it was empirically established that under rainfed conditions, the risk of fertilizer use substantially increases with increasing rates of applied fertilizer. The question is do farmers also perceive such risk and do risk perceptions differ among farmers? As early as 1964, Misra (1964) hypothesized that in decisions about the selection of agricultural techniques farmers' outcome perceptions and feelings about the risks associated with techniques were important factors explaining observed differences in actual applied fertilizer levels among farmers.

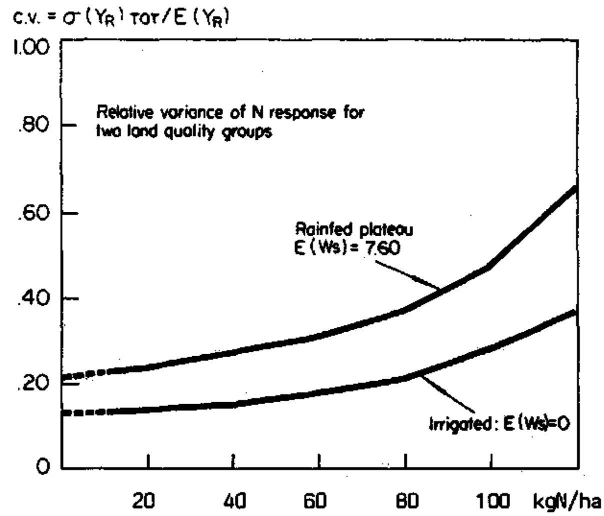


Fig. 8.3.2 Coefficient of variation of nitrogen response due to the overall influence of risk factors for rainfed plateau and irrigated fields (first crop, IR-varieties)

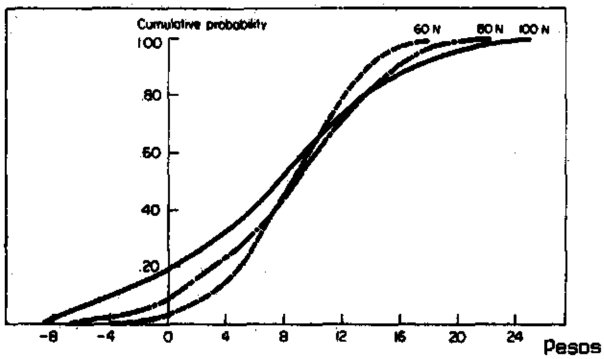


Fig. 8.3.3 Cumulative density functions of net returns to nitrogen (rainfed plateau fields, IR-varieties)

8.4.1 Farmers' perception of fertilizer response

Limited research experience has been obtained sofar with the elicitation of farmers' yield perceptions. In Section 3.3.1, biases and problems surrounding the elicitation as well as interpretation of return and risk perceptions were discussed. The employed techniques are still largely experimental, particularly when applied within the context of semi-subsistence farmers. Careful interpretion of results of any employed elicitation method is thus warranted. Further, for this particular study, the absence of experienced researchers in the field of applied psychology and anthropology during the fieldwork period was felt as a severe drawback with respect to the interpretation of observations made during the interviews as well as the results derived from these interviews. Consequently, the findings presented below are inevitably, to a large extent, speculative.

Dynamic yield expectations

An initial attempt to elicit farmers' feelings with respect to rice yields involved the simple procedure to ask farmers at two-week intervals to express their feelings concerning the rice yield, given the actual stand of the crop, in terms of the best possible, worst possible, and most likely yield (i.e., a triangular distribution (TD)) to be expected for all their major rice crops. The main purpose of this relatively intensive survey technique was to shed more light on the issue of how yield expectations developed during the crop growth cycle, i.e., whether and how farmers adjust yield perceptions in the course of crop development, specifically under adverse environmental conditions, and whether such expectations relate to actual decisions made. Since expectations were formulated for actual crop situations, it was expected that farmers would find it less difficult to express themselves compared to imaginary situations. To avoid anchoring on previous expectations, farmers had to formulate 'fresh' perceptions each time, without being given their estimates of two weeks before. In the course of two years the following observations were made:

First, farmers were reluctant (or found it meaningless) to express yield expectations prior to the stage that the crop was fully established, i.e., two to three weeks after seeding in case of wet seeded crops. Initial crop establishment is seen as a critical stage to further crop development as it determines, to a large extent, both the degree to which the crop can withstand future adverse conditions successfully and the inputs needed for weeding and replanting. Since farmers appear to require the actual crop status on which to base their expectations, it appears doubtful whether expectations formulated prior to crop establishment are relevant to decisions made later in the growth cycle of the crop.

Second, farmers had difficulty in expressing the 'most likely' yield estimate. This is rather surprising as one would intuitively expect this particular yield expectation to strike first in the mind of farmers as it is closest to what farmers usually obtain. However, in rainfed areas, modal values may not be clear in yield distributions. Furthermore. the concept presupposes that farmers think in probabilistic terms and combine yield information over a considerable number of years. It appears that farmers base their perceptions of a 'most likely' yield on a conservative estimate of the best yield they (or their father) ever obtained. That is, they have a strong tendency to anchor on the 'best possible' yield and then to adjust downwards to arrive at a 'most likely' yield expectation. Given this observation, it is questionable whether 'most likely' yield perceptions or, alternatively, modal values of yield distributions have an operational meaning in actual decision making. This observation supports the view of Shackle (1961) that farmers perceive yield variability in terms of simple ranges rather than in terms of a number of particular yield levels with attached probabilities.

Third, hypotheses regarding the adjustment of yield expectations in the course of crop development were at odds with actual findings. The initial yield range perceived by farmers was expected to include all later expectations, whereas the perceived yield ranges were expected to become smaller the closer the crop would be to the stage of maturity. That with the passage of time uncertainty with respect to final yield would decrease and, consequently, input applications at the later growth stages of the rice crop would be considered less risky compared to inputs at the beginning of the crop growth period.

With respect to the first issue, it was a commonly observed phenomenon that end-points of later perceived ranges were above or below the end-points of the initial perceived range. It appears that instead of taking into account all possible yield levels in their initial yield range expectations, farmers rather perceive a section of the potential range which lies well within the mid of this range. They seem to focus on a 'most likely' yield range based on a normal crop development given the initial stand of the crop and planned levels of inputs, rather than taking into account low probability yields at the tails of the yield distribution. Depending on actual crop growth development, ranges are subsequently adjusted upward and downward or - more commonly - only one of the end-points is adjusted in consecutive expectations. Figure 8.4.1 shows a number of examples of how farmers adjusted yield expectations in reaction to the occurrence of water stress in dry seeded rice crops. Unless a severe stress situation develops, zero yield expectations are not included in farmers' perceptions, not even for the second rice crops which are generally considered by farmers to be risky. If a severe stress situation occurs, farmers are reluctant to express any expectation at all.

Although, the hypothesized tendency that the 'best possible' and 'worst possible' yield expectation would converge in the course of crop growth was generally apparent, perceived yield ranges still

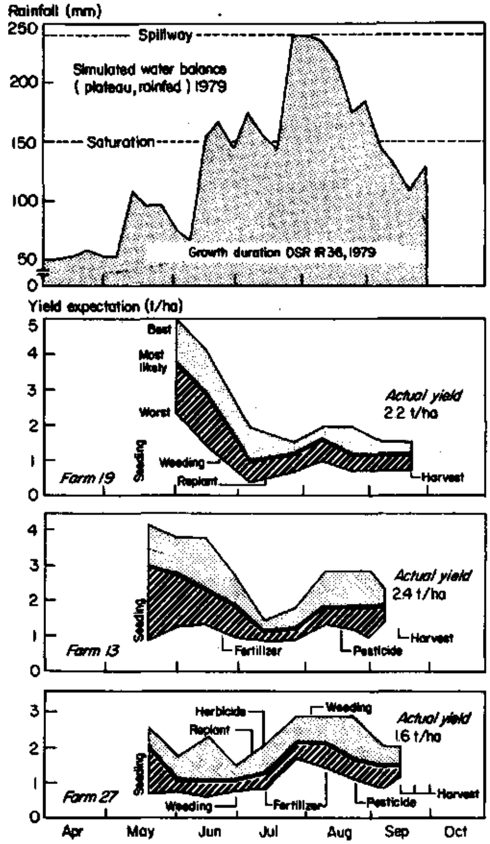


Fig. 8.4.1 Adjustment of farmers' yield expectations in the course of crop development (1979)

remained fairly wide until harvesting. It should be realized, however, that the extent to which such convergence can be expected depends on the distribution of the various risk factors over the growth cycle of the rice plant as well as their relative importance in terms of their likely effect on yield. As indicated earlier, healthy vegetative crop growth is an essential but not the only condition for high yields. Final yields critically depend on the panicle and spikelet stage which occurs at about two-thirds of the life-cycle of the plant. Any stress exerted on the plant during this stage may cause substantial yield reduction. Furthermore, even if a crop reaches full maturity, accurate estimates of final grain yield may be difficult to make because grain yields depend on a combination of factors such as stand density, panicle and spikelet number as well as the percentage of properly filled grains. These factors often show a high within-field variation caused by differences in water depth and spot infestations of pest and diseases. Finally, farmers who are not experienced in the cultivation of modern varieties may find it difficult to estimate final grain yields because of the different plant type.

Although, farmers do not seem to actively anticipate adverse crop conditions, they do at least not reveal such attitude in their yield expectations, such observation should be made carefully because of the possibility of semantic inaccuracies in the questioning procedure. The local dialect lacks words to exactly translate probability heuristics used in the survey technique. Concepts like 'the most likely' translate into local expressions such as husto lang (it is normal) or igo-igo lang (it is enough), whereas 'worst possible' translates into 'very bad' (minus or pigaw). The exception forms the 'best possible' heuristic for which the local dialect has the expression jackpatan (you win the jackpot). Partly due to these semantic inaccuracies there is a danger of range contraction bias, especially because of too optimistic expectations at the lower end of the range. Although, it was initially indicated to farmers that 'worst possible' could also include zero-yield expectations, this was not repeated during the survey to avoid the potential danger of steering perceptions into a certain direction.

Contraction of perceived yield ranges

An attempt was made to investigate the relative magnitude of this bias. A number of farmers were asked to evaluate yield variability using a technique known as the 'visual counter (VC) method'. A chart is prepared showing a number of discrete intervals along a yield range. The yield range given by the maximum and minimum yield level is ascertained from the farmer. The farmer is then given a number of counters (e.g. 25 matches). He is requested to allocate the counters over the intervals along the yield range in such a way that, if he believes a certain yield interval to occur more frequently than another, he puts more counters in that interval. The ratio of the cell frequencies to the total number of counters indicates the probability of the corresponding yield interval. The probabilities may be accumulated at each cell, and when plotted against the yield range, a cumulative density function can be drawn.

It was expected that this method would result in more reliable responses. Since zero-yield levels are automatically included as outcome possibility, farmers are forced to think about low probability events. Furthermore, farmers can take more time in contemplating and reflecting upon their yield expectations. Before farmers were actually able to apply the method, a considerable effort in explaining the technique was required and in most cases an example had first to be shown which, of course, may have biased farmers' responses. The manner in which farmers reacted to the technique differed substantially. Certain farmers found it quite interesting and carefully distributed the counters over the yield range, whereas others found it (but politely did not say so) the craziest thing they ever did in their lives. In general, it was felt that - in spite of the fact that it was related to an actual crop situation - the technique was too abstract as indicated by a young farmer who exclaimed: 'how can you expect me to think in terms of 25 years (the number of counters used). I am only farming for 6 years!'.

Although, most farmers finally complied with the method, it remains questionable what the value is of the resulting cumulative density function. Since the method is based on the assumption that farmers can attach probability weights to the occurrence of different 'states' of a continuous variable (yield), the resulting distribution may imply a certain sophistication in farmers' ability to assess the occurrence of uncertain events which is simply not valid. However, the endpoints of the density function may better reflect the potential yield range farmers perceive. Table 8.4.1 shows a comparison between yield range expectations elicited through the 'triangular distribution' (TD) method and the 'visual counter' (VC) method for a sample of 19 farmers growing BE-3 crops in the season of 1980.

Table 8.4.1 Comparison between yield expectations (ton/ha) elicited through the 'triangular distribution' (TD) method and the 'visual counter' (VC) method, BE-3 rice variety (19 respondents)

Yield expect.	VC	TD				
Most likely (ML)	2.16 (0.37) 1)	2.28 (0.47)	Average % difference (abs.) between TD and VC ML-values	= 6.5%;	within 10% range	= 76%
Worst possible (WP)	0.26 (0.32)	1.47 (0.39)	Average probability WP(VC) ≤ WP(TD)	= 19.9%;	within 15-30% range	= 76%
Best possible (BP)	3.72 (0.39)	3.16 (0.49)	Average probability WP(VC) ≥ WP(TD)	= 9.5%;	within 0-15% range	= 82%

1) Figures in parentheses are coefficients of variation.

It appears that the TD-method results in a more or less systematic contraction of the expected yield range when compared with results derived through the VC-method. In contrast to the former method, expectations elicited through the VC-method frequently include zero-yield outcomes, albeit at low probability levels. Visual comparison of the VC cumulative density functions with the discrete values of the TD distribution learns that the probability of lower tail VC-values falling below the 'worst possible' TD-expectation is about 20% on average. Of the upper tail VC-values, roughly 10% are above 'Best possible' TD-expectation. This finding applies to most farmers. For roughly three-quarters of the farmers, lower tail VC-values are below the 'worst possible' TD-expectation in the probability range of 15 to 30%, whereas upper tail VC-values are above TD-expectations in the range 0 to 15%. The 'most likely' expectations are, on average, very similar for both methods, but for some farmers deviations between both types of expectations are substantial. Still, in most cases the 'most likely' TD-expectation does not differ more than 10% from the modal value of the VC-distribution.

Since expectations are influenced by the type of elicitation method, the question arises what type of expectations may best represent farmers' feelings with respect to yield uncertainty in actual decision making. Given the likely situation that farmers perceive yield uncertainty in terms of ranges and base their decisions on 'best' and 'worst' outcomes, the question is what elicited yield range best reflects farmers' feelings. To the extent that differences between methods are systematic - as it appears to be in this case - for practical reasons such question may not require specific attention since, irrespective of what yield range perceptions are used, choices would be identical in both cases. However, to facilitate choice between certain types of risky alternatives, a probability based truncation of the yield range may be required. It is, for example, quite easy to construct two alternatives that are identical with respect to expected return as well as the end-points of the yield range, but are different with respect to yield variability and yield risk. The idea is to make one of the distributions more 'peaked' than the other. Choice between such alternatives based on the real endpoints of the yield range would be indeterminate. However, if endpoints are taken at some probability level, the adjusted endpoints will be different and choice including risk considerations will be possible (Figure 8.4.2).

The main conclusion that can be derived from the above findings is that farmers neither actively anticipate severe adverse nor very favourable environmental crop growth conditions. Initial yield range expectations as well as subsequent expectations under normal growth conditions do not include yield levels at the tails of the yield probability distribution. Unless adverse crop conditions develop, yield expectations are relatively stable until the reproductive stage after which the perceived yield range becomes narrower towards the harvesting date. If a stress situation occurs, farmers adjust their yield expectations on the basis of actual crop development.

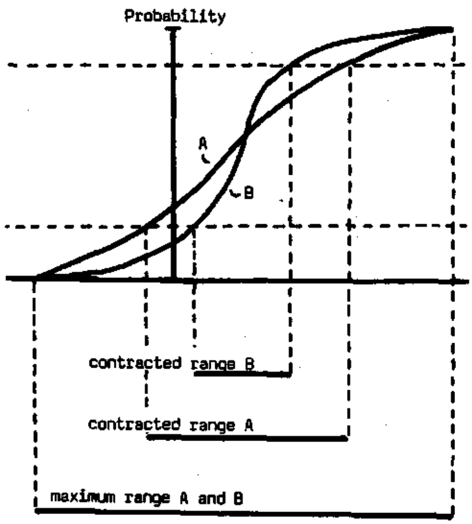


Figure 8.4.2 Contraction of yield ranges

Thus, it appears that instead of perceiving the whole range of possible yield levels in their initial yield expectations, farmers perceive a truncated version of this range with an implied risk perception that may be considered rather optimistic. Initial worst return expectations are not based on the worst possible yield ever experienced or expected, but rather on values that are substantially above this level. These 'worst possible' expectations may be related to what Simon (1955) refers to as a reference point for feelings of failure or to Shackle's focus loss concept (Shackle, 1961). On the other hand, farmers explain their optimistic view of lowest returns with a kind of 'peace of mind' argument: 'Why would we always worry about the worst possible. If you keep on thinking what may happen to your crops you better stop farming, (otherwise) you get grazy!'.

Finally, since farmers adjust their yield expectations on the basis of actual crop development, the question arises to what extent initial yield expectations can be employed to explain farmers' behaviour with respect to inputs that are sequentially applied or to what extent it is valid to formulate recommendations based on such expectations.

Fertilizer response perception

For a more elaborate survey concerning fertilizer response perceptions of farmers, the 'triangular distribution' elicitation procedure was used. It appeared that farmers could more easily relate to this procedure, while it is also much less time demanding compared to the 'visual counter' method. The results presented below, although obtained for specific fields of farmers, do not relate to actual crop situations. Therefore, in view of the earlier made observation concerning abstract questions, farmers may have had some problems in relating to the questioning procedure. However, at the time of the survey farmers were quite experienced in this technique. Moreover, if it is assumed that inaccuracies and biases are similar for all farmers in the sample, relative differences in perception may be used to explain relative differences in actual fertilizer application levels.

Farmers were asked to express their feelings with respect to final yield states given different levels of nitrogen. The questions were posed in terms of: 'if you apply 'x bags' of urea to a particular crop on parcel A, what do you expect as the best possible yield and what as the worst possible yield', followed by 'what do you expect as the most likely yield'. This was asked for five levels of nitrogen (0, 1.5, 3, 5, 7 bags of urea per hectare) for different types of rice crops. To facilitate comparison between farmers, parcels were chosen as much as possible in the same land unit class (plain waterway). For other land unit classes, response perceptions were elicited for two nitrogen levels (1.5 and 3 bags/ha of urea). These subjective nitrogen response perceptions are used in the regression analysis presented in Section 8.5.

Table 8.4.2 Subjective nitrogen response perceptions (plain waterway); average 25 sample farmers

Nitrogen level (kg/ha)	Worst possible (ton/ha)	Most likely (ton/ha)	Best possible (ton/ha)	Mean expectation (ton/ha)	c.v.
HYV (1st crop)					
0	1.03 (.26) 1)	1.45 (.23)	1.99 (.19)	1.42 (.21)	0.18
34.5	1.45 (.23)	2.35 (.23)	3.14 (.16)	2.25 (.18)	0.21
69.0	1.68 (.24)	2.80 (.23)	3.69 (.15)	2.66 (.18)	0.21
115.0	1.92 (.23)	3.21 (.23)	4.18 (.14)	3.05 (.17)	0.21
161.0	2.25 (.18)	3.64 (.20)	4.57 (.13)	3.46 (.15)	0.19
HYV (1st crop)					
0	0.90 (.28)	1.37 (.27)	1.91 (.24)	1.33 (.24)	0.20
34.5	1.37 (.24)	2.24 (.21)	3.04 (.17)	2.14 (.18)	0.21
69.0	1.64 (.23)	2.63 (.22)	3.44 (.15)	2.51 (.17)	0.20
115.0	1.86 (.21)	2.95 (.20)	3.77 (.13)	2.81 (.16)	0.19
161.0	2.07 (.20)	3.25 (.19)	4.04 (.13)	3.09 (.15)	0.18
BE-3					
0	0.61 (.38)	1.20 (.28)	1.75 (.23)	1.14 (.25)	0.27
34.5	1.12 (.25)	2.04 (.22)	2.85 (.17)	1.94 (.19)	0.24
69.0	1.35 (.22)	2.50 (.23)	3.34 (.15)	2.35 (.18)	0.24
115.0	1.54 (.22)	2.86 (.21)	3.77 (.14)	2.69 (.16)	0.24
161.0	1.72 (.20)	3.23 (.21)	4.14 (.14)	3.02 (.16)	0.23

1) Figures in parentheses are coefficients of variation (c.v.)

Table 8.4.2 shows the results for three different crop types (dry seeded rice is excluded because of its similarity with the first wet seeded crop) for the sample of 25 farmers. At all levels of fertilizer and for all 'crop states', the wet seeded rice crop performs best in the view of farmers followed by the traditional BE-3 crop which at low levels of fertilizer performs better than the second wet seeded rice crop. Differences in perception between farmers - given by the coefficient of variation - tend to decline with increasing levels of fertilizer. They are greatest for the 'worst possible' perceptions and lowest for the 'best possible' estimate. This seems to indicate that farmers' perceptions conform closer when yields tend to move towards their maximum. That is, perceptions differ particularly for sub-optimal growth conditions either in terms of the effect of environmental stress conditions or low levels of fertilizers.

A comparison between the mean subjective response estimates and the empirical response function is shown in Figure 8.4.3. For nitrogen levels up to about 100 kg N, the shapes of the empirical and subjective response functions are surprisingly similar for the first HYV and BE-3 crops. At higher N-levels farmers still perceive a more or less linear response to nitrogen, whereas the empirical response declines. This divergence is probably due to the fact that, on the one hand, most farmers have no experience with N-levels above 80 kg and simply anchor their perceptions on their response experience in the trajectory of say 60 to 80 kg N

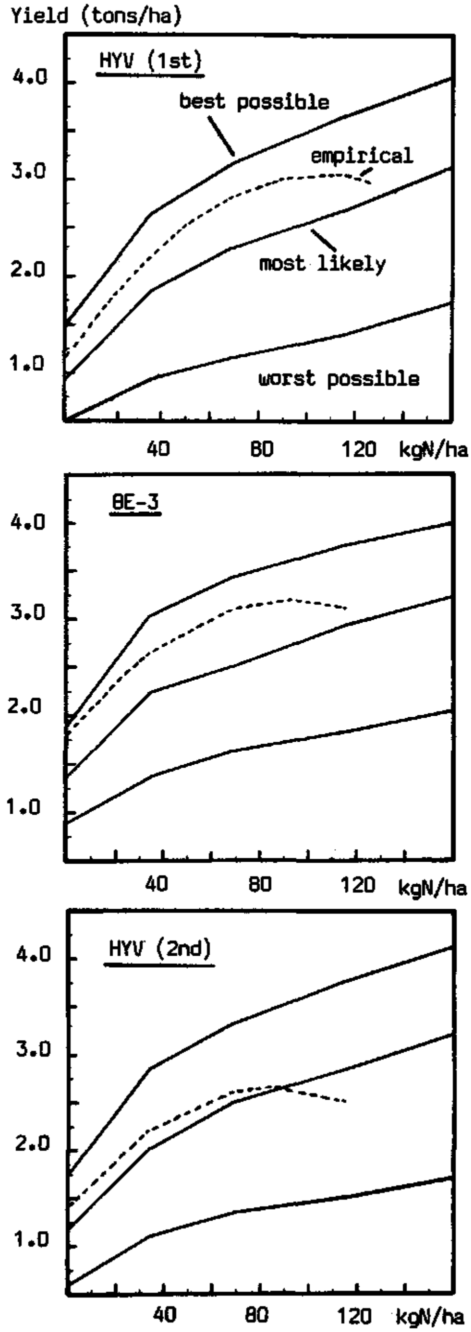


Figure 8.4.3 Subjective response functions for three types of crops for three types of crop conditions

(which explains the almost linear response above the 60 kg N level). On the other hand, the divergence may be too accentuated due to the employed quadratic response function which may poorly represent actual response at higher N-levels.

An alternative reason explaining the linear response at high N-levels is that farmers may implicitly change perceived crop conditions when considering high fertilizer application levels. This may in part be due to the way in which the reponse questions were framed, i.e., 'if you apply so much fertilizer what do you expect?'. Since farmers think in terms of two sequential applications of fertilizer when high fertilizer levels are concerned, there is a tendency among farmers to argue that if they apply such high nitrogen levels crop conditions must be favourable. That is, at the time of the second application one of the major stress factors - water availability - can be quite accurately assessed by the farmer. Thus, yield perceptions above a certain nitrogen level may be subject to an implicit switch in the perception of the status of environmental conditions, i.e., high fertilizer rates are only applied under favourable crop growth conditions. This may result in the hybridization of two response relationships as shown by Figure 8.4.4. Such hybridization may also explain better why farmers have a tendency to perceive a more than linear increase in their 'worst possible' perception at high N-levels.

The subjective assessment of nitrogen reponse for the second HYV crop is more optimistic than the empirical reponse would suggest. This may result from anchoring on the first rice crop since farmers have not much experience with second rice crop

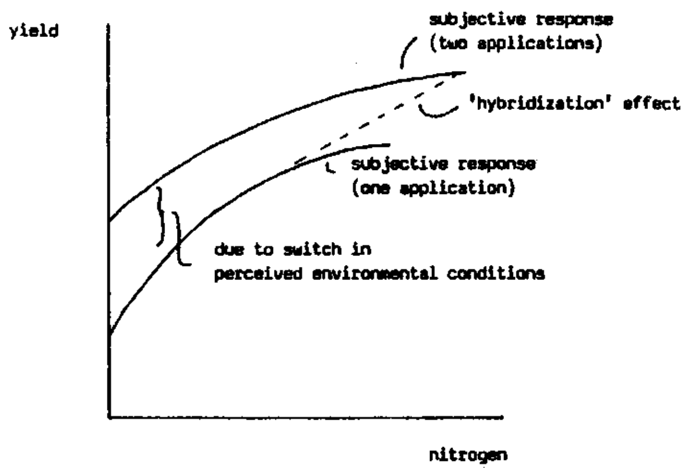


Fig. 8.4.4 The effect of the hybridization of two response functions

cultivation. Compared to empirical results, both the subjective reponse and intercept level is more optimistic than for the two other types of rice crops. This optimistic response perception may in part explain the earlier observed relatively high nitrogen levels farmers actually applied to second rice crops.

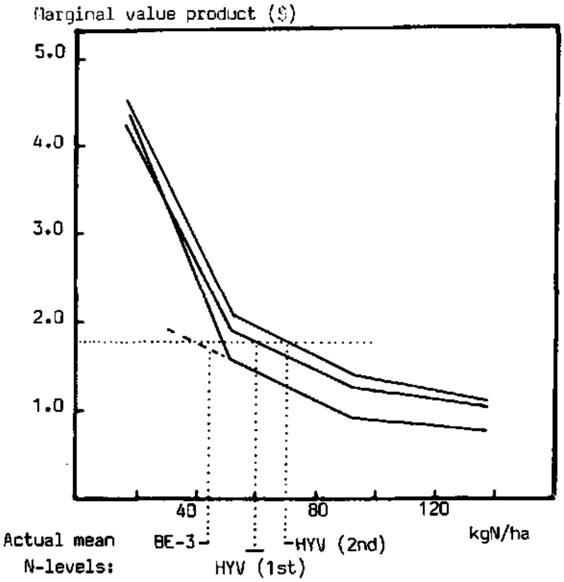


Fig. 8.4.5 Marginal value products of subjective nitrogen response functions for the 'best possible' growth condition for three types of rice crops.

Figure 8.4.5 shows the similarity in shape of the marginal product curves for the best possible yield condition of the three crop types. This indicates a similar coefficient for the 'higher' nitrogen term in the subjective reponse relation (visual inspection of the subjective reponse surfaces suggests a function of the form $Y = a + bN + (c/N)$ implying increasing linearity with increasing N-levels). However, the coefficient of the linear term in the response relationship ('b' in the above equation) differs between crops. Farmers perceive a substantial weaker response to nitrogen for the local BE-3 variety for nitrogen levels above the 34 kg N compared to the IR-varieties. In the same figure, the average actual applied mean nitrogen levels for the various crops (plain waterway fields) over a period of four years is indicated. It is striking that the associated marginal products of the three crop types are almost equal at a marginal benefit/cost ratio of about 1.75.

Perceived risk of nitrogen response

Risk perceptions are inherently more difficult to rationalize than the above main performance expectations. Within the context of fertilizer reponse, an operational concept of risk may be

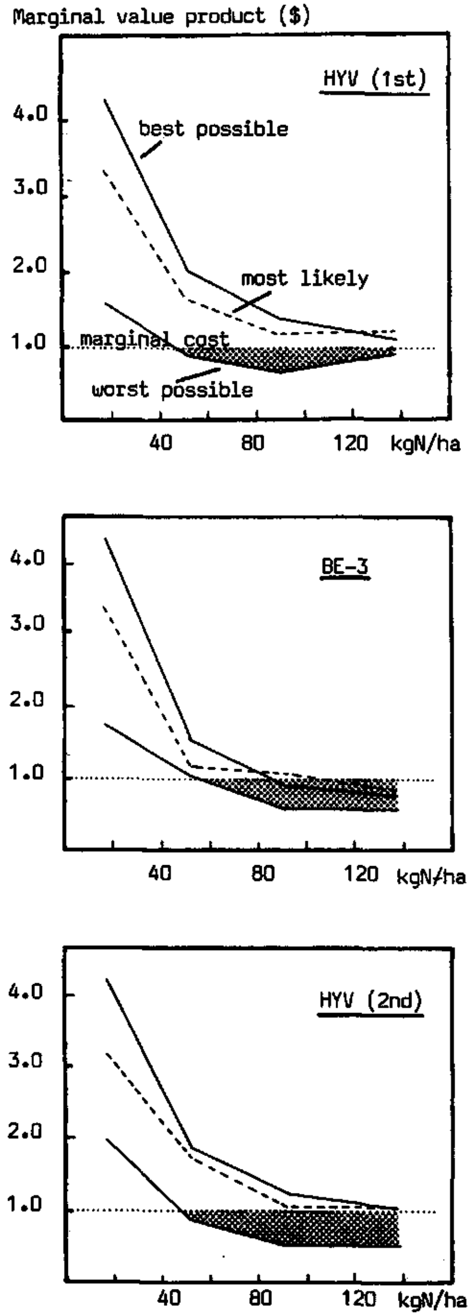


Figure 8.4.6 Marginal value product curves of subjective response functions of three types of rice crops for three crop growth conditions

formulated as the probability that the marginal value product falls below the marginal cost of the input. Figure 8.4.6 shows the marginal value product curves for the three different yield conditions. The most striking feature of these curves is that they tend to converge at higher levels of nitrogen which may be due to the earlier indicated 'hybridization effect'. As shown by the 'worst possible' MVP-curve, farmers perceive that returns are always above - what appears to be - a rather well-defined level which is very close to the actual cost-line or 'minimum break-even return' of nitrogen ($0.54/kg N).

It should be remembered, however, that due to the possible truncation of the yield range caused by the employed elicitation procedure, the 'worst possible' return curve may actually represent a probability boundary where returns have a chance of about 20% to fall below. The feeling that farmers do not include zero yield outcomes in their stated beliefs concerning yield expectations is further confirmed by an inconsistent response to two different questions related to the riskiness of second rice crops. Prior to assessing farmers' feelings with respect to nitrogen response, farmers were asked to assess the likelihood of second rice crop failure in terms of the number of years out of ten, for crops planted in the first half of October. For fields in the plain waterway area, estimates ranged from 1 to 3 years with an average of 1.8 years. However, when questioned about the nitrogen response, none of the farmers expressed zero yield as the worst possible yield outcome. Although such inconsistencies cast serious doubts on the adequacy of the elicitation procedure or the farmers' ability to express worst return perceptions, if we assume these to be independent of the nitrogen level, we may still employ them as a relative measure.

The relative riskiness of the three crop types - in terms of the possibility that marginal returns fall below marginal cost - is presented in Figure 8.4.6 by the shaded areas under the marginal cost line. For all crops, the possibility of a negative marginal rate of return starts in the nitrogen range 34.5 - 69 kg N, but increases more sharply for higher N-levels for both the second HYV and BE-3 compared to the first HYV crop. For the less nitrogen responsive BE-3 crop, even for the 'best possible' yield condition, marginal returns fall short of the marginal cost above the 69 kg N level.

With respect to the second crop, farmers perceive a somewhat lower benefit and a higher risk of investing in fertilizer in the range 69 - 115 kg N compared to the first HYV crop, but the difference is much less pronounced compared to empirical' findings. However, if risk is defined in absolute terms, for instance as the worst possible yield perception at zero N-level, the risk of the second crop is substantially higher. 'Worst possible' returns of the second rice crop are about 40% lower compared to the first rice crop.

8.4.2 Farmers' attitudes towards risk

In assessing farmers' risk attitudes, a distinction should be made between risk averse behaviour that results from structural factors and risk aversion that is due to differences in the psychological make-up of individuals (Chapter 3). The former type of behaviour is influenced by the farmers' risk taking ability which - in the present case - is closely related to the capacity of the farm-household to produce a surplus above basic consumption requirements (Section 6.3.3). The farmer's willingness to take risk (attitudinal risk aversion) is considered to be independent of the farmer's risk taking ability in that it solely relates to his psychological disposition to avoid fair bets (Lipton, 1979). As indicated earlier, this distinction has more than theoretical importance. From a policy point of view, if risk averse behaviour is mainly induced by structural factors, there is scope for supporting poor farmers through measures that increase their risk taking capability. If, on the other hand, risk aversion turns out to be a purely idiosyncratic phenomenon, it will take much more effort to change risk-induced behaviour patterns.

In eliciting farmers' risk attitudes it is, however, difficult to ensure that pure attitudes are measured. Particularly in case the elicitation procedure involves choices related to the actual farm situation, one may expect pure risk attitudes to be confounded with resource-induced risk aversion. Resource poor farmers' preoccupation with the goal of obtaining minimum subsistence requirements may substantially distort elicited pure risk attitudes. In order to reduce such influence, it was decided to elicit farmers' preferences for hypothetical choice alternatives. They involve choice options that differ with respect to the intensity of input use and risk for a rice production activity on a one hectare field, with basic subsistence needs not at risk.

Measuring farmers' willingness to take risk

One of the standard procedures to elicit farmers risk attitudes is to establish their preference for simple choice options of the type:

- option A: a fixed income of 30 bags of rice
- option B: a 50% chance of no rice income and
a 50% chance of 60 bags of rice

The expected income level of both alternatives is the same. The risk averse farmer is expected to opt for alternative A. The procedure is to lower the fixed income value to such an extent that the farmer becomes indifferent between the two alternatives. The fixed income under alternative A is identified as the <u>certainty equivalent</u> of alternative B. The income difference between the certainty equivalent and the expected income of alternative B is the <u>risk premium</u> of the farmer for this particular choice. It represents the amount of expected income the farmer is willing to forego in order to avoid choosing the risky alternative B. If a series of such certainty equivalents is established, a risk preference function can be fitted to these points using regression analysis. Alternatively, one may use the risk premium of one particular choice situation as a partial risk aversion coefficient or partial risk insurance premium.

In pre-testing this procedure it became apparent that farmers had problems in relating to the 50:50 type gambling questions. It was mentioned by farmers that the questions were indeed too much like gambling: obviously, in agriculture, choice alternatives with fixed outcomes or 50:50 type outcome probabilities are rather uncommon. To allow for a more realistic set-up of the choice situation we adopted an elicitation procedure developed and applied by Webster and Kennedy (1975). They specifically designed this method to measure farmers' preferences for ranges of outcomes defined in terms of Shackle's (1961) focus-gain and focus-loss income. Focus gain and focus loss outcomes are loosely defined as, respectively, those highest and lowest outcomes which farmers would be surprised to reach in any eventuality. Since this procedure employs ranges of yields rather than specific yield outcomes, the type of choice situation conforms closer to the manner in which farmers themselves perceive outcome uncertainty (Section 8.4.1).

This method entails an interview procedure in which the farmer is directly confronted with a lay-out describing the possible outcomes of a choice in terms of a focus-gain, a focus-loss and an expected outcome level. The lay-out consists of a sheet of graph paper, with net returns in terms of bags of palay (Y) ruled along the vertical axis. The range of Y is large enough to cover the potential range of net returns that can be expected from a one hectare rice field (0 to 60 bags of palay). Y is defined as gross yield minus harvesters' share, land rent, and cash input costs. The only other equipment used besides the graph is a series of plastic strips of different lengths, with arrows marked at halfway point. It is explained to the farmer that these strips represent rice production activities that only differ with respect to the intensity of input use. The longest strip - representing the most intensive rice production activity - is placed first on the graph and aligned parallel to the Y-axis. The farmer is told that each strip represents a range of possible yields. The expected yield is marked on the Y-axis by the arrow halfway along the strip. It is explained that other yield levels are given by the whole length of the strip as well as that only once every ten years yields will fall somewhere below the bottom of the strip and once every ten years above the top of the strip.

In this way, a strip placed on the graph enables the farmer to visually appreciate a range of possible yields. After the longest strip is placed on the graph with the arrow marking a pre-specified expected yield Y and after its significance is explained to the farmer, a slightly shorter strip is introduced. The shorter strip represents a smaller dispersion of yield possibilities and is positioned alongside the initial strip so that its arrow indicates the same Y as the arrow of the intial strip. The farmer is then asked which strip represents the more desirable range of yields. If the initial strip is selected, the shorter strip is raised; if the shorter strip is selected, the shorter strip is lowered. The shorter strip is manoeuvred until the farmer is indifferent towards the yield possibilities represented by the two strips. This procedure was repeated two times with successively shorter strips.

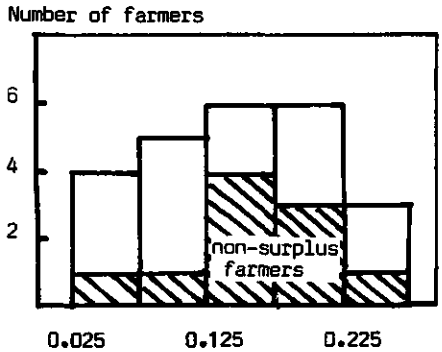


Fig. 8.4.7 Distribution of partial risk aversion coefficient (sample farmers)

Figure 8.4.7 shows the distribution of the partial risk aversion coefficient for the sample of 25 farmers. These are computed as 1 - (E(Y4) / E(Y1)), where E(Y1) and E(Y4) are the expected returns from the initial and last outcome strips, respectively. It shows that all farmers are, to some extent, risk averse. Non-surplus farmers appear to have a somewhat higher risk aversion coefficient compared to surplus farmers. However, of the latter category, some farmers are severely risk averse. The mean partial risk aversion coefficient for this sample of farmers is about 0.17, which indicates that most farmers are intermediate to moderately risk averse according to the scale employed by Binswanger (1980). These findings conform closely to results obtained by Binswanger (1980) and Sillers (1980) for samples of farmers in India and the Philippines, respectively.

8.5 <u>The impact of risk on fertilizer decisions</u>

Above, a substantial number of factors that may influence fertilizer decisions made by farmers were identified and discussed. It was empirically established that risk increases with increasing fertilizer use, that farmers also perceive increasing risk of fertilizer use, and that all farmers are, to some extent, averse to risk. In this last section, the relative importance of these factors will be assessed. In particular, attention is paid to the relative importance of the farmer's <u>willingness</u> to take risk as opposed to his <u>ability</u> to take risks.

For reasons discussed in Chapter 3, no attempt is made to test the validity of a specific model regarding economic choice under uncertainty. Instead, regression analysis will be used to assess the relationship between the farmer's deviation from optimum fertilizer levels and a number of decision variables and household characteristics. Such approach has the advantage that variables can be simultaneously tested for their relative importance in explaining fertilizer use. Given the inadequacies in variable measurement as well as the problems encountered in modelling the technical relationship of fertilizer response (Section 8.2.2), it is clear that the results derived from the analysis below should be treated carefully.

8.5.1 Model specification

The dependent variable for the regression is defined as the per cent difference between the computed optimum level of nitrogen (Nopt) and the actual level of nitrogen applied (Nact), viz. (Nopt - Nact) / Nopt. For each plot, optimum nitrogen levels were computed taking into account land unit type and type of rice crop, and using fixed input-output price ratios for nitrogen irrespective of the type of fertilizer applied. The regression analysis is limited to first rice crops because not all farmers grow second rice crops.

The following independent variables are included in the regression model:

- surplus area index: This index is defined as the farm area remaining after the area needed for basic consumption requirements is subtracted. This variable is a proxy for the risk taking capacity of the household.
- life cycle: The life cycle stage is represented here as a continuous variable and is approximated by the farmer's age. It is expected to have a negative influence on the use of cash inputs in crop production such as fertilizer based on the earlier indicated strong relationship between life cycle stage and cash expenses for education.
- risk attitude: The earlier derived partial risk insurance premium is used as an index for the farmer's willingness to take risk. Since increasing risk aversion is expected to result in decreasing fertilizer application, which in turn implies decreasing risk of fertilizer use, the root value of this index is included as a variable in the regression.
- response perception: This variable represents the farmer's perception of the yield increase over the fertilizer range 34.5 -69 kg N for the 'best possible' yield outcomes and is expressed in cavans (approx. 42.5 kg bags) per hectare. It is specified by crop type and land unit classes.
- risk perception: There are two ways to operationalize risk perception as a variable for regression analysis. On the one hand, risk perceptions may be expressed in absolute

terms, e.g., as the probability of a negative rate of return for a certain level of fertilizer or, alternatively, as the fertilizer level where the marginal net return becomes zero. On the other hand, one may opt for a relative measure expressed in terms of the marginal increase in risk over a range of the fertilizer input. What measure is appropriate depends on the way farmers perceive risk. It was decided to use the relative measure because of the difficulties encountered in measuring risk perceptions and in determining the exact point where marginal returns equal marginal costs due to the discrete nature of the elicited response perceptions. This variable is defined as the reciproque of the increase in yield for the 'worst possible' outcomes for the fertilizer range 34.5 - 69 kg N.

- <u>price of fertilizer</u>: The price of nitrogen, calculated as the ratio '(deflated) price of fertilizer per bag/kilograms N available per bag', is primarily used as a proxy for the relative concentration of nitrogen. This variable is included in the regression to check the earlier mentioned observation that farmers tend to perceive the quantity of fertilizer in terms of bags of fertilizer and the relative price per bag, rather than on the basis of nitrogen content.

- <u>HYV dummy</u>: This variable is zero for traditional rice crops and one for IR-varieties. It is included to evaluate possible differences in fertilizer application levels between rice varieties.

- <u>second application dummy</u>: This dummy variable is included to check whether farmers using two applications of fertilizers apply higher dosages of fertilizers.

Table 8.5.1 presents the mean values of the variables included in the regression for each category of households. It shows the slight correlation between the surplus area index and pure risk attitudes. Response perceptions are highest for the middle-aged non-surplus households, whereas they are lowest for the young surplus category of households. This is partly due to differences in land unit classes and crop types between household categories, but in part may also be explained by optimistic fertilizer

Table 8.5.1 Mean values of independent variables

Life cycle	Surplus	Surplus area	Farmer age	Risk attitude	Risk perception	Response perception	Price nitrogen 2)	Share tenancy
young	no	0.51	34	0.19 (0.08) 2)	0.42 (0.26)	20.4 (4.76)	4.21 (0.98)	25.0%
mid	no	0.39	49	0.19 (0.03)	0.22 (0.13)	20.5 (4.53)	3.88 (0.19)	13.8%
young	yes	1.51	30	0.16 (0.05)	0.25 (0.12)	15.9 (7.39)	4.29 (0.43)	46.4%
mid	yes	1.59	51	0.14 (0.06)	0.28 (0.10)	14.5 (4.49)	4.34 (0.43)	19.8%
old	yes	1.74	64	0.17 (0.07)	0.27 (0.13)	15.5 (3.55)	4.28 (1.03)	25.5%

1) The price of nitrogen and the percentage of land under share tenancy are means of annual aggregated crop observations on a farm basis (4 years).
2) Figures in parentheses are standard deviations.

Table 8.5.2 Regression results for individual years and all years for individual crop observations (first rice crops IR-varieties and BE-3)

Variable	1978	1979	1980	1981	Pooled
Surplus area	-22.2 ** 1)	-19.5 **	-22.6 **	2.9	-17.1 **
life cycle	2.8	5.5 *	4.6 *	-0.4	3.7 **
Risk attitude	72.2 *	69.7 *	90.9 **	48.4	72.4 **
Response perception	-1.2 **	-1.9 **	-1.5 **	-0.6	-1.2 **
Risk perception	1.5	2.3	0.4	1.4	0.1
Price N	11.1 *	10.5 *	36.9 **	14.3	30.6 **
(Price N)2	-	-	-2.1 +	-0.3	-1.7 *
2nd appl. dummy	-12.7	-32.4 **	-37.3 **	-25.4 **	-29.5 **
HYV dummy	15.0 *	-2.1	9.4	-6.1	2.3
Year dummy: 1978					11.0 **
1979					10.4 **
1980					-3.3
Intercept	-30.8	2.1	-105.9 **	-48.1	-86.5 **
R2	0.23	0.27	0.57	0.26	0.33
s.e.	28.1	30.9	23.3	29.0	28.5
No. of observations	90	126	106	87	409

1) Significant at the 0.10 (+), 0.05 (*), and 0.01 (**) levels.

response expectations of poor farmers who usually operate at the lower end of the response function. In general, non-surplus farmers apply less expensive fertilizers compared to surplus farmers. Substantial differences occur in the rice area under share tenancy. Although this variable was initially included in the regression, it did not show any relationship with applied fertilizer levels.

8.5.2 Discussion of results

Table 8.5.2 shows the results of the individual year regressions and the pooled estimate for all years for individual crop observations. Except for the farmers' risk perception and the HYV dummy, all variables are significant for the pooled regressions and in conformity with prior expectations with respect to the sign of the coefficient. The non-significance of the risk perception variable is probably due to the earlier indicated measurement problem. Further, the interaction between risk attitudes and risk perception - not included in this regression model - is not significant. This casts additional doubts on the reliability with which risk perceptions are (or can) be measured. Except for 1978, the HYV dummy shows no significant effect and the sign of the coefficient differs between years. It indicates that there are no systematic differences in fertilizer application levels between varieties when such levels are evaluated relative to the optimum application level. It is not clear why farmers applied relatively less fertilizer to IR-varieties in 1978. It may still represent a learning lag with respect to fertilizer requirements of these varieties.

In order to assess the relative importance of the variables included in the regression in terms of their contribution to explaining differences in N-application levels, for each independent variable the range value of the dependent variable (in absolute terms) over the maximum observed range of the variable was computed. Table 8.5.3 shows that results are relatively stable for the first three years of observation. Apart from the price effect and the dummy variable for the second fertilizer application, the surplus area index shows the largest contribution to differences in N-application levels: the difference in deviation from the optimum N-level between farmers with the smallest and largest surplus area is in the order of 45%.

Table 8.5.3 The effect of independent variables on N-application in terms of the absolute percent deviation from the optimum N-level (%) over the maximum observed range of the independent variables; individual crop observations (first rice crops IR-varieties and BE-3)

Variable	1978	1979	1980	1981	Pooled
Surplus area	48.4	42.5	49.3	6.3	37.3
Life cycle	11.0	22.2	18.4	1.7	14.8
Risk attitude	18.0	17.4	22.8	12.0	18.1
Response perception	20.4	32.3	25.5	10.2	20.7
Risk perception	8.9	13.8	2.2	8.2	0.8
Price N	59.3	56.1	58.2	69.0	54.0
2nd application dummy	12.7	32.4	37.3	25.4	29.5
HYV dummy	15.0	2.1	9.4	6.1	2.3

N-application rates are negatively correlated with the life cycle stage, indicating that older farmers generally apply less fertilizer. Although, it was hypothesized that such a relation can be expected in view of the increasing need to use cash for education, it is possible that other differences between age groups of farmers contribute to this relationship. One possible difference between young and older farmers is that young farmers still have to prove their ability as farmers. For instance, it is an observed phenomenon that young surplus farmers are keen on maximizing grain yields.

Farmers' nitrogen response perceptions appear to be slightly more important than risk attitudes, with the former explaining a maximum difference between farmers of around 25% and the latter of 20%. The price effect roughly confirms the earlier mentioned hypothesis that farmers perceive fertilizer quantities in terms of bags of fertilizer rather than in terms of the relative concentration of nitrogen available. For farmers using 14-14-14, the estimated coefficients imply that in such a case farmers apply about 60% less nitrogen compared to farmers using urea fertilizer.

The above results support the hypothesis that both the risk taking capacity and pure attitudes towards risk are significant in explaining differences in applied fertilizer levels between individual farmers. However, the effect of the risk taking capacity is much more pronounced. It should be realized, however, that the surplus area index which is used here as a proxy for the risk taking capacity of households, is also a proxy for budget constraints and perceived cost of capital. Although, as mentioned earlier, this distinction is, to a large extent, artificial, it remains difficult to establish whether resource-poor farmers apply less fertilizer because they face severer consequences in the case of poor production results or whether they economically apply less fertilizer because of higher perceived cash costs.

It is interesting to note that for the 1981 growing season, following the very good production year of 1980, both the magnitude and significance of all variables (except for the price effect) substantially decrease. In particular, both structural farm-household characteristics - surplus area index and life cycle stage - are not significant. The subjective variables - perceptions and attitudes - appear to be more stable. These results indicate that differences in behaviour between categories of households are highly influenced by cash and resource flows and possibly by resource-induced risk aversion.

For the above discussed crop-based regression analyses, the percentage of 'explained variance' in the dependent variable - given by the R2 - is relatively low. This can be expected, given the variation in plot sizes as well as peculiarities of individual crops. On small plots, even poor farmers are able to apply fertilizer at a relatively high rate on a per hectare basis. Further, crops may receive an extra dosage of fertilizer in case other crops turn out to have a poor crop stand and farmers have a certain amount of fertilizer in stock. Such individual plot differences can be expected to cancel out when crop observations are aggregated by year on a farm basis. Another advantage of aggregation is that the importance of plots in the regression analysis is weighed proportional to their size.

Table 8.5.4 compares the regression results for individual crop observations with results when crop observations are aggregated on a farm basis and subsequently taken as averages over the four year period of 1978-81. The portion of 'explained variance' in the dependent variable increases substantially. Except for the price effect, all variables included remain significant. The life cycle effect becomes more important, apparently at the expense of the surplus area variable. It is also surprising that the risk perception coefficient increases in magnitude, although its contribution does not become significant. The non-significance of the price effect can be expected because of the low variation in prices for aggregated observations due to the predominant use of urea.

Finally, in order to determine the extent to which the independent variables differentiate between categories of households, for each

Table 8.5.4: Comparison of regression results for individual crop observations and aggregated crop observations by farm (first rice crops IR-varieties and BE-3)

	Individual crops	Farm basis 2)	Max. range effect (%) 1) plot	Max. range effect (%) 1) farm
Surplus area	-17.1 ** 3)	-14.6 **	37.3	31.9
Life cycle	3.7 **	6.1 **	14.8	24.4
Risk attitude	72.4 **	92.8 *	18.1	22.1
Response perception	-1.2 **	-1.3 *	20.7	21.3
Risk perception 4)	0.1	2.2	0.8	8.3
Price N	30.6 **	3.3	54.0	8.3
(Price N)2	-1.7 *	n.i. 5)	-	-
2nd application dummy	-29.5 **	n.i.	29.5	-
Intercept	-86.5 **	-20.6		
R2	0.33	0.56		
s.e.	28.5	11.2		
No. of observations	409	25		

1) The effect of independent variables on N-application in terms of the absolute percent deviation from the optimum N-level (%) over the maximum observed range of the independent variables; individual crop observations.
2) Mean values over four years for aggregated crop observations by farm
3) Significant at the 0.10 (+), 0.05 (*), and 0.01 (**) levels.
4) Value risk perception / 10
5) N.i.: not included in regression

household category the mean difference in the percentage deviation from the optimum N-level relative to that of the category of the young surplus households was computed. Farmers in this latter category are closest to the optimum fertilizer level. On average, they apply nitrogen at a rate of about 8% below the calculated optimum level. Table 8.5.5 shows the substantial contribution of both structural farm-household variables 'surplus area' and 'life cycle stage' and the minor contribution of the subjective variables 'risk attitude' and both perception parameters. Of course, this can be expected given the minor differences between household categories in the mean values of the latter type variables (Table 8.5.1). When the effect of the subjective variables is combined, differences between household categories become even smaller. Of course, this does not imply that

Table 8.5.5 Relative differences among household categories in terms of the percentage deviation from the optimum N-level (%); the young surplus household category is used as base for comparison

Life cycle	Surplus	Surp area (a)	Life cycle (b)	Sum struct. factors (a+b)	Risk att (c)	Resp perc (d)	Risk perc (e)	Sum subj. factors (c+d+e)	Price effect (f)	Total difference predicted (a+ .. +f)	Total difference observed
young	no	14.6	2.4	17.0	2.5	-5.7	3.7	0.5	-0.2	17.3	25.1
mid	no	16.4	11.5	27.9	2.5	-5.7	-0.7	-3.9	-1.4	22.6	28.3
mid	yes	-1.2	12.4	11.2	-1.9	1.8	0.6	0.5	0.2	11.9	17.0
old	yes	-3.3	20.5	17.2	0.6	0.4	0.4	1.4	0.0	18.6	21.2

Surp area: surplus area; risk att: risk attitude; resp perc: response perception; risk perc: risk perception subjective factors are not important in explaining differences in N-application levels between individual households, it merely indicates that they do not explain differences in N-application levels between categories of households. This finding indicates the limitation of target group specific policy measures that are aimed at reducing underinvestment in agriculture caused by risk attitudes and perceptions.

9 THE IMPACT OF RISK ON AGRICULTURAL DECISION MAKING: SYNTHESIS AND IMPLICATIONS ON RESEARCH AND AGRICULTURAL DEVELOPMENT

The premise of this study was to evaluate whether the impact of risk on resource allocation warrants specific attention to farm management analysis of small-scale agriculture and agricultural policy formulation. The underlying issues are twofold:

First, does farmers' risk avoidance cause economic inefficiency and impede agricultural development. Underlying this issue are two other research questions related to the cause and effect of farmers' risk aversion:

- are farmers not willing to invest in risky but profitable technology because of averse attitudes towards risky investment, causing an overall underinvestment in agricultural inputs and misallocation of resources, and/or;
- are farmers not able to invest in risky technology because of a limited risk taking capacity leading, apart from underinvestment, to an unequal distribution of benefits derived from new technologies.

Second, does the influence of environmental uncertainty on decision making necessitate modification of existing economic decision models, i.e., what type of information is required on the basis of which farmers can be assisted in improving resource allocation and policy makers in making better decisions in variable production environments.

In this concluding chapter it will be argued that precise quantitative answers to the question of risk-induced economic inefficiencies are of minor importance to many issues that directly concern farmers and affect agricultural development. This study leads to the conclusion that if risk research is to become less theoretical and more practically useful, there is an urgent need for redirecting the research effort. The central question should not be how and to what extent farmers avoid risk - the central concern of most studies - it is how farmers (necessarily have to) deal with environmental variability (in the broadest sense), what can be learned from farmers' risk management strategies, and eventually how they can be better assisted in making good decisions. It is high time that both economists and agronomists start to realize that the impact of variable production circumstances on activity and input choice goes much further than simply introducing an additional - and usually erroneous - choice criterion in existing decision models.

In Section 9.1 we will summarize some of the salient features of the farmers' choice process: (1) how they arrive at decisions in variable and dynamic choice situations; (2) given such process, what type of performance criteria (or choice attributes) farmers can reasonably be expected to consider when evaluating choice alternatives; (3) what priority is given to the various choice attributes, i.e., what motivates farmers in their economic behaviour, and why do (certain categories of) farmers pursue certain types of activities and disregard others. In Section 9.2 the impact of risk on economic efficiency and distribution of income will be evaluated. In the closing section (Section 9.3) implications on research and policy will be indicated.

Although not explicitly dealt with in this synthesis, it is clear that farm management decisions should be understood within the wider context of farm-household decision making. As will be discussed further on, short-term consumption expenditures often (have to) take precedence over productive investments. The division of activities among members of the farm-household and associated division of decision making fields and responsibility bearing is dealt with in Chapter 5.

The conclusions derived below are based upon the study in the Philippines. They are derived from farmers' choice behaviour in a decision making environment that, although it is rainfed, is characterized by relatively favourable production circumstances both in a physical and technological sense. It has offered farmers distinct opportunities to improve existing farm practices. The (optimistic) findings regarding farmers' risk behaviour should be interpreted within this context. They may be less applicable for other areas in the world where extremely erratic rainfall, very poor physical resources, and stagnant or only marginal improvements in production technology prevent farmers from increasing agricultural income. In such situations, a process of worsening man-land ratios may lead to an entirely different management orientation and decision making pattern.

9.1 Farmers' real-life decision making

It is obvious that farmers cannot foresee the consequences of all their actions, nor can they predict the behaviour of other farmers or persons (e.g. landlords) and organizations that may influence the outcome or feasibility of their activities. With the explicit recognition of risk and uncertainty in household decision making, the complexity of farm production processes and associated decision problems becomes apparent. Due to a variable onset and termination of the growing season in rainfed agriculture, the availability and/or requirements of all basic factors of production are, to some extent, uncertain. Dependency on external means of production (e.g. land, casual labour, cash inputs) or decisions of other persons (e.g. type of crops cultivated by neighbouring farmers) may further aggravate uncertainty in agricultural decision making. Thus, not just the outcome of agricultural activities is uncertain, the feasibility of (or, alternatively, the constraints to) activities is uncertain and, consequently, the entire choice problem is fuzzy. Making decisions in such a situation inevitably means simplifying the choice problem the solution is sought for.

There are essentialy two ways through which farmers simplify decision making:

I. <u>cautious optimization over a period of time</u> based on adaptation to changes in internal and external circumstances, search for new technologies and improvements of existing techniques, and experimentation; and

II. <u>sequential decision making (economizing) within years</u> based on adaptation to chance constraints and opportunities as they evolve in the course of a production cycle.

Economizing behaviour based on these two decision principles - that are similar but differ with respect to time span - serves the dual purpose of an efficient use of information in dynamic choice situations that are typified by uncertainty, and thus potentially good decisions, and maintaining risk within manageable proportions.

I. <u>Cautious optimization</u>

In changing and/or improving existing farm practices and cropping systems, the farmer is best represented as making more or less cautious departures over years from current production practices in the best (most promising) direction according to current perceptions and constraints. <u>Cautious optimization is a major tool of farmers to gradually improve agricultural productivity and increase agricultural income, while keeping production and financial risks on a manageable level</u>. It includes both adaptation to internal household characteristics (asset position and life cycle) and external environmental conditions (including agricultural technology), and own search for improvements in the production system and new production possibilities to increase income.

<u>Asset position and life cycle dynamics</u>

Adaptation to internal household conditions shows both seasonal and long-term characteristics. Due to changes in the financial position of households caused by low agricultural incomes or high household expenditures (hospitalization, funerals, weddings, etc), year-to-year adaptation in areas of cultivated crops or input levels are often required. For example, a poor production year may induce farmers to enlarge the area under the photo-sensitive BE-3 rice variety at the expense of HYVs not because of a lower fertilizer requirement per crop for BE-3 but because the timing of application is much later in the season which allows poor households to accumulate financial means to purchase fertilizer. Low agricultural income may also result in excessive selling of <u>dagmay</u>, thus diminishing the seed inventory and reducing next year's area. In extreme cases of poor financial circumstances, farmers may even decide to rent out fields to other farmers rather than working them themselves with low input investments to facilitate participation in the wage labour market. Adaptation of a more gradual character is due to the cyclical development of households. We have indicated the likelihood that due to a changing resource composition (man-land ratio) and expenditure level (subsistence requirements and education) households gradually change management patterns when moving from one life cycle to another.

Adaptation to external environmental conditions

Seasonal adaptation occurs in response to market price changes of inputs and outputs. Adaptation to changes in farmgate prices of agricultural products is primarily important for seasonal crops that are of limited importance to household consumption. It was difficult to measure farmers' response to changes in rice prices because of a relatively stable price pattern during the study period. In response to changing market prices, the area of seasonal, pure market (commercial) crops may change quite rapidly between years. The same applies to the level of applied cash inputs such as fertilizers and pesticides. Application rates may profoundly change in reaction to changes in the relative prices of inputs and outputs. It should be realized, however, that (given present farm sizes) households have become heavily dependent on cash inputs to meet subsistence requirements. Drastic reductions in the rate of fertilizer application may seriously affect the viability of the household unit. Accompanying the decline in farm sizes has been a process of land use intensification that has become increasingly dependent on external inputs (e.g. fertilizers and pesticides) to sustain or raise productivity levels. In this process, the overall level of risk that rural households face has increased. With limited off-farm employment opportunities, smaller farm sizes imply a lower degree of risk spreading and, combined with a high dependency on cash inputs, imply a higher risk of indebtness.

Apart from changes in external economic circumstances, households are also faced with a changing institutional environment. Of the numerous development activities that were imposed upon the village community during the 1970s, the majority did not contribute much to improving the living conditions of households but instead created an atmosphere of uncertainty and were counterproductive to the needs and economic development of households.

Search and experimentation

Change in activities does not merely involve adaptation to changing internal household conditions or external environmental circumstances. Farmers themselves actively search for possible improvements in their production system, induced by the strong pressure on most households to increase agricultural income to secure medium-term subsistence needs and the long-run viability of the household unit (e.g. through education of children). There is no doubt that the first and major attribute farmers look at in searching for new alternatives is to increase returns to fixed family labour resources either through intensification of production or by reducing the level of paid-out costs. The rapid adoption of direct seeding methods of rice crop establishment replacing transplanting indicates the importance of returns to family labour relative to stability of returns. There simply is no better strategy to reduce medium and long-term risk than to increase household income.

Experimentation logically follows search and selection of promising production techniques or crop activities. Learning by experimentation provides an important means to farmers for obtaining the necessary information on which to base an assessment of new technologies and to improve upon existing farm plans and practices. Farmers are experienced experimentors. They are quite able to enterpret the results of experiments as long as they can relate the influence of the main environmental factors on the performance of the technology. New technologies showing an initial poor performance are not immediately rejected nor do farmers show a rigid perception of how a technology ought to perform. This study reveals that poor farmers do not refrain from experimentation. In contrast with the commonly held belief, experimentation is not a prerogative of wealthy farmers. Whether farmers are active in search for or testing of new technological possibilities depends more on personal characteristics than on income. Further, it is a fallacy to assume that farmers only obtain one experiment per season and that, consequently, farmers' experimentation is a long time affair.

Incremental analysis

Experimentation followed by gradual adaptation of farm plans allows incremental analysis. By increasing the scale at which new activities are undertaken, farmers gradually get an idea of the various management problems and risk components associated with new activities and to what extent such activities conflict with input demands of existing activities. In reaction to these problems, new management practices may be found that are aimed at reducing the effect of these problems and risks as much as possible. Incremental analysis does not only facilitates a gradual apprehension of new production technology, but also allows marginal (pair-wise) comparisons with the performance of existing production techniques they are intended to (partly) replace. Because the choice problem is narrowed down to a part of the production system, the size of the choice problem is highly reduced. Thus, alternatives can be better evaluated, even considering multiple, and possibly conflicting choice attributes, including various risk aspects. The need for incremental analysis explains why farmers, on a voluntary basis, seldom adopt in one time all components of so-called 'integrated technology packages'.

Apart from the overriding importance attributed to returns to family resources, we have discussed various other choice attributes on which farmers screen production activities. Among others these include the timing of output relative to fluctuations in the income stream (see the advantage of short-maturing varieties), whether the output is attractive from both a consumption and marketing point of view (reduction of marketing risk), whether activities require early investments in cash inputs, reduction of workload or drudgery of labour, etc. Assessing the performance of new activities on such (non-stochastic) choice attributes is relatively straightforward and does not pose any problem to farmers. Although conflicts between attributes are likely to occur (e.g. the wish to have an early harvest of rice with short-maturing varieties vs. the wish to have input investments late in the season with long-maturing varieties), such conflicts are, if possible, resolved by not opting for either one activity but to undertake both on a reduced scale. However, as will be indicated further on, conflict resolution is important with respect to consumptive vs. productive investments and short-term vs. long-term investments.

Risk assessment is difficult at an early stage of testing a new technology. Obviously, farmers cannot be expected to assess the risk of new technologies in terms of the long-run yield variability of the yield of the activity. Instead, farmers primarily look at the susceptibility of the production activity to specific risk factors such as pests, weed infestation, drought, flood, etc. They decompose final output risk in individual risk factors and assess to what extent such risk factors can be controlled, and to what extent new technologies differ in risk susceptibility compared to existing technologies. In the screening of new technologies farmers' risk considerations may either play a role by disregarding new alternatives altogether or by the setting of cautious targets (i.e., small-scale experimentation followed by gradual expansion of the new activity) to the introduction of new farm technologies. Thus, perceived risk acts as a strike out rule of not considering activities at all or leads to a slowing down of the adoption process until more information is acquired concerning the performance of the technology.

Among technologies that are not seriously considered are those that show a high perceived technical input application risk in the sense that farmers have no experience in determining either how to apply it and what can be expected of it in terms of performance and risk. Pre-emergence herbicides for dry seeded rice is a typical example of such technology. A one time failure of a new production activity due to a risk factor for which farmers lack the knowledge to assess the likelihood of occurrence or the cause of risk (e.g. bacterial diseases or viral infections), is very likely to result in non-adoption of such technology, even if it has a high potential return. Also technologies that show a high susceptibility to irreducible risk factors (e.g. drought, flood) are likely to be disgarded at an early stage of the screening process, similar to technologies that require high initial investments relative to the income earning capacity of the household, in particular when returns are spread over a number of years. Even when such investments appear economically attractive, they will not be seriously considered by households unless credit allows the financing of such an investment.

II. Sequential economizing and risk control

The fact that farmers are cautious decision makers does not imply that they are conservative in assessing the feasibility of crop production opportunities and benefits derived from such opportunities. Farmers neither perceive physical environmental factors such as rainfall in average terms nor do they perceive the environment as a malevolent opponent as implied by a number of game theories. In fact, farmers' cropping plans are guided by a rather optimistic assessment of early season rainfall conditions, whereas farmers' subjective yield expectations indicate that they neither actively anticipate severe adverse nor very favourable environmental crop growth conditions. In comparing the returns to alternative cropping strategies farmers think in terms of the best cropping pattern in the strategy (i.e., the one feasible under optimal rainfall conditions), whereas in assessing returns to crop production activities farmers appear to employ rather optimistic return figures. Also farmers' yield risk assessment regarding activities in which they are experienced cannot be considered conservative. Instead of perceiving the whole range of possible yield levels, farmers perceive a truncated version of this range with an implied risk perception that may be considered rather optimistic. If a crop stress situation occurs, farmers adjust their yield expectations on the basis of actual crop development.

Thus, rather than perceiving the physical environment as a source of distress farmers view it as a productive resource of which the opportunities for agricultural production should be maximized as much as possible. In choosing between alternative cropping plans, farmers are primarily concerned with balancing the wish to attain the best agricultural output vis-a-vis actual climatic circumstances with the need to minimize the risk that crop production activities 'go out of hand', i.e., the situation that farmers lose control over the crop production process due to their inability to react adequately to adverse crop conditions or to unexpected constraints to production activities. Economizing in the face of climatic and biological uncertainty is not to opt for stable activities that do well during 'average' years, it is to opt for production strategies that allow adaptation to climatic and biological factors as they evolve in the course of the growing season. Sequential decision making and reacting to an evolving rainfall pattern allows for an efficient use of information and thus facilitates (potentially) the best use of resources in terms of types of crops cultivated and reduces the chance of over- or underinvestment in agricultural inputs. Instead of gravitating towards an optimum farm plan composed of fixed activities, farmers aim at flexible cropping strategies that are robust in the face of climatic uncertainty allowing the best use of climatic circumstances in any one year.

Risk control

Risk control is an essential element of sequential economizing. In planning crop activities the farmers' main concern regarding risk is not with final output variability, their main focus is on how to deal with variable resource (chance) constraints. Chance constraints may either result from uncertain input requirements or from the uncertain availability of inputs caused by variable market conditions and budget constraints. For example, due to such factors as a late onset of the rainfall season, or a dry spell after land preparation or at the time second crops have to be established, crop activity tasks (e.g. weeding, ploughing, seeding, replanting) may get seriously congested causing delays in crop operations or postponement of crop establishment. Such task congestion may be disastrous if family labour is scarce and no cash is available to hire labour to timely carry out the necessary tasks or when the supply of wage labour is limited. Through various practices farmers attempt to avoid as much as possible such situations to occur and opt for production strategies that allow for optimum crop management conditions and risk control during plan execution. Such strategies are often erroneously classified as resulting from farmers' risk aversion. They are, however, sound economic practice.

First, farmers operating in variable production environments typically prefer cropping systems that are flexible and diversified crop options allowing for adaptation of crop plans to a variable onset and decline of the rainfall season as well as safety margins and flexibility in the planned use of crop inputs. It should be realized that diversification in farming does not end with resource and crop based diversification. Agronomic and management practices play a significant role in diversification and flexibility. Such operation-based diversification includes planting of specific crops on certain toposequence positions, staggered plantings of rice crops and upland crops, cultivation of rice crops differing in growth duration, etc. Through the introduction of direct seeding techniques farmers have added a high degree of flexibility to rice crop production. In contrast with transplanted rice, this type of crop establishment is not dependent on hired labour and allows a quick reaction to rainfall conditions. Hence, farmers are able to rapidly establish even very small plots of rice.

Second, farmers prefer activities with input profiles that allow for adaptation to environmental factors during the crop cycle. The importance farmers attach to sequential determination of input investments and the wish to control investment risk as much as possible is clearly reflected in a common rule-of-thumb used among both rich and poor farmers: 'do not invest too much too early in the growth cycle of crops'. The idea behind this rule-of-thumb is that the earlier the input investment is made the higher the chance of an investment loss due to uncontrollable risk factors. Thus, it is not surprising that farmers do not follow recommended practices that show an input profile of high input outlays at the start of the growth cycle of crops such as basal dresssings of fertilizer, pre-emergence applications of herbicides, and profilactic applications of pesticides. It also explains why farmers do not transplant but wet seed second rice crops, while, in the long-run, transplanting second rice crops would certainly yield higher returns and lower yield risks.

Third, apart from the timing of input investments, farmers also attach importance to the flexibility or elasticity in the timing of input application or the carrying out of crop management tasks. Such flexibility is particularly important to young households with limited labour resources that may find difficulty in the management and monitoring of crops requiring strict timing of operations and application of inputs. Also for poor farmers the necessity to postpone input application is often inescapable because of timely budget constraints caused by delayed harvestings or poor results of crops the proceeds of which are needed to finance the inputs. One of the main reasons why young farmers continue to grow single BE-3 crops is that this crop is relatively easy to manage. Compared to HYVs the timing of input applications is much more flexible whereas it requires much less monitoring with regard to water control.

Implications of sequential economizing

Sequential decision making regarding crop establishment and adjustment of inputs in the course of crop growth development has three main implications on decision theory. First, a single optimum farm plan does not exist. If the growing season's duration is variable and farmers' strategies include options to adapt the establishment of crop activities to a variable onset and termination of rainfall and adjust input application levels to actual crop growth conditions, an expected profit maximization plan is as meaningless as an average rainfall year. Thus, apart from the problem that it is difficult to determine a long-run expected profit maximizing solution to the whole-farm planning problem, a more serious problem is that such solution is not only sub-optimal for any one year, it is not even optimal in the long-run.

Second, it is difficult to generalize about farmers' choice behaviour in terms of economic efficiency. Because choice situations follow each other sequentially throughout the production cycle, farmers do not make one decision, they make many decisions. Some of these decisions will be of a strategic nature including many decision variables. As they will profoundly affect the freedom of decisions later in the production cycle (e.g. initial crop planting decisions), they are difficult to make. Others may include few decision variables and are relatively isolated from other decisions and much easier to make (e.g. fertilizer application). In the case of complex choice situations such as whole farm planning, best decisions are very difficult to define ex-ante, for farmers as well as professional decision analysts. However, when we consider the far simpler decision problem of choosing a certain level of fertilizer, the best input level is much more clearly defined and farmers may come very close to optimizing behaviour. Thus, depending on the particular type of decision involved, farmers may be both 'satisficers' and 'optimizers'.

Third, timing of decisions is of critical importance. The passing of time enables a better assessment of the status of most factors influencing production such as climate, level of weed and pest infestation, input availability, market prices, etc. However, it also reduces the flexibility of the system, i.e., it reduces the number of possible alternatives which are both technically feasible and economically justified. Good farm managers are distinguished from poor farm managers by their ability to strike a fine balance between these two influences. Good farmers do not simply make good decisions, they make good decisions at the right time.

9.2 Risk, economic efficiency, and equity

Perceived risk

Given the various attributes of farmers' risk assesment it will be clear that it is difficult to pinpoint a single parameter that could take account of the farmers' risk perception. For the following reasons, the influence of risk and uncertainty on decision making simply cannot be reduced to a single universal piece of additional information about choice alternatives that together with other attributes is used to compare the attractiveness or utility of alternative courses of action.

First, farmers may face different production risks to the same production activity due to differences in risk control capacity. Perceived risk of a production activity depends in part on the farmers' ability to react adequately to controllable risk factors. For example, weed incidence in dry seeded rice may pose a severe threat to households with limited labour resources. They may either face the risk of an insufficient supply of labour from the wage labour market or insufficient financial means to hire wage labour. Because of a relatively high time expenditure for non-productive activities, young households are in a very tight labour supply situation. Compared to the middle-aged and old households, they are in a much weaker position to quickly mobilize labour in case farm conditions render such necessary. Consequently, these households face (ceterus paribus) higher production risks due to a lower level of risk control. Also, to the extent that risk control depends on cash inputs (pesticides, herbicides), poor households that encounter problems in purchasing these inputs face higher production risks compared to wealthy households. Taken together, both factors cause young non-surplus households to face the highest production risks, whereas they are in the weakest position to bear the consequences of these risks.

Second, farmers' risk perception cannot be seen in isolation from their financial risk taking capacity and the need to secure the financial viability of the household unit, both in the short and long term. Farmers may face different financial risks to the same input investment due to differences in wealth position (surplus production capacity), whereas for the same household perceived risk may differ between periods because of changes in the household's financial position. Poor farmers are often forced to consider specific investment losses attached to certain inputs of an activity because of the immediate consequences of sustaining such losses for the short-run financial position of the households. Under conditions of a high level of indebtedness, minor risks in the sphere of production may translate into a substantial risk in the sphere of financing household consumption.

Third, farmers' response to risk cannot be assessed independently from the time horizon over which behaviour is evaluated. There may exist conflicts of interest between risk reduction in the short and medium term as well as between the medium and long term. As part of a 'safety-first' type of strategy, non-surplus households give priority to income earning opportunities that provide income security during the lean period of the year. For the young non-surplus households with a relatively low family labour availability this often implies that they have to forego income earning opportunities in agriculture requiring labour investments early in the season and are less capable of adequately managing and monitoring crop activities. Thus, by focusing on short-term income security, these households increase subsistence risk in the medium term.

A conflict between security objectives also arises with investments in education. We have seen that middle-aged households give high priority to education of their children in order to secure the long term viability of the household unit. The bulk of these expenses has to be made at the start of the agricultural season, thus immobilizing investments for agriculture and reducing income security in the medium term. In fact, many non-surplus middle-aged households borrow substantial amounts to finance the education of children.

Risk taking willingness and economic efficiency

Research has historically focused on farmers' aversion to production risk resulting from uncontrollable risk factors and investigated the relationship between the farm's output or return variability and the farmers' willingness to take risks. Within this context reduction of output variability or low return probability is seen as the principal way through which farmers reduce household income risk, i.e., risk averse farmers are willing to sacrifice agricultural income to increase the stability of the income flow. Among others this has led to pleas for stable but low yielding technology requiring low levels of external inputs.

From the foregoing, it will be clear that it is difficult to evaluate farmers' response to risk in such general terms. Risk constitutes different entities, risk perceptions differ between farmers, and for the same farmer perceived risk may change over time. Thus, without specifying the type of risk and the period of decisions, it cannot be evaluated whether risk deters investments in inputs or adoption of technology more for one category of farmers than another. For example, we have seen that young wealthy farmers show cautious (risk averse?) behaviour with respect to the adoption of 'dry seeded - wet seeded rice' cropping due to a perceived chance constraint on wage labour, but at times overinvest in fertilizer inputs. In contrast, middle-aged poor farmers underinvest in fertilizers due to perceived financial constraints, but increased too rapidly the scale of double rice cropping (risk seeking?).

Assessing the impact of risk on economic efficiency is even more difficult. Apart from the above problems, quantitative research into the issue of risk-induced underinvestment in agriculture and misallocation of resources faces serious specification problems. First, it is difficult, if not impossible, to determine economic optima for complex choice situations such as whole-farm planning which allow sequential decision making and risk taking, especially when decision making takes place in a dynamic environment. Second, it is difficult to assess the extent to which risk is responsible for deviations from the economic optimum due to the possible influence of other factors such as perceptions of returns or farmers' preferences other than risk aversion (time preferences for income, leisure preferences, etc.)

Hence, one should generally be careful to typify behaviour as risk averse based on superficial observations of the farmers' determination to keep variability of production within reasonable limits. First, many farmers' practices that have evolved over time serve the dual purpose of obtaining 'best' returns to investments while keeping risk at a reasonable level simply because such practices make efficient use of variable environmental factors. Second, farmers' aversion to fluctuations in agricultural output often has a sound economic basis. Apart from risk aversion, there are good economic reasons for limiting large between-year fluctuations in output such as limiting interest payments associated with alternating borrowing and lending in case borrowing costs are higher than returns to lending.

However, the effect of attitudinal risk aversion on crop activity choice and investment behaviour, i.e., the farmer's unwillingness to take production risks, is likely to be marginal. Given farmers' own efforts to increase income from agriculture by substituting stable 'traditional' rice activities (e.g. transplanted BE-3) with HYV-based direct seeded rice and double rice cropping, we may safely conclude that households are not much interested in stabilizing agricultural output if such implies an even moderate reduction in perceived income. This particularly applies to households that have sufficient financial means to bear the consequences of risk taking. However, also for households that are in a poor financial position, stabilizing the long-run output flow has little meaning as short-term safety-first income generation that maximizes the short-term financial security of the unit takes precedence over long-term security. In fact, by concentrating on short-term income-earning opportunities poor households increase production risks in self-employed agriculture. To the extent that risk averse attitudes may cause a somewhat conservative choice behaviour, such effect appears to be more than compensated for by optimistic return perceptions.

Risk taking ability and equity

Apart from unacceptable chance constraints that may affect both poor and wealthy farmers, the usual reason why farmers choose for less risky options is that they are not able to take the financial risks. Consequently, risk taking in agricultural production is highly situational. At the start of the growing season, the immediate need to satisfy consumption requirements may simply prevent poor households from taking even moderate risks in the sphere of agricultural production (e.g. losing one bag of rice seeds in dry seeding). However, the same households are willing to seize high risk opportunities in agriculture provided they are in a financial position to do so.

Thus, it should be realized that the fact that farmers are generally averse to financial risk taking, i.e., the risk of becoming overextended through excessive borrowing, does not necessarily imply that they are also averse or not willing to take production risks. It is not so much the perceived (business) risk in agriculture that prevents poor households from choosing risky alternatives, it is the necessity to choose for particular activities (limiting other choice options) that secure immediate subsistence needs and avoid specific investment losses to keep financial risk at a manageable level. From a production point of view farmers simply cannot be classified as risk seekers or risk averters. They may fit both classes depending upon the particular type of decision studied and the period in which and conditions under which the decision is made.

Given the continuous indebtedness of non-surplus households, perceived financial risk may constitute a serious cause for underinvestment in agriculture, particularly as poor households tend to saturate cash investments with more labour than wealthy households. For households faced with a high level of indebtedness, sharp interest rates for loans and the risk of a spiralling debt accumulation caused by insufficient surplus production capacity, even small risks from a production point of view may loom large financially. Poor farmers are often forced to capital rationing for productive investments due to the high cost of sustaining subsistence (e.g. interest payments for consumption loans) and the necessity to keep financial risk on an acceptable level. Hence, given that productivity increases have increasingly become dependent on cash inputs, differences in financing capacity (or, alternatively, risk taking capacity) are likely to translate into widening income disparities between poor and wealthy households.

Summarizing, we conclude that it is dangerous to base risk analyses on superficial observations and generalize about risk behaviour of small farmers:

- Many farmers' strategies and practices - often erroneously identified as resulting from risk averse behaviour - serve the dual purpose of reducing risk and attaining best economic results. Such strategies are often based on sequential decision making and risk control, allow for an optimum use of environmental resources and, thus are sound economic practice.

- Risk describes various phenomena, is not a constant entity and changes over time. Differences in financial risk taking capacity (surplus production capacity) and resource composition (life cycle status) are such that in an apparent homogeneous class of rural households, different household categories perceive different production risks as well as financial risks to similar activities and, thus show a different response to risks present in agricultural production. There may even exist conflicts of interest between risk reduction in the short and medium term and in the medium and long term.

- Households are used to risk taking in agriculture. They are not much interested in stabilizing agricultural output if such implies an even moderate reduction in perceived income. If risk-induced underinvestment is important, the cause should be found in the limited capacity of poor households to take financial risks rather than in risk averse attitudes. Given the risk of a spiralling debt accumulation, perceived risk may constitute a serious cause for underinvestment in agriculture and widening income disparities between poor and wealthy households.

9.3 Implications on risk theory and research

Focus
The main implication of the above findings is that the question whether farmers like or do not like to take risks is, to a large extent, irrelevant. Apart from problems encountered in establishing the existence and effect of attitudinal risk aversion, it appears questionable whether such knowledge would improve our ability to deal with risk issues that directly concern farmers and affect agricultural development. Far more important than posing the question to what extent farmers avoid risk and what the effect is of risk avoidance on the economic efficiency of production, is the issue of how farmers deal with it. To what extent do farmers effectively manage agricultural production in the face of an uncertain production circumstances. Emphasis on risk management forces one to consider how farmers can be assisted in managing the risk they necessarily encounter in their crop production activities and how their capacity to take financial risks can be improved. It appears that - within the context of available technology and knowledge - farmers are far ahead of

economists and agronomists alike in making the best use of the variable opportunities provided by the environment. In this respect, there is an urgent need for scientists to catch up with farmers and learn from their risk management strategies both in the sphere of agronomic management and financing production and consumption.

Choice models

As analytical tools, most operational risk programming models are largely inadequate to deal with risk management strategies. This directly results from the economists' tradition to strongly adhere to optimization and sacrifice problem representation for optimizing algorithms. In contrast, farmers necessarily have to consider a richer set of properties of the real world and - depending on the complexity of the choice problem and their experience - may either strive for satisfactory solutions (crop activity choice) or 'near optimum' solutions (fertilizer application).

Because of the divergence between theoretical models and real-life decision making, existing choice models often do not address choice problems farmers are facing in reality. Among others, they cast the analysis on a static and timeless environment, whereas farmers are concerned with between-year adaptation and within-year sequential economizing and risk control; they emphasize final output risk, whereas farmers are interested in specific investment losses; they focus on production and production risks, whereas farmers have to deal with conflicts between consumption and production decisions, and are more concerned with financial than production risks.

When the objective of economic choice models is to aid farmers in making better decisions or are otherwise used to explain farmers' behaviour in variable production environments, there is a need to change the focus from improving upon choice algorithms to a better design and structuring of the choice problem itself. If further model development is restricted to a refinement of the decision algorithm, it is very likely to be an inefficient use of scarce research resources. However, on the other hand, it is not feasible to employ as a standard tool normative decision models that do take into account the relevant aspects of farmers' risk considerations. Such models (e.g. stochastic control programming) tend to become too complex, data demanding and, more importantly, too specific to certain choice situations to be generally applicable. The increased benefits, in terms of improved decision making at the farm level, that may be derived from applying the results of such models is not likely to cover the cost of developing and applying such choice models.

Thus, it is not recommended to concentrate research resources on the development of normative farm planning models that attempt to adequately represent a risky choice in complex decision situations. Of course, this does not imply that analyzing risk of new crop technology is unimportant. Neither does it imply that whole-farm modelling is useless. As a modelling tool, linear programming provides economists with a useful means to structure and systematize information about farming systems and may provide valuable information regarding possible constraints to new production activities. The point is that one should not attempt to include risk considerations as a standard element in optimization routines, neither in the objective function nor as part of the programming matrix.

Research methodology

Risk research may deal with (a) improvements in farmers' existing risk management strategies, and (b) ex-ante risk analysis of new technologies. Research into the effect of risk on farmers' decision making should start with an inventory of the various risk factors present in the environment and their effect on the feasibility and outcomes of production activities. Such inventory should focus on component risks (e.g. not annual rainfall variability, but specified for critical periods), use judgements of farmers as well as other knowledgeable persons, and, to the extent possible, contrast such information with existing data on risk factors. Next it should be investigated how farmers deal with these risk factors and to what extent their risk management strategies are effective. Asking relevant questions concerning risk management strategies should logically precede any attempt to quantitatively assess the riskiness of production activities, and inclusion of details of strategic decision making and risk into analytical models. With the notable exception of Jodha (1978, 1984), studies concerning risk management aspects of farmers' behaviour and economizing strategies are presently extremely limited. Contrasting farmers' plans with realized production activities may provide, on the one hand, valuable insights into what production strategies farmers perceive as feasible and, on the other hand, how farmers adapt such strategies to actual environmental conditions and internal household circumstances. Insight into the cash and product flows of households is another prerequisite for understanding farmers' risk management strategies.

Once such information is available, research can better be focused on those risk issues that count in farmers' decision making. Moreover, on the basis of such knowledge it can be established what type of information is required by farmers and how such information should be presented to farmers. It appears that, in most cases, a relevant risk assessment with respect to variable resource constraints can be carried through simple sensitivity analysis using linear programming. By varying relevant parameters of the programming matrix, an idea may be obtained about the 'robustness' of the solution vis-a-vis variable input requirements and output levels as well as production constraints. Such sensitivity analysis should certainly include the effect of a variable rainfall pattern on the feasibility of solutions by employing variable land and/or draught power constraints. It should also take into account the daily necessity to cover subsistence needs.

In analyzing the above aspects of farmers' behaviour a distinction should be made between, on the one hand, farmers' short-term management (coping) strategies as observed in any one particular year and, on the other hand, farmers' long-term adaptive strategies. For situations where the context of decision making is highly determined by variable environmental factors such as rainfall, basing analysis of farmers' economizing principles on one or two year observations is extremely dangerous. Indications of such general behaviour or decision making perspective can only be obtained from a careful assessment of how agricultural development evolved in the past and against this background what changes are taking place in the farm-household system at present. For any serious study regarding (aspects of) farmers' decision making, a historical analysis of past agricultural development is mandatory. However, this should not be intepreted as a plea for long-term, massive data gathering excercises, the results of which often become available after they have lost much of their actual value. Discussions with farmers and other knowledgeable persons should usually prove adequate in case researchers are sensitive to the dynamics of agricultural development and the role various segments of the community play in this process.

Agricultural technology generation

Agricultural research should not concentrate too much on developing a restricted number of 'best' agricultural techniques, even if such strategy takes into account differences in production environments. In variable rainfed environments such technology simply does not exist, whereas for different categories of farmers the best type of technology may be quite different. Farmers are more benefited by research that aims at developing and testing diversified production strategies comprising various options that are flexible and robust in the face of climatic and biological uncertainty and allow for an optimum use of the varying opportunities provided by the environment. Agronomists should allow for more environmental variability in the design of their experiments.

Apart from yield potential, pest and diseases resistance, drought tolerance, etc., agronomic research should pay more attention to the development and testing of technologies that allow management flexibility and show input profiles that facilitate sequential adaptation to environmental factors and sequential economizing regarding input use. It is striking that quite a number of technologies that have been advocated by agricultural development programmes in the area show the wrong input profile, i.e. high input investments at the start of the growth cycle of crops. Such technologies may be agronomically sound and even economically attractive when using a long-run average cost-benefit analysis. However, when evaluated within the context of sequential decision making and taking into account risk in terms of early investment loss such techniques may not be of interest to farmers.

The scope for quantification of production risks of new agricultural technologies prior to introduction appears limited. This is primarily due to a lack of time series data on most uncertain environmental factors influencing agricultural production. Moreover, if such time-series exist they are likely to be very location specific, limiting the general applicability of the results based on such data. However, one should not concentrate too much on the quantification of yield or net return risks. It often suffices to compare new technologies with existing techniques on a number of salient risk features such as susceptibility to uncontrollable risk factors, need for cash inputs, input investment profile, market dependence, etc, and, to the extent possible, evaluate interactions with other activities to identify chance constraints to the activity. In such areas, a qualitative assessment is usually sufficient.

If quantification of production risks is required (e.g. for technologies with high initial investment outlays), the earlier discussed random coefficient model may provide an efficient means of using existing information, i.e. cross-section and time series data. A promising alternative to risk assessment based on such a statistical technique may be simulation modelling employing water balance models incorporating the essential features of bio-dynamics of crop growth. Risk is best evaluated in terms of the size of the investment loss relative to the level of household income and its likelihood of occurrence. However, incorporation of risk aspects as criteria in the technology generation process should not induce researchers to disregard too quickly highly profitable techniques that, in first instance, appear to be too risky. The example of the rapid introduction of the 'dry seeded - wet seeded rice' cropping pattern should suffice to warrant against conservative research strategies.

Farmers' involvement

In order to increase the efficiency in the use of existing information and improve upon the effectivity of technology generation, a better use should be made of both the researchers' and farmers' knowledge. Instead of extensive testing of technologies on experimental stations, it is generally far more efficient to confront researchers with farmers and guarantee the farmer's participation in the technology generation and testing process as early as possible. In the design and testing of new technologies it is virtually impossible to take into account all desirable properties (some of which may be quite unexpected) on the basis of which farmers assess the overall attractiveness of a technology. Also, in directing agricultural research and setting of research priorities, farmers' knowledge concerning the micro-ecology of the environment and existing crop and livestock production systems should be used to the fullest extent possible.

Although adaptive research projects on farmers' fields are now becoming a regular feature in most Third World countries, they are generally still extremely limited in scale, highly dependent on expatriate personnel, and often poorly integrated into the national research system. Instead of limiting farmers' participation in the testing of technology to such small laboratory-like research projects, support to farmers' own experimentation and testing of technologies should become an integral component of regular agricultural development programmes. Farmers should be assisted in their experimentation by providing them with the techniques and financial means as well as technical support in terms of experimental design, interpreting results and solving of problems. It is striking that commercial chemical companies in the area already started with 'experimentation kits' some fifteen years ago, whereas official development programmes often restrict experimentation with advocated technologies by the setting of too high entrance thresholds (e.g. credit packages for one hectare and above). In such type of programme, the role of the extensionist should change from one who purely transfers information (the value of which is not to be questioned), to one who facilitates a dynamic flow of information on new possibilities and feedback of experiences between researchers and farmers.

9.4 Policy measures to reduce the impact of risk on agricultural development

In considering policy alternatives that may be employed to reduce the negative effect of resource-induced risk aversion, we may either think of measures that:

- reduce environmental risk and uncertainty;
- are aimed at reducing the effect of risk factors on the outcome of production activities;
- increase the farmers' risk taking capacity, i.e., reduce the financial consequences of risk taking.

Reduction of environmental risk and uncertainty

The first category of measures includes all those measures that increase control over environmental variability. Measures to reduce the effect of adverse physical environmental factors may include (supplementary) irrigation, flood protection measures, soil conservation, etc. These measures either serve the dual purpose of substantially increasing returns and reducing the variability of returns or may be specifically designed to reduce the incidence of severe risk factors. They usually require heavy capital outlays and, in the short term, the benefits may not always be directly clear to farmers as is the case, for example, with soil conservation measures. Although the effect will be difficult to quantify, in evaluating such measures the additional economic benefits in terms of a reduced effect of risk on activity choice should be accounted for.

A second type of measure is to reduce biological risk (pest and diseases) by the use of pre-emergence herbicides or profilactic applications of pesticides. However, we have indicated that although such measures may reduce physical yield risk, they may (and certainly do in the mind of farmers) increase net return risk, whereas the long-run economic benefits of reduction in yield variability through such measures are often not clearly established. Moreover, a liberal use of such chemicals may seriously affect the ecosystem. Another type of biological risk control includes cultural practices such as simultaneous plantings of crops to prevent pest or disease build-up.

A third type of measure aims at reducing market price risks. Although it is often argued that price stabilization will reduce risk, the opposite is quite plausible since prices are often negatively covariant with yield. However, given the fact that poor households in years of low production face the market as consumers interested in low buying prices rather than as producers who may benefit from high selling prices, price stabilization may stabilize the income and expenditure flow of poor rural households.

Fourth, it is often necessary to increase the reliability of the technical and institutional infrastructure. It is not uncommon that one of the chief sources of risk in rural areas is an ill-functioning government support system. Instability in the supply of farm inputs, poor market infrastructure, poor timing or non-availability of credit, and inadequate extension service are all sources of risk that induce farmers to be careful to become too dependent on them.

Fifth, reduction of perceived risk due to the provision of adequate information. Although we have seen that farmers may obtain a surprisingly adequate intuitive grasp of technology through attentive observation, this often does not imply that they understand the basics of the technology. Such apprehension is sufficient as long as environmental and other factors conditioning the response or preformance of the technology remain constant. However, in case circumstances change, farmers may be at a loss as to how to adapt the technology. Further, because of lack of information, farmers may be quite selective in their search for new technologies that align with their knowledge base.

Increasing farmers' risk control

The second category of policy measures does not aim at reducing the occurrence of risk factors but reduce their effect on the returns to activities. First, they include all the earlier discussed measures that increase the flexibility of the production system and allow sequential decision making in the face of evolving climatic and biological constraints in the course of the growing season. Second, reduction of crop yield variability is attained through breeding for varieties that are resistant to pest and diseases and tolerant to adverse climatic factors. Yield stability criteria are now incorporated as a standard goal of most crop research and breeding programmes. However, it appears that the genetic base on which the breeding for stability commences is extremely small. Because of the erosion of varietal diversity, the development of a few varieties 'par excellence' may prove to be a mixed blessing in the long run as it may substantially increase the risk of large-scale crop failures due to susceptibility to (unforeseen) pests or diseases.

It should be noted, however, that - within the context of small-scale agriculture in Southeast Asia - we are *not* pleading for a stable, low-external input technology. Although such research is certainly warranted (particularly as a hedge against worsening cash input-output price ratios), for the time being cash inputs such as fertilizers and pesticides are prerequisites for the survival of small farm units. For poor households the best option is not to generate low risk, low yielding technology, but to provide them with better facilities to cope with the financial consequences of (inevitable) risk taking in agricultural production.

Improving farmers' risk taking capacity

The third category of measures aims at increasing the ability of farmers to take risks. One of the most obvious forms of government intervention to offset the consequences of risk taking and thus reduce the effect of risk aversion is crop insurance. Here, we will not discuss in detail the growing body of literature concerning the effect and economic rationality of crop insurance. However, in general, one should be careful in considering crop insurance as another panacea for getting agriculture moving (Roumasset, 1979). Given the lack of data on which to base risk assessments, insurance programmes generally face serious difficulties in establishing premium structures that are actuarially fair (i.e., break-even in the long-run), whereas it is well-known that farmers are rarely able and willing to shoulder such insurance premiums (Ahsan, 1983). This causes insurance programmes to seldom be self-liquidating, a problem that is further aggravated by high administration costs and the fact that the principle of risk pooling, the ultimate objective of insurance, often does not materialize due to adverse selection. This is the tendency that only the risk prone farmers purchase insurance or that farmers only insure those fields that are particularly unfavourable to cultivation.

It is further questionable whether such programmes would indeed reduce risk averse behaviour and increase agricultural output. Because of the problem of 'moral hazard', the phenomenon that the insured farmer takes less care of the 'insured-against event', crop insurance may in fact cause reduction of agricultural output and induce economically inefficient behaviour. Moreover, we have seen that surplus farmers have sufficient means to diffuse income variations and are not likely to be interested in crop insurance unless premiums are highly subsidized. Poor farmers are not likely to be able to afford actuarially fair insurance premiums, whereas restricting the participation in subsidized insurance programmes to poor farmers severely restricts the risk pooling function of insurance. It generally appears that crop insurance can only be defended for those situations where a very limited number of clearly defined and measurable risk factors cause substantial variations in production.

A second type of measure in this category is to improve credit facilities in rural areas. Access to relatively cheap sources of instutitional credit is presently strongly biased in favour of the wealthier households. Often poor households cannot meet the requirements of becoming eligible for formal lending. They do not have ownership rights to land or other types of collateral (e.g. working animals) or in case of non-collateral supervised lending, the minimum lending floor is set too high relative to the borrowing capacity of the household. Although it appears that informal suppliers of credit can largely meet the demand for credit of poor households, the high cost of local credit is a major factor causing underinvestment in agriculture due to perceived financial risks caused by the high cost of sustaining subsistence in case of input investment losses or low production outcomes.

However, especially poor households with sufficient family labour resources show a high rate of labour utilization per hectare with a low level of complementary crop inputs such as fertilizers. This implies that the marginal benefits from an increased use of fertilizer by poor farmers will substantially exceed those of wealthier farmers, and in case wealthy farmers are close to the optimum level of fertilizer application, will substantially exceed the cost of capital. Thus, the provision of formal credit for poor households will both increase the economic efficiency of production and will reduce the overall risk these households are facing. It should be clear, however, that in meeting poor households' credit needs much more is involved than a policy towards pure farm credit. In order to meet fluctuations in the provision of subsistence goods as well as to safeguard households from background risks, farm-household lending must include facilities that allow lending throughout the year for both consumptive and productive uses and must involve flexible loan amounts that are realistic with respect to the repayment capacity of the household.

Finally, an important means of improving the long-run viability of small farm-households is to provide for measures that stimulate income earning opportunities outside agriculture. The village economy shows signs that, in spite of widespread adoption of 'modern' varieties and cash inputs, it is reaching a saturation point with respect to the further absorption of farm-households. The scope for further improvements in agricultural technology is difficult to predict. However, it should be realized that after farmers have reached the level of 6–7 tons of rice production per hectare under rainfed conditions - short of introducing irrigation or a substantial reduction in landrent levels - few major breakthroughs in rice crop production can be expected that would substantially increase the labour absorption capacity of the agricultural sector. To prevent agricultural involution and an increase in the number of households that face serious subsistence risks, urgent attention is required for the development of (semi-) industrial activities in both urban and rural areas.

GLOSSERY OF KINERA'A TERMS

agsa	land tenure contract with 50:50 sharing of production between landowner and tenant
alili	local cash loan of which both the principal sum and interest are repaid in rice; effective monthly interest rate 4.2 - 7.7%
alogbate	type of Indian Spinach (Bassella rubra)
arabon	once common photosentive rice variety extensively grown in rainfed lowland areas; predecessor to BE-3
arat-lauwan	advanced payment of casual labour that can be requested with priority in the course of the crop season
arkilado	fixed rent (leasehold) land tenure contract
aslum	inherently good soils that have become 'acid' after continuous use of ammonium sulphate fertilizers
bacolod	hill summit at the highest part of the toposequence
bagtik	compacted soil condition when puddled soils start drying out
bakili	steep hill slope located directly below the hill summit
balus	what you lose in a bad year, you expect to get back in a good year
banglid	gently sloping foot portion of hills or highest portion of low hill ridges
bantod	small narrow bunded rice fields with a substantial vertical drop between fields
baras-baras	sandy loam
bariri	weak and elongated rice tillers
bayanihan	voluntary help or cooperative work bee
BE-3	photosentive rice variety introduced in the 1960s and once extensively grown in rainfed lowland areas. To a large extent, it has now been replaced by IR-varieties
bolos-bolos	taking turns, e.g. in the cultivation of undivided land
bolto	volume measure equal to two cavans
buga-buga	silty clay soils
bukay	'white head'; empty whitish panicles of rice plants caused by stemborer attack during the flowering stage of the plant
bungak	first ploughing; breaking open of the soil
buro-balangtang	period of continuous, but low intensity rainfall
but'ong	local delicacy made of cassava flour and sugar
buylohan	intensively managed fields located close to the homestead
caltex	volume measure equal to one litre
camoros	non-photosensitive, drought resistant reddish rice variety grown on sideslope areas
capacidad sang lupa	inherent fertility of the soil
carabao	water buffalo
cavan	volume measure equal to three panigas or, depending on the rice variety, equal to 42-46 kg of unmilled rice
dagmay	superior kind of taro (Colocasia spp.) known as dasheen (Hodge, 1954) cultivated on upland fields
dagyaw	contractual arrangement where equal amounts of labour and/or carabao services are exchanged
danaw	lowest fields in the toposequence

dar-os	stunted growth and yellowing of leaves of rice seedlings caused by sudden submergence
ekonomia	dividing limited resources for various enterprises
fiesta	annual village celebration in honour of the village saint San Isidro de Labrador
ganta	volume measure equal to 1/25 of a <u>cavan</u>
gina tamasok	'dead heart' of rice plants caused by stemborers cutting off the growing part of the plant from the base
gintapat	extra high dosage of fertilizer
gutok	high stand density of rice crop
hagpok	crumbly soil condition
herbolario	traditional doctor or herbalist
hilot	local masseur or midwife
hinis-hinis	silty clay loam
hitsura	healthy appearance of rice crop; literally face
hunob	seepage
husto lang	it is normal; used to indicated normal yield level
huyos	small and not well-filled rice grains
igo-igo lang	it is enough; term used to indicated normal yield level
ipil-ipil	common tree species used for firewood production (<u>Leucaena glauca</u>)
jackpatan	the jackpot; terms to indicate the best possible yield level
jeepney	small local truck used for the transportation of persons and hauling freight
kangkong	common broadleaf weed species in well-watered lowland fields used as pig fodder (<u>Ipomoea aquatica</u>)
kayog	finger-blade harvesting knife used for harvesting rice by panicle
kul-aw	term commonly used for situations in which something appears more than it is or less than expected
kusim	rice leaf folder (<u>Cnaphalocrocis medinalis</u>)
lahos	rice establishment technique involving one ploughing followed by a furrowing and planting of seedlings in the furrow
lamgud	soil mined; inherently rich soils that lack fertility
lampano	appearance of healthy rice crop; broad and green leaves
lay-on	fine soil deposits in fields coming from the erosion of higher positioned fields
linamudan	local dish consisting of a mixture of rice and corn
loya-loya	crude way of rice crop establishment involving only one furrowing before transplanting
lungasod	see <u>danaw</u>
lus-on	stunted growth of rice on fields strongly deficient in internal drainage
malakpatan	by chance
mamag-o	rotation of crops or varieties
mara-mara	mole crickets (<u>Gryllotalpa africana</u>)
minongo	rice crop establishment method involving the broadcasting of pregerminated seeds in standing water. Field is drained after one day
minus	very bad; term used to indicated very poor yield
naga bilog -bilog	early reproductive growth stage of rice (booting stage)

naga-puras	stunted growth of rice seedlings and yellowing of leaves caused by a sudden ponding of water in a dry field
nagulpihan	fertilizer boost
nakusgan	stunted growth of rice plants at the vegetative stage due to sudden flooding of a field near cracking stage (bagtik soil)
nipis	low stand density of rice crop
nono-o	very fine clay soils
pabay-an	poor crops that are abandoned, i.e., left without any further care
pakyaw	contract labour group, e.g. for harvesting rice or ploughing a field
palagbung	rice crop establishment technique involving the broadcasting of pregerminated seeds in standing water followed by drainage of the field ten days after seeding until such level that the tips of the seedlings become visible
palay	unmilled rice grains
pal-ay	healthy appearance of rice crop two weeks after germination
palay-ang	rice crop establishment technique involving the broadcasting of ungerminated seeds in dry soil conditions ahead of the rainfall season
palusot	rice crop establishment method similar to minongo, but with ungerminated seeds
panarot	general term for devastating pests
paniga	volume meaure roughly equal to 14 kg of unmilled rice
pangamote	luck is against you; you always lose whatever you do
panubli	inheritance
panu igon	fluctuating; variable
paray-paray	seeding in furrows; also grassy weed species (Echinochloa crus-galli)
pasapar	free participation in rice harvesting
pasimpalad	risk; adventure
pasuerte	luck
patag	plain fields
patag hagdan-hagdan	fields transcient between sideslope and plain areas
patas man gihapon	two options that give the same results; there is no winner
patas sa gasto	the returns just cover the expenses
pigaw	very bad; term used to indicate very poor yields
pilit	glutinous rice
porcentuan	harvesting arrangement common in the harvesting of dagmay
prenda	mortgage
produktuan	local cash loan of which the principal sum is repaid in cash and the interest in rice; effective monthly interest rate of 2.3 - 5.0%
pug-a	fine-textured soils
pugtak-pugtak	typical concentric damage caused by hoppers (hopper burn)
quinta	land tenure contract with 40:60 sharing of the production between landowner and tenant, respectively
rimata	forfeiture in mortgage
risidiran	you will do something although you have the feeling that it is too risky
sab'a	plantain

sabati (sabog-)	rice crop establishment technique involving the broadcasting of germinated seeds unto puddled soil
sabod-sabati	rice seedling nursery established in puddled soil conditions
sabod-samara	rice seedling nursery established in dry soil conditions
sagahay	local rice loan of which the principal sum and interest is repaid in rice; effective monthly interest rate of 3.3 - 5.0%
sagod	tenure arrangement typically occurring with animals, whereby the sagod-taker agrees to feed the animal owned by another person in return for a 50:50 sharing of the proceeds after sale
saka-an	local cash loan of which both the principal sum and interest are repaid in case; effective monthly interest rate of 5 - 10%
salabay	rice caseworm (Nymphula depunctalis)
salmon	volume measure equal to a regular salmon tin, roughly equal to 1/50 of a paniga
Samahang Nayon	pre-cooperative village association introduced in 1972
samara (sabog-)	rice crop establishment technique involving the broadcasting of ungerminated seeds in slightly moist soil conditions that allow immediate germination
sarama	good stand of rice crop, even height and colour
selda	small joint liability groups of farmers to facilitate surpervising institutional credit
sibu	local cash and rice loans in the sphere of mutual-aid for which no interest is charged
sitio	small neighbourhood in village
suki	local arrangement which involves a subscription to regular purchases on credit of particular consumer goods of which the full amount is paid after a certain period
sul-og	see bayanihan
suyod	wooden, tooth-piked harrow for levelling puddled rice fields
tagustos	army-worm (Mythimna separata)
tahus	water retention capacity of fields
tamasok	rice stemborer (e.g., Scirpophaga incertulas and Tryporyza innotata)
tamasok puti	adult moths of the stemborer
tamasok ulod	stemborer larvae
tambok	the immediate effect of urea on the colour of the rice plant
tanum	transplanting of rice seedlings
tiangaw	rice bug (Leptocorisa oratorius)
tindog	density of the rice crop
tresa	land tenure contract with a land rent of one-third of the gross yield minus harvesting costs
tuba	mild alcoholic beverage obtained from the drippings of young flower pods of the coconut palm
tundal	bananas suitable for direct consumption
waya-waya	brown plant hoppers (Nilaparvata lugens) and green leaf hopper (Nephotettix spp.)

LIST OF ABBREVIATIONS

BGF	Barrio Guarantee Fund
BSF	Barrio Savings Fund
CYMMIT	International Maize and Wheat Improvement Centre
DSR	dry seeded rice crops
FaCoMa	Farmers Cooperative Marketing organization
GLS	generalized least squares regression
HYV	high yielding rice variety
IRRI	International Rice Research Institute
IR-varieties	rice varieties released by IRRI
M-99	government initiated rice production cum credit programme introduced in 1973
MOTAD	Minimum of Total Absolute Deviation
NGA	National Grain Authority
OLS	ordinary least squares regression
RCR	random coefficient regression
TD	triangular distribution of outcomes
TPR	transplanted rice crops
USAID	United States Agency for International Development
VC	visual counter method for eliciting subjective cumulative density function of outcomes
VPP-index	Village Palay Price Index. This index (1979-80 = 100) - indicating the increase in the price of rice - is used to deflate monetary values for the seasons of 1978-79 (= 95), 1980-81 (= 116), and 1981-82 (= 126). All monetary values presented in this study are deflated against this index implying a constant real value of the employed monetary unit of US$1 = 6.8 kg of unmilled rice
WSR	wet seeded rice crops

NOTES

Chapter 3

1) Because risky choice implies choice between probability distributions of consequences, mental balancing of a number of possible consequences simultaneously is required. Bernoulli's principle, or as it is more commonly known, the expected utility theorem provides the means for ranking risky prospects in order of preference, the most preferred being the one with the highest expected utility. It brings together in an explicit way the person's degrees of belief (subjective probabilities) and his degrees of preferences (utility of consequences). It postulates that a utility function (U) exists for a decision maker that associates a single real number (expected utility value) with any risky prospect. Von Neumann and Morgenstern showed that Bernoulli's principle is a logical deduction from a small number of axioms that many people agree are reasonable, at least to the extent that they would wish their own choices to conform with them (Anderson <u>et al</u>, 1977):

   (1) <u>Ordering and transitivity</u>. A person is assumed to have a consistent preordering over actions the outcomes of which are uncertain (i.e., risk prospects). A person either prefers one of two risky prospects a1 and a2 or is indifferent between them. The logical extension of ordering is to transitivity of orderings of more than two prospects. That is, if a person prefers a1 to a2 and prefers a2 to a3, he should logically prefer a1 to a3;

   (2) <u>Continuity</u>. If a person prefers a1 to a2 to a3, a subjective probability P(a1) exists other than zero or one such that he is indifferent between a2 and a lottery yielding a1 with probability P(a1) and a3 with probability 1 - P(a1). This implies that if faced with a risky prospect involving a good and bad outcome, a person will take the risk if the chance of getting the bad outcome is low enough;

   (3) <u>Independence</u>. If a1 is preferred to a2, and a3 is any other risky prospect, a lottery with a1 and a3 as its outcomes will be preferred to a lottery with a2 and a3 as outcomes when P(a1) = P(a2). Preference between a1 and a2 is independent of a3.

Chapter 4

1) Excessive cutting of firewood was due to the practice of continuously smudging mango trees with slow-burning smoking fires to prevent pest infestation. This practice abruptly stopped after chemical insecticides became available. It is interesting to note that the introduction of insecticides sometimes may have a positive influence on the ecology of an area. On the other hand, the dangers of spraying a large tree with a knapsack sprayer by inexperienced persons should not be underestimated. On one occasion it occurred that a person fell out of a tree intoxicated and barely made it to the hospital.

2) The harvesting of <u>dagmay</u> was organized around 6-10 labour gangs that harvested <u>dagmay</u> for one day, cleaned and bundled it the following two days, and then transported it by carabao sleds to the nearby town. Each gang had its own leader-cum-seller, who kept contacts with other groups in order to schedule harvesting operations and prevent an oversupply of <u>dagmay</u> on the market. They also dealt directly with one of the three big contract buyers in Iloilo City. A certain quantity was wholesaled to other buyers.

3) Byerlee <u>et al</u> (1980) define a recommendation domain as a group of roughly homogeneous farmers with similar circumstances for whom we can make more or

less the same recommendation. Recommendation domains may be defined in terms of both natural factors (e.g., rainfall) and economic factors (e.g., farm size).

Chapter 5

1) This group of relatively large farmers is not represented in the sample. It is a group of local entrepreneurs who are also engaged in money/rice lending, rice and livestock trading. Further, they are the owners of rice threshers and rice mills and have the highest percentage of owned or pledged land. Although they were explicitly invited to participate in the daily recording survey, for various reasons (e.g. no time) they refrained from doing so. The underlying reason for their non-participation may have been the perceived risk of allowing an outsider to make an in-depth analysis of their operations. However, in the course of the study this group of farmers provided valuable information on numerous subjects.

2) Of the total cadastral survey area (247 ha) of the village, 20% is owned by village people of which roughly half is hilly land left uncultivated. Of the remaining area, 75% is owned by residents in the nearby town, primarily small landowners with only a few owning landholdings above the 5 hectares. A small part of the land (8%) is owned by residents of a neighbouring village, whereas 17% of the area could not be traced to known landowners of which probably a large number is living outside the municipality. Roughly three-fourths of the land titles held by villagers in the cadastral survey area are smaller than 1 hectare, with an average area per title of 0.33 hectare. Moreover, 24% of the area covered by these titles (36% of the total number of titles) is undivided property, whereas of the area covered by titles above 1 hectare 63% is undivided. Land often remains cadastrally undivided as the surveying of land by the Bureau of Soils is too expensive ($54). Titles remain either in the name of the deceased parent, or are transferred to one of the children.

3) Especially during the last decade, purchase prices of land have sharply increased to levels of around $2,000 per hectare. The upward pressure on land prices is caused by purchases of relatively rich town people looking for safe investments in land, preferably in an area where relatives can take care of the land rent payments. In 1979, a town resident working overseas offered $2,300 for a hectare of rainfed land. This is roughly equal to the price paid for irrigated land in a nearby area.

4) The computation of annual income derived from cattle production is difficult. It stems from the fact that annual inputs do not directly result in income as the activity output is realized over a number of years. Hence, the computation of annual income to cattle activities is largely arbitrary, especially in the case it is not exactly known when the animals are purchased or born. In Table 5.2.1 only a percentage (20%) of the income derived from actual sales is included. Imputed income due to natural growth and birth of cattle is accounted for in the asset balance of the household (Figure 6.3.2).

5) Unlike crop production for which detailed production accounts were collected including all costs and returns (home consumed and sold products) of activities, for perennial crops data collected did not include home consumption of products. Hence, income derived from perennial crops is only composed of sold products. Home consumption of perennial crop products mainly include bananas and firewood.

Chapter 6

1) Except for livestock production and indirect productive activities, the presented labour data are collected through daily recording and include walking distances. Since livestock activities and indirect productive activities usually involve a more or less fixed daily time expenditure, no daily records were kept on these activities as with the direct productive activities such as crop production and wage labour. Assessment of the total time spent on indirect productive activities and livestock production was based on a special study (Res, 1983).

2) This implies that in this case the earlier defined rough classification variable 'subsistence coverage factor' (Section 5.3.1), based on the potential income that can be expected from crop production, is a good proxy for the risk taking capacity of the household. That is, the capacity to generate surplus income from crop production activities (i.e., income above basic subsistence requirements) critically determines the household's income-earning capacity and overall asset position. It should be realized, however, that in situations where off-farm income is important and dependable, such source of income should be accounted for in the potential income-earning capacity of the household in order to serve as a proxy for the household's risk taking capacity.

Chapter 7

1) In order to investigate the farmers' assessment of the technical feasibility of double wet seeded rice cropping for the various land units, a method was designed to elicit farmers' subjective assessment of the onset and termination of the ponding of water in rice fields. The procedure consisted of two series of questions, the first concerning the onset and the second concerning the termination of the ponding of water in lowland rice fields. The first series started with the question before what week farmers expected to never have ponding water in their rice field, followed by the question after what week they expected to always have ponding water. For the period in between these two weeks, starting with the week following the 'never' statement, farmers were asked to indicate for each week whether they expected to have ponding water in their fields in terms of the following probability heuristics: 'sometimes, but usually not' (0.25); 'half of the time' (0.5); and 'usually, but sometimes not' (0.75). With these probability heuristics (including 'never' (0.0) and 'always' (1.0)) it is possible to derive the cumulative probability distributions of the onset of ponding water in rice field as presented in Figure 7.2.1. The same questioning procedure was used to evaluate the termination of ponding water in rice fields.

2) It is surprising that in the economic literature concerning farmers' crop activity choice almost no attention is paid to farmers' own plans. In the conventional economic analysis of farm management (planning) decisions, attention is commonly focused on <u>ex-post</u> assessments, i.e., what farmers have done, rather than what they were planning to do. In such analyses, the efficiency with which farmers allocate their resources to the various activities is evaluated on the basis of a comparison between the <u>ex-ante</u> farm plan derived from a deterministic farm planning model (e.g. Linear Programming) and the observed <u>ex-post</u> farm activity pattern of farmers. Clearly, in dynamic or stochastic choice situations such comparison is inappropriate. Observed cropping plans are the result of actual production circumstances as they

develop in the course of a production season and the reaction of farmers to such circumstances. At best, deterministic farm planning models may be used to evaluate farmers' ex-ante farm activity plans, i.e., plans that are formulated by farmers before the onset of the growing season. The farmers' initial plan best indicates the choice of farmers based on their beliefs regarding the likely feasibility and attractiveness of alternative production opportunities, perceived constraints, and preferences.

3) The lack of buyers occurred due to a local oversupply of rice on the market resulting from large rice sales of farmers from a nearby irrigated area. Because of more favourable production circumstances, irrigated farmers harvested rice two weeks ahead of the first harvests in the rainfed village. The fact that rainfed farmers can seldom benefit from the high price period of rice and even find problems in marketing it, is a facet of the more general problem that rainfed rice farmers are at a disadvantage compared to irrigated farmers. In the rice production sector not only poor farmers, but rainfed areas as a whole are at a clear disadvantage in capturing the 'economic rent' that is associated with the early use of profitable new rice technology when markets have not yet adjusted to such higher productivity/market supply situation.

Chapter 8

1) The above safety principles can be transformed into mean - standard deviation rules by assuming that outcomes are normally distributed or after resort to the Chebychev inequality. This inequality shows that for any random variable 'x', the probability is never more than $1/h^2$ that 'x' assumes a value outside the closed interval from $E(x) - h * s(x)$ to $E(x) + h * s(x)$. For the Safety principle, using Chebychev's theorem, Roy (1952) found that

$$Pr(p \quad d'; p) \quad s^2(p) / (m(p)-d')$$

where p is profit, and m(p) and s(p) are the mean and standard deviation of profits respectively. Hence, if $m(p) \quad d'$ and $m(p) \quad 0$, his principle can be approximated by maximizing the ratio

$$k = ((m(p)-d') / s(p)$$

without assuming any more detailed information of the probability distribution of outcomes.

For normal distributions, the Safety Fixed rule is equivalent to maximizing a utility function of the form $m(p) - k * s(p)$.
The Safety First restriction can be rewritten after either resort to the Chebychev inequality or based on the assumption that outcomes can be considered normally distributed, as $s^2(p) / (m(p)-d')^2 \quad a'$.

2) Because of the limited occurrence of second fertilizer applications as well as the small contribution of these applications to the total amount of fertilizer applied, the effect of the second fertilizer application is not separately accounted for, but added to the first application. Although this is not likely to influence the shape of the response function, it may cause some underestimation of the risk involved in applying very high dosages of fertilizer in the first gift.

3) Although for similar fields the possibility of weed infestation is higher for dry seeded rice crops compared to wet seeded crops, farmers consciously choose less weed infested fields for dry seeded crops.

4) The comparison between the two data sets is not entirely valid because of the difference in rice variety. The variety IR-36 (farmers' data) is superior to IR20 (experimental data) with respect to disease and pest resistance as well as drought tolerance. Further, the influence of risk factors on rice yield (this excludes water stress because the response functions relate to irrigated conditions) may have been somewhat different for the period during which the experiments were undertaken (1969-75) and farmers' data were collected (1978-81).

5) The finding that the probability distribution of yield is poorly represented by a variance measure - a common measure of risk in many economic decision models - is in line with the general finding that the profit distribution of crop activities is often nonnormal. The present data confirm Day's hypothesis (1979) that the underlying weather variables influencing crop yields are nonnormally distributed and that crop yield distributions simply reflect them.

APPENDIX I

ECONOMIC MODELS OF DECISION MAKING UNDER UNCERTAINTY

1. Expected income-dispersion analysis

Expected utility maximization can be characterized by the following solution to an uncertain choice problem (Robison, 1982):

- identify the action choices available and the possible states of nature under which action choice consequences may be experienced;
- assign probability weights to the states of nature consistent with the probability calculus;
- identify the consequence of each action choice under each state of nature and assign to each a preference measure, a utility value;
- calculate the expected utility index for each action choice by multiplying the utility indices with their respective probabilities;
- implement the action choice with the highest index.

Within the expected utility maximization framework, preference measures or utility values assigned by risk averse individuals to the various outcomes of a choice option are considered to be a reflection of their diminishing marginal utility of money. A person is said to be risk averse when holding an assured amount, will refuse a chance to win or lose an equal amount, with fair odds (Arrow, 1971). Stated otherwise, for the risk averse individual the expected utility E(U) of the gamble 0.5 U($0 win) + 0.5 U($200 win) is less than the utility derived from U($100 assured). Such relation indicates that for risk averse individuals the utility function U(x) for money is non-linear against the value of 'x'. Hence, risk aversion is viewed as a reflection of the diminishing utility of money: a guaranteed sum of $100 is preferred to a 50:50 chance of $200 or nothing because the satisfaction or utility to be gained from an extra $200 is less than twice to be gained from an extra $100. Thus, it can be shown that the necessary and sufficient condition for risk aversion is that the first derivative of the individual's utility function for income (or wealth), i.e. his marginal utility, is positive and strictly decreasing (Arrow, 1971). Increasing marginal utility implies risk preference and a constant marginal utility implies risk indifference. Utility indices do not provide absolute value judgements as outcomes are valued relative to each other.

The main difficulties in using the method of maximizing expected utility relate to the emperical estimation of utility functions (and subjective probabilities), and to the computation of expected utilities with continuous probability distributions and abitrary utility functions. For simple choice problems involving few options with discrete outcomes, assigning utilities to all individual outcome possibilities may not pose a particular problem. However, for the more common case of a substantial number of options with continuous outcome distributions, such procedure becomes tedious.

For such cases, it is common to assess utility in terms of the probability distribution of income itself and to assume that such utility values can be encoded in a risk preference function. In such an approach, expected utility is expressed as a weighed sum of a series of moments of a probability distribution using Taylor series expansion (Anderson et al, 1977). Although, in principle, it is possible to assess probability distributions with an infinite series of moments, in practical applications it has been popular to take into account only the first two moments of the distribution, i.e., the mean and variance or any other variance related measure.

As an early example of a non-agricultural application of such analysis, Markowitz (1959) assumed that an investor choosing a portfolio of stocks and bonds would choose amongst alternative portfolios on the basis of a utility function defined in terms of the mean and standard deviation (or variance) of portfolio returns. An increase in the mean or expected value of returns is expected to increase utility, whereas increases in standard deviation decrease utility. Given these assumptions, a rational investor should restrict his choice to portfolios whose standard deviations of returns are minimum for given levels of expected returns. Using methods such as quadratic programming or Heady and Chandler's (1958) modified simplex technique, a schedule of minimum variance portfolios (also called the risk efficient choice set or frontier) with associated profit levels can be determined. Employing the utility function of the individual investor (expressed in terms of income and income variance), a utility maximizing portofolio can be selected from this schedule. All other risk programming models essentially follow the same procedure, i.e., the minimization of a measure of risk for a range of possible levels of expected profit, subject to the ordinary farm constraints and restrictions.

Presenting risk preferences in terms of the mean and variance of income, however, puts serious restrictions on either the distribution of outcomes or on the form of the preference function. Choice according to the mean-variance approach is consistent with the expected utility theorem and with the underlying assumptions (axioms), only on the condition that either profits (or any other return measure) are normally distributed or that the individual's utility function is assumed to be of quadratic form.

If returns are normally distributed, the probability function (and thus the utility of a prospect) can be fully expressed by the first two moments of the distribution. This is a necessary condition for Freund's (1956) farm production model based on the assumption of an exponential utility function of the form

$$u = 1 - e^{-by}$$

where (u) denotes utility, (y) denotes income, and (b) is a risk aversion parameter. Assuming that income is normally distributed, expected utility evaluates at $E(u) = E(y) - 0.5\ b\ V(y)$, which is linear in the mean and variance of income.

A mean-variance model can also be justified by assuming a so-called quadratic utility function of income (as suggested by Markowitz), regardless of the way in which income is distributed. For quadratic utility functions, expected utility of a prospect is evaluated solely as a function of the mean and variance. That is, quadratic utility does not take into account higher moments of the probability distribution of outcomes. Because mean-variance analysis based on quadratic programming routines is tedious, a number of linear approximations to the mean-variance model have been suggested (Boussard, 1979). Of these models, MOTAD programming (Hazell, 1971) is the most popular as it yields risk efficient sets remarkably similar to the mean-variance solutions (Anderson, 1979). This approach is based on minimizing the mean absolute value of negative deviations from the mean, for any given level of mean return.

Apart from problems associated with eliciting risk preference functions (see Chapter 3.3), the use of mean-variance analysis and the implied risk preference functions have been heavily criticized for a number of other reasons:

First, the assumption that profit distributions are normally distributed is very restrictive. Empirical evidence suggests that field crop yields exhibit frequency distributions that are more often than not nonnormal in character and with pronounced variations in skewness and kurtosis. Day (1965, 1979) hypothesizes that the underlying weather variables influencing crop yields are nonnormally distributed and crop yield distributions simply reflect them (see also Section 8.3).

Second, quadratic utility functions are characterized by increasing absolute risk aversion, i.e., they imply that individuals are less willing to accept risk at increasing levels of wealth. On this ground they have been rejected by many theorists (e.g. Pratt, 1964). The exponential utility function suggested by Freund provides a more realistic representation of risk attitudes as it implies constant absolute risk aversion. However, because of the frequent occurrence of nonnormal profit distributions this functional form is generally not applicable.

Third, the continuous, smooth character of the quadratic utility function implies that for all ranges of income individuals are always willing to accept some sacrifice in expected return in order to reduce variance. A number of studies have demonstrated, however, that utility functions which are not monotonically increasing are quite common (e.g. O'Mara, 1971; Masson, 1974). For example, it is quite common to find S-shaped utility curves. Masson argues that such results suggest a security-based behaviour over critical income ranges.

Fourth, a clear drawback of variance as risk measure is its implied symmetrical treatment of upper and lower deviations from the mean. The decision maker is not assumed to be concerned with higher moments of the outcome probability distribution such as skewness. It is however quite likely that decision makers are particularly concerned with the outcomes at the lower tail of the outcome distribution (downside risk). For particular cases consideration for downside risk may lead to preference for high variance alternatives. It is for instance quite easy to construct reasonable looking utility functions and probability distributions for two risky options, say F and G, for which F has a larger mean and a smaller variance than G, and yet have G be preferred to F. The idea is to make G highly skewed to the right. To alleviate this problem, Markowitz (1959) proposed to replace variance by target semi-variance. Semi-variance is the expectation of squared deviations below some fixed (disaster) level. This measure allows for a common target return when evaluating risk across alternatives and only considers deviations below this target level. However, due to the computational problems involved, this model formulation is not popular.

Stochastic dominancy

The problems associated with eliciting risk preferences and the general non-applicability of mean-variance analysis or related approaches, has led to the development of an approach - stochastic dominancy - that can be applied to situations in which little is known about the decision makers' preferences and where entire profit distributions are evaluated instead of certain parameters of such distributions as in mean-variance analysis. This approach is also based on the expected utility maximization framework, but does not require complete specification of the utility function. The essence of the method lies in the comparison of entire cumulative frequency distributions (CFD) of arrays of possible profit levels associated with choice alternatives. The procedure is to screen CFDs of profits according to a number of rules that allow the subsequent elimination of alternatives that are dominated by others. Hence, the method involves a partial ordering of alternatives as opposed to the complete ordering inherent to maximizing models. In theory, it is possible that, after the application of the first rule, only one alternative remains. The first rule simply states that a decision maker prefers maximum profits which implies that the CFD of profits of a preferred alternative lies everywhere to the right of the dominated alternative(s). The second rule compares CFDs that cross each other and allows a preference ordering for risk averse decision makers with a utility function that is smoothly increasing and strictly concave. The preferred alternative lies more to the right in terms of the area under the CFD cumulated from the lower values of the profit scale. The assumption underlying the third rule is that as people become wealthier, they also become decreasingly risk averse. How these rules are related to the expected utility maximization theory is described in detail by Anderson <u>et</u> <u>al</u> (1977).

2. <u>Safety First approaches</u>

The safety first approaches originate from descriptive decision theories and are based on the notion that in common usage risk is closest defined as the possibility of loss. Following Roy's (1952) original proposition, loss can be conceived as a particular (range of) negative outcome(s) which decision makers try to avoid; 'it is reasonable, and probable in practice, that an individual will seek to reduce as far as possible the chance of such a catastrophe occurring' (Roy, 1952). Such outcomes can be taken as net losses from a business activity, erosion of assets, or income falling below a critically low level.

The central tenet of the safety first approaches is the overriding importance of security motives on the part of decision makers. Day <u>et</u> <u>al</u> (1971) surveyed three security based rules-of-thumb:

- The <u>Safety</u> principle (Roy, 1952) involves the minimization of the probability that income or activity returns will fall below a specified target level. If (a) is the probability that disaster occurs, (p) is stochastic profit, (x) is a vector of decision variables, and (d') is the target income, this rule can be written as: minimize $a = Pr\ (p\ \ d';\ x)$.

- The <u>Safety Fixed</u> rule (Telser, 1955) involves the maximization of the minimum return that can be obtained with a given probability or a probability bound. According to this rule, the individual maximizes the income level (d) subject to the restriction that $a' = Pr\ (p\ \ d;\ x)$. It is argued that this principle may be useful in situations where it seems more natural to identify a fixed confidence level (1-a') than to identify the critical minimum income level (d').

- The <u>Safety First</u> principle, advocated by Shackle (1949) and applied by Kataoka (1963), assumes that the individual is satisfied to work within the context of some minimum perceived probability of disaster (a') and maximizes the expected profit level consistent with this constraint. Hence, the decision maker maximizes profit subject to the restriction that Pr (p d'; x) a'.

Both the Safety and Safety-Fixed Principles ignore the expected value of the alternative choice options. Particularly the Safety Principle discriminates unreasonably between choices of low risk, irrespective of their expected value. A further drawback of the Safety Fixed rule is the non-existence of a pre-determined disaster level. In contrast to these two rules, the Safety-First rule is concerned with both the probability of disaster and the the expected value of the objective function. This rule is closely related to the Chance Constraint Programming approach developed by Charnes and Cooper (1959) in which profit is maximized subject to a chance constraint on loss. In this model risk aversion takes the form of rejecting any alternative with an unacceptably high chance of failure. Once this amount of security is ensured, the decision maker is assumed to be risk neutral regarding his choice among remaining alternatives, i.e. maximizes expected profit.

As indicated by Roumasset (1976), it may not always be possible to satisfy the chance constraint, implying that the best choice cannot be determined. He proposes two alternative rules using lexicographic ordering of alternatives based on a combination of the above rules, which he labels Lexicographic Safety First (LSF). The first rule (LSF1) combines the Safety First rule with the Safety Principle. It involves a switch to the Safety Principle if none of the alternatives satisfy the chance constraint. That is, the decision rule is to come as close to satisfying the chance constraint as possible. The other rule (LSF2) combines the Safety First with the Safety Fixed Principle. If the risk constraint is fulfilled, both rules predict the same choice, i.e. expected profit maximization.

The above safety principles are also employed within the framework of mean - standard deviation analyses. By assuming that outcomes of alternatives are normally distributed or after resort to the Chebychev inequality (see Note 1, Chapter 8), all these rules can be transformed into mean-standard deviation rules and in this form they closely resemble mean-variance analyses (Pyle and Turnovsky, 1970). However, apart from the earlier mentioned problem related to the assumption of normal outcome distributions, it appears that by employing such mean-standard deviation approximations of safety principles, the whole meaning underlying these principles changes. The importance of short-term security objectives is transformed into a long-run concern with trading-off expected profits against risk in terms of the standard deviation of profits.

3. Game theoretic approaches

Decision criteria employed in game theoretic approaches are outlined in many economic textbooks (e.g. Baumol, 1972). Among others they include:

- The Wald criterion, also known as maximin: Here the best selection between alternative courses of action is the maximum-minimum pay-off, i.e., that course of action which yields the best result if the 'opponent' (be it a human being or natural circumstances) does his worst. This rule represents the most extreme case of risk aversion. It is a special case of the Safety Fixed rule where a' is zero. Also according to this rule, prospects are ordered solely on the basis of the minimum value of each distribution.

- Hurwicz's pessimism-optimism criterion: The best and worst pay-offs for each alternative course of action are compounded with a 'pessimism index' (x), ranging from 0 to 1, and (1-x). The expected pay-off is calculated for each alternative and the alternative with the maximum is chosen. The Wald's maximin criterion is an extreme case of this rule.

- The Laplace principle of insufficient reason: Since in choices involving uncertainty the probabilities of specific outcomes are unknown, Laplace argues that they can be regarded as equally likely. The alternative giving the highest average return is chosen.

- The Savage minimum regret criterion: For any one strategy of his opponent or of 'Nature' there is a best outcome for the decision maker. If a course of action is chosen which does not achieve this, then some regret of not choosing that alternative may be experienced. Savage suggests that the decision maker may choose that course which minimizes this regret.

There are no theoretical grounds for preferring one criterion to another. McInerney (1967) was the first to apply the maximin criterion to a farm planning model, and Maruyama (1972) generalized the maximin model to incorporate variability not only into the activity returns, but also in the input-output coefficients and constraint levels.

APPENDIX II

II.1 The Green Revolution at the village level: Masagana-99

On a nation-wide scale, the Masagana-99 (M-99) rice production programme was launched in May 1973. Its main objective was to recover from severe shortfalls in rice production in previous years, reduce importation of rice, and achieve self-sufficiency in rice. To this end, a 16-step package of rice production technology was put together and disseminated to farmers through production technicians, radio, and leaflets. The package included the use of IR-varieties and recommendations on the timely and correct application of crop inputs and farming practices. Low cost, non-collateral production loans under the supervision of the production technician were extended to farmers provided they organized themselves into groups of 4 to 5 farmers. These so-called '<u>seldas</u>' (Appendix II.2) were supposed to act as joint liability groups for loan repayment. The maximum loan per hectare started with $104 in 1973, was raised to $127 in 1974, and stabilized at $160 in 1975 and subsequent years. Roughly half of the loan was given in kind (fertilizer and pesticides) through a coupon system, whereas the other half was given in cash to cover labour-hiring expenses. To encourage farmers to join the programme a palay-price support system was established and implemented by the National Grain Authority (NGA).

The M-99 programme was rushed into the village around the end of August 1973 through a second meeting of the newly established local farmers' association <u>Samahang Nayon</u> (Appendix II.2). Since the programme was launched in the middle of the growing season, the few members of this association had to decide on the spot whether to participate. One <u>selda</u> was formed composed of eight relatively large farmers grouped around (and related to) the two wealthiest farmers of the village: the rice mill owner and a local moneylender. Although all members repaid their loan at the end of the crop season, for most of the members of this group it was the only time they participated. Being in a position to acquire loans from other sources (e.g. a 12% bank loan with land as collateral) or to generate their own cash, they apparently found the M-99 procedures too burdensome to obtain a second loan.

In its second year of operation (1974), the number of participants increased sharply. Partly attracted by the low cost credit (1973 was a bad crop year), but mainly because for most farmers it was the only way to obtain fertilizer (the large-scale implementation of the M-99 programme caused a fertilizer scarcity situation and drying up of commercial channels), 30 farmers (35% of the total number of farm households) applied for a M-99 loan. Some of these farmers were persuaded to apply for a loan by the local technician who benefited from increased lending through a bonus system.

At the start of 1975, it became apparent that most farmers did not have the cash to repay their loans, partly because of a drought period during the main crop period, but mainly because the surplus production capacity of most households was totally insufficient to cover loan repayment. Most of the loans were re-financed for the next year, i.e., farmers were given a new loan the cash component of which was used to repay the balance of the previous loan still remaining. In this way, the cash portion of the 1975 loan could finance around two-thirds of the 1974 loan leaving a balance of $40 to be paid by the farmer. Under the pressure of both the technician and their fellow <u>selda</u> members, most farmers made use of this scheme and, consequently, participation rates remained at almost the same level.

Evidently, in 1976 repayment problems similar to the previous year occurred. However, in contrast with the previous year, re-financing of loans was not possible and heavy penalties were imposed on defaulting. Farmers were threatened with jail and a few persons - including a barrio captain - were actually imprisoned. They were not released before they had repaid a substantial portion of the loan which forced some of them to sell their working animal (carabao). So other farmers, afraid to be put into custody as well, sold their carabaos, took the boat to Manila to borrow money from their children, or borrowed money from local moneylenders. However, even under this pressure, it was impossible to reach full repayment of the loans and the authorities changed to a policy of restructuring loans. From that year onwards it became possible to repay the loan gradually, in instalments with practically no lower limit with respect to the annual amount to be repaid.

In 1976, none of the 1974-75 <u>seldas</u> were able to enter the programme. In 1977, two small <u>seldas</u> were able to repay their 1975 loans and acquired a new loan. All farmers participating in these two groups can be considered relatively large with farm areas of over 2 hectares and fields located on the better land units, some portions of which are partially irrigated. It was essentially this last group of survivors (8% of the total number of farmers) who could have (or did) benefit(ed) from the M-99 lending were it not for the fact that it took them again two years to repay and by that time (1979) there was no technician present in the village to mediate in their loan application.

From the above it is clear that, for this particular village with rainfed rice agriculture, M-99 as an institutional credit programme was not very successful. Most participants (83%) received only one loan which was re-financed and subsequently restructured. One of the major reasons for the poor performance is that the yield levels aimed at in M-99 - 99 sacks of unmilled rice (<u>palay</u>) per hectare which is roughly equivalent to 4.2 tons/ha - are difficult to attain under rainfed conditions. Although under favourable weather conditions it is certainly possible to obtain such production per hectare, yields of IR-varieties under rainfed conditions (particularly those released during the M-99 period) are, on average, closer to 2.8 tons per hectare ($400/ha). Obviously, such lower expected yield level jeopardizes the very basis of non-collateral lending. Given such lower yield level and resulting lower benefit/cost ratio, small farm-households depending upon 1 to 1.5 ha of rainfed lowland rice for their subsistence needs simply cannot improve their surplus income earning capacity to such an extent that they are able to repay $160, not even in a better than average year (Chapter 6). Stated differently, subtracting harvesters' share and land rent payments from the gross yield (roughly 40%) and given the fixed subsistence requirements in rice, these households cannot absorb more than $40 to $45 in farm investments yearly. This is barely above the necessary expenditures for fertilizer/chemical inputs for a 1 hectare rice crop. Moreover, assuming that the M-99 years were not all of the type of 'better than average', it is not surprising to find that most farmers repaid their loans with the proceeds from upland crop sales. This even rendered the rice price support system for most farmers totally ineffective.

A survey undertaken in 1979 reveals that only 13% of the farmers would again participate in M-99 or a similar credit programme, but none of them would borrow more than the amount required for fertilizer and pesticides. Table II.1 provides a picture of village participation over the period 1973-1979 set against the pattern of the Philippine National Bank (PNB) releases for Iloilo Province. These figures tend to indicate that a similar pattern has occurred in other villages.

Table II.1 Masagana-99 participation

Year	Village participation: No. of seldas	No. of farmers	Iloilo Province 1): PNB loan releases (Pesos '000)	Repayment (%)
1973	1	8	6,117	98
1974	5	30	13,061	84
1975	4	26	13,125	70
1976	1	5	745	95
1977	2	7	2,270	86
1978	-	-	2,162	77
1979	-	-	1,320	11

1) Source: PNB loan releases and repayment bulletin (1980)

It is more difficult to determine the general impact of the programme on agricultural development of the village since farm techniques were already changing before M-99 entered the area. Farmers were experimenting with the new IR-varieties (IR5 in 1968, IR20 in 1970), higher fertilizer levels on both old and new varieties, as well as higher pesticide application levels. Moreover, the land reform (1973) may have given some farmers more room for experimenting with new crop production technology as land rent payments were substantially reduced.

However, according to farmers the programme recommendations did not fit their rainfed rice production conditions. Although it may have given farmers a sense of properly timing the main crop operations and may have helped them in the (complex) use of pesticides, it certainly did not substantially contribute to the adaptation of the new short-maturing varieties to rainfed farm systems. The proper timing of crop operations was certainly appreciated by farmers and interviews revealed that they easily memorize the timing of most major operations. However, at the same time they argue that they often cannot follow the optimum time schedule because of the uncertain nature of water availability in their rice fields. Moreover, the resulting yield variability leads them to adopt a decision procedure which is essentially less mechanical in character than that followed by their irrigated counterparts and described in the M-99 brochures (For an analysis of the impact of irrigation on farmers' decision making see Jager (1980)). For instance, their experience has learned them to be careful not to invest too much cash in a crop too early. They deliberately postpone certain input investments until they think that the crop has a reasonable chance of repaying the investment. Hence, it is not surprising that farmers neither used the cash budgeted for hiring labour to plough the field, nor adopted the recommended straight-row planting method of crop establishment or the recommended basal application of fertilizer.

Land preparation is usually carried out as much as possible by the farmer himself or with the help of (unpaid) exchange labour. Straight-row planting would increase crop establishment cost with 50% without yielding any reliable increase in net production. The fact that a straight-row planted field is easier to weed because it facilitates the use of a rotary-weeder, apparently did not appeal to farmers. They reason that it is impossible to use such device in a dry or slightly moist field and even if the field gets flooded once in a while the rotary weeder is only effective against sedges and broadleaf weeds which are relatively easy to control with herbicides. Instead of adopting the more expensive straight-row planting, farmers started to use - in spite of all recommendations and extension efforts in the area - the direct seeding method of rice crop establishment in puddled fields and later in dry fields. This practice proved to be so viable that most farmers completely abandoned transplanting IR-varieties. In fact, combined with the introduction of IR-varieties, it can be considered the biggest breakthrough in rice farming in the area which actually stimulated the use of IR-varieties.

II.2 Government imposed farmers' associations: the Samahang Nayon and selda

Following the proclamation of martial law and the subsequent declaration of Land Reform in 1972, the Department of Local Government and Cooperative Development hurriedly started to organize village associations or Samahang Nayon. These pre-cooperative organizations were supposed to replace the old, municipality-based, and defunct Farmer Cooperative Marketing Organization (FaCoMa). The idea was to shift the cooperative effort in two directions, in a first phase downwards to the village level and in a later stage - after these organizations proved viable - upwards to the district level.

The broad objective of this association was stated as 'to improve the quality of life for village people both socially and economically by encouraging them to work together in an atmosphere of joint cooperation'. More specifically, it was meant to ensure amortization payments by farmers for land received under the land reform programme and elicit savings to finance the operation of this programme. Further, these associations were supposed to serve as a channel for essential services provided to farmers. In addition to an entrance fee of 10 pesos kept in a general fund and used for the association's operational expenses, members were expected to contribute one sack of palay per hectare per crop per year (with an approximate value of $6 per hectare per crop) to a Barrio Guarantee Fund (BGF), and to forego 5% of the value of each loan received from an institutional source, to be credited to a personal account within a Barrio Savings Fund (BSF). Members not borrowing from institutional sources were expected to contribute about $8 to the BSF annually. The guarantee fund was meant - among others - to support members' land amortization commitments, whereas the savings fund was intended to acquire shares in existing or new rural banks.

The organization was introduced in the village in May 1973. By the end of that year it counted 41 members (about half of the number of farm households) who all paid their membership and annual fee. The main reason for joining the organization was the idea that it would facilitate access to fertilizer and other farm inputs that had become scarce after the nation-wide introduction of M-99 in 1972. After the M-99 programme was introduced in August that year and one group of farmers had acquired loans from this programme, most farmers started to pay their membership fee with the aim of becoming eligible for the M-99 scheme next year. Further, quite a few farmers were interested in the life insurance facility offered through the organization. None of the officials, however, mentioned the organization's specific function in the land reform programme and when asked, merely stated that this programme was of no use to the village. Still, a few landlords prevented their tenants from joining the organization.

Given the strong link-up between the Samahang Nayon and the M-99 programme as viewed by farmers and taking into account the development of this programme, it is not surprising that the enthusiasm for the SN rapid declined in the following three years. Payments to the guarantee fund decreased from an initial 41 sacks of palay in 1973, to 29 sacks in 1974, 20 in 1975, 10 in 1976, to none in 1977 and the following years. Still in 1975, on the suggestion of a government official, the organization was officially registered. Moreover, the same official urged the local board members to subscribe to 10 shares of $13.5 to help capitalizing a cooperative marketing organization. After 1976 the organization became effectively a dormant society. The then acting president resigned from office induced by the aggressive repayment drive of the M-99 programme launched that year. Since none of the farmers were prepared to take over his position, the very official who was instrumental in establishing the association took over the presidency.

Obviously, the main cause for the poor performance of this association followed directly from the fact that with an ineffective land transfer programme - as in this village - the main function of this association disappeared. However, even under a failing land reform programme, the Samahang Nayon could still have performed its other functions. By substituting for services rendered by landlords (e.g. credit) it could have facilitated a more vigorous and widespread change in tenure conditions. The major weakness of the programme was that it never entered the stage where it could have developed its own support services as promised to farmers during the start of the programme. Although for the larger tenants, M-99 may have, to some extent, bridged the credit gap that arose after tenants started to oppose existing land rent levels and sharing arrangements, it certainly did not help the smaller tenants. For short-term farm input credit and emergency assistance in case of crop failures or major diseases in the family, they remained dependent on landlords and local moneylenders. Among others, these strong landlord-tenant relationships partly explain the still widespread occurrence of (illegal) share tenancy, covering about 30% of the total cultivated area.

Further, the association could have provided a common meeting ground where local participation and interest could have been generated and local action could have started to solve problems encountered in farming and in the village in general. However, given the limited number of meetings as well as the vague notion members had of the purpose of the organization, attempts at cooperative education and mobilization should be considered rather unsuccessful. In fact, it seems that none of the members ever perceived the Samahang Nayon as their cooperative. The members - including the local officials - had no idea what to do with the organization. Essentially, the only person considered to understand the organization's rules and purposes was the government official himself. As a result the members of the organization merely followed his directives which finally caused the embezzlement of the association's funds.

The selda system

Nationally, seldas were officially introduced in 1970 and were established throughout the country at the beginning of 1972. Apart from providing an easy control over loan repayment, the seldas had to serve as the basic production unit at the farm level; as a channel for facilitating distribution of farm inputs; as collection and assembly points for agricultural marketing; as rural nuclei for concentrated technical training and extension assistance; and as sub-units for social development within the village structure.

For this village, however, the selda system was introduced as a side effect of the M-99 programme. The idea behind the formation of seldas was to form small-scale joint liability groups facilitating the supervision of production credit. Members were required to sign a promissory note stating joint liability for all production loans and a joint marketing agreement, and members had to comply with a budget prepared by technicians and agree to follow the supervision of a group leader. It was expected that the Filipino spirit of 'bayanihan' (farmers voluntarily helping each other) was to become the cornerstone of an internal policing system of repayment of credit. It was felt that with small groups of farmers, the social pressure exerted by the bayanihan spirit would ensure improved credit delivery and repayment systems.

For farmers in this village it remained largely unclear how this joint liability system should have worked. According to one farmer they should have jointly worked the land of a defaulting member in order to repay his loan with the proceeds, whereas others argue that they had to repay his loan with their own money or force the farmer to repay his own loan. In both cases, a defaulting farmer would change his debt position with the bank to a much heavier debt position within the village. Most farmers viewed the selda as a necessary evil accompanying the M-99 programme (see also Castillo, 1982).

The main reason why the selda system never worked may be found in a basic misunderstanding of its very guiding principle: the bayanihan spirit. Bayanihan, locally known as sul-og, belongs to a group of 'quasi-contractual reciprocity' arrangements which involve more or less balanced exchanges where the terms of repayment are not explicitly stated before the contract is made. Rather the terms are implicit in situations which culture recognizes and defines as calling for these terms. Reciprocity comes into play automatically without any specific prior arrangement, and repayment is made in a mechanical, almost non-affective manner (Hollnsteiner, 1972).

Sul-og arrangements typically occur when activities require a large amount of labour such as the *relocation or repair of houses, fencing a field, etc.*, and thus takes the form of a cooperative labour project which commonly takes place in the off-farm season. Sul-og activities have the character of a social event. People join voluntarily, food and drinks are provided by the organizing party. Strict farm activities are explicitly not included. For such activities, labour is either hired on a daily wage basis or exchanged (dagyaw). The latter also involves a reciprocity arrangement but has a contractual nature: two or more people agree to behave towards one and another in a specified way for a specified time in the future. For instance, dagyaw activities occur in land preparation where farmers agree to take turns in ploughing one another's fields. Participation in these activities is not generated by a feeling of being responsible for each other. It is not a mutual-help mechanism which can be relied upon in the case of rice or other shortages. In fact, in order to reduce such commitments, it was typical that seldas were seldom composed of close relatives.

The non-functioning of the joint liability groups also became evident to the M-99 organization. In a first effort it allowed existing seldas to regroup and finally decided to completely abandon this component of lending requirements.

APPENDIX III

Computation of the income to family factors derived from crop production

Table III.1 Structure of crop production; annual averages per household category for the period 1979-81 ($)

	Average	Non-surplus young	Non-surplus middle	Surplus young	Surplus middle	Surplus old
Gross production	869	400	511	991	1404	1037
Payment to external inputs 1)	343	163	150	423	541	432
Hired labor	110	48	27	140	169	164
Cash	35	17	2	57	58	40
Kind	75	31	25	83	111	124
Rent	144	77	80	166	222	173
Purchased current inputs	64	29	28	87	105	71
Fertilizer	56	25	25	75	94	61
Chemicals	8	4	3	12	11	10
Capital rental	25	9	15	30	45	24
Seed use	60	28	36	74	93	72
Imputed income family factors	466	209	325	494	770	533
Labour	165	106	136	178	246	161
Profit (residual) 2)	301	103	190	316	525	372

1), 2) See footnotes Table III.3

Table III.2 Structure of rice crop production; annual averages per household category for the period 1979-81 ($)

	Average	Non-surplus young	Non-surplus middle	Surplus young	Surplus middle	Surplus old
Gross production	632	278	364	628	1100	790
Payment to external inputs 1)	278	128	119	319	472	351
Hired labor	95	40	25	120	163	129
Cash	31	14	1	48	58	35
Kind	64	26	24	72	105	94
Land rent	102	56	55	99	169	132
Purchased current inputs	56	23	24	70	95	66
Fertilizer	50	21	22	61	86	58
Chemicals	6	2	2	9	9	8
Capital rental	25	9	15	30	45	24
Seed use	36	16	21	35	62	47
Imputed income family factors	318	134	224	274	566	392
Labour	89	62	82	60	142	100
Profit (residual) 2)	229	72	142	214	424	292

1), 2) See footnotes Table III.3

Table III.3 Structure of non-rice crop production; annual averages per household category for the period 1979-81 ($)

	Average	Non-surplus		Surplus		
		young	middle	young	middle	old
Gross production	237	122	147	363	304	247
Payment to external inputs 1)	65	35	31	104	69	81
Hired labour	15	8	2	20	6	35
Cash	14	3	1	9		5
Kind	1	5	1	11	6	30
Land rent	42	21	25	67	53	41
Purchased current inputs	8	6	4	17	10	5
Fertilizer	6	4	3	14	8	3
Chemicals	2	2	1	3	2	2
Capital rental		.				
Seed use	24	12	15	39	31	25
Imputed income family factors	148	75	101	220	204	141
Labour	76	44	54	118	105	61
Profit (residual) 2)	72	31	47	102	99	80

1) Interest payments are not included in the cost of production.

2) For the few cases that households own land, returns to own land are included in the residual profit.

APPENDIX IV

Weeds in rice fields identified by farmers

Scientific name	Local name	Occurrence 1)
Grassy weeds		
Brachiara mutica	gasa	
Cynodon dactylon	buko-buko	*
Dactyloctenium aegyptium	blantiki	*
Echinochloa colona	ginga	**
Echinochloa crus-galli	paray-paray	*
Echinochloa glabrescens	lalaki paray-paray	
Ischaemum rugosum	limba-limba	**
Paspalum conjugatum	blantiki	*
Paspalum paspalodes	loya-loya	
Paspalum scrobiculatum	gasa	
Sedges		
Cyperus difformis	lisu-lisu	**
Cyperus iria	payong-payong	*
Cyperus rotundus	lalaki payong-payong	**
Fimbristylis littoralis	bungot-bungot	**
Broadleaf weeds		
Alternanthera sessilis	lupo	
Eclipta prostrata	tinta-tinta	*
Commelina benghalensis	sabilao	**
Ipomoea aquatica	kangkong	**
Phyllanthus niruri	San Pedro	*
Marsilea minuta	apat-apat	*
Ludwigia adscendens	kurokudkudan	*
Ludwigia octovalvis	kahoy-kahoy	
Monochoria vaginalis	yahong-yahong	
Spenoclea zeylanica	kahoy-kahoy	*

1) Frequency of occurrence: common (*) and very common (**)

APPENDIX V

Insect pests in rice crops identified by farmers

In total eight insect pest species affecting rice crop production were identified by the majority of farmers.

Minor insect pests

Mole cricket (mara-mara) is particularly a problem in dry seeded rice where soil conditions are favourable to their development. They feed on the roots of the young rice plants causing stunted growth or death of seedlings. None of the farmers found it difficult to identify this pest. Flooding the field effectively controls the pest, but may not be possible under rainfed conditions. Occasional handpicking of insects occurs. Once the area is flooded, affected areas are usually replanted with seedlings from dense portions of the field.

Leaf folders (kusim) also occur in the early stages of crop growth and the infestation usually subsides when the plant grows older. However, the pest may sometimes attack at the more sensitive later stages of crop growth. Farmers describe the pest as 'worms hiding and eating on the leaves'. Larvae fasten the edges of a leaf together and live inside the folded leaf while eating the leaf tissue. Infestation usually occurs under conditions of continuous rainfall and especially on fields which are shaded by trees. The afflicted portions of the leaves dry up, giving a serious infested field a scorched appearance. This pest is considered easy to control by farmers with any type of pesticide. One farmer mentioned effective control of the pest with the use of a local brand of soap.

Rice caseworm (salabay) is also considered a minor pest, although it occurs quite frequently. It develops under humid (cool and cloudy) conditions when there is an abundant water supply in the field. The defoliating effect of this pest is easy to identify in the field. Insects mainly feed on young plants and attack early in the season. Most farmers mention cutting off of leaves and stems causing stunted growth and death of young plants. Drainage of fields is considered an effective control practice by farmers. It prevents larvae from floating on water from one plant or field to another. Any kind of pesticide is found to be effective in preventing a pest build-up. Replanting of vacant spaces may follow infestation.

Army-worm (tagustos) is considered a major threat to rice production, but only older farmers can remember serious outbreaks of this pest.

Major insect pests

Stemborers (tamasok) may severely reduce yields especially when infestation occurs during the latter part of the growth cycle. Stemborers bore and feed inside the rice stem. While feeding, the borer cuts off the growing part of the plant from the base. This condition results in what is commonly known as 'dead heart' (gina tamasok). A borer attack during the flowering stage causes empty whitish panicles that are called 'white heads' (bukay). Plants attacked during the early vegetative stage can recover from a mild attack since they can grow new tillers to replace those destroyed. Farmers are generally well aware of the development cycle of stemborers. The adult moths (tamasok puti) were identified as 'those insects that lay eggs, that will later become the worms (tamasok ulod), that make holes and eat the inner protion of the plant'. According to most farmers, no serious damage is inflicted by the adult moth, but farmers control them to prevent a build-up of larvae. Common control consists of foliar spraying with broad-spectrum pesticides such as endrin and assodrin, usually upon visual occurrence of a sufficient number of adult moths in the crop or actual damage caused by stemborer larvae. The optimal condition for a pest build-up was considered a long rainy period after a drought, partly because rain prevents farmers from spraying against the adult moths. Most farmers mention that it is difficult to control the pest once the larvae are inside the stem.

Brown plant hoppers and green leaf hoppers (waya-waya) may cause serious damage to plants when a large number of these insects congegrate on a crop. However, only a few localized infestations were reportęd during the survey period. The typical concentric appearance damage caused by hoppers (hopper burn) is locally known as 'pugtak- pugtak'. Farmers indicate that although there is sufficient water available in the field, plants seem to dry up. They attribute hopper burn to the presence of hoppers at the base of the stem of the rice plant, and indicate that these insects damage the plants by sucking the sap ('these insects are sucking the nutrients taken by the plant from the soil') or that they inject a poisonous substance into the plant. Farmers control hoppers when sufficient numbers are present in the field either by foliar spraying (green leaf hoppers) or by spraying towards the base of the plant (brown planthopper), usually with Shellcarb.

The last insect pest of this group, rice bugs (tiangaw), may have a devastating effect on final grain yields if a severe infestation occurs. The local expression 'you are visited by rice bugs' means that somebody is very unlucky. Both nymphs and adults suck the sap of developing rice grains which may result in shrivelled, empty, or partially filled grains. Rice bug populations usually increase at the end of the rainy season and will, therefore, especially affect the photo-sensitive BE-3 variety which is harvested in December. Warm weather, overcast skies, and frequent drizzles favour the development of the pest. No major infestations occurred during the survey period, but if necessary, farmers will do everything in their power to control the pest in case they expect a good harvest which may go as far as spraying pesticides every other three days.

APPENDIX VI

Specification of the Random Coefficient Regression Model

A random coefficient model specifies a relationship in which the left-hand or dependent variable responds to a unit change in the right-hand or explanatory variable with a random change that is characterized by a certain mean and variance (Theil, 1971). These models are usually applied to pooled cross-section and time-series data to allow for heterogeneity between observation units. Another rationale for using this model is that incomplete specification is unavoidable because of the inevitable omission of influential variables.

Mount (1974) points to the potential use of this model for risk estimation '.... in a production process, particularly if influenced by the weather, it is the unexplained variability of output over time that contributes to risk .... if the slope coefficients are specified as stochastic, the variance of output depends upon the input level, and as a result, risk behaviour can be investigated in this type of model'.

Based on Swamy's specification (Swamy, 1970), the random coefficient regression (RCR) model with one explanatory variable can be written as follows (Maddala, 1977):

$$y_{ij} = b_i x_{ij} + u_{ij};\quad i = 1,2,\ldots\ldots T \text{ (time periods)} \quad j = 1,2,\ldots\ldots N \text{ (observations)} \tag{1}$$

$$E(u_{ij}) = 0$$

$$\mathrm{var}(u_{ij}) = s_i^2$$

the b_i are independent with mean b and variance d^2. We can write $b_i = b + v_i$, where $E(v_i) = 0$ and $\mathrm{var}(v_i) = d^2$

Under these assumptions regression model (1) can be written as

$$y_{ij} = bx_{ij} + w_{ij}$$

where $w_{ij} = u_{ij} + v_i x_{ij}$

and $\mathrm{var}(w_{ij}) = s_i^2 + d^2 x_{ij}^2$ (2)

$$\mathrm{cov}(w_{ij}, w_{ik}) = \mathrm{cov}(u_{ij} + v_i x_{ij})(u_{ik} + v_i x_{ik}) = d^2 x_{ij} x_{ik}$$

$$\mathrm{cov}(w_{ij}, w_{i'k}) = 0; \text{ for } i \neq i' \text{ for all j and k}$$

Thus the variance-covariance matrix of the w_{ij} is

$$V = s_i^2 I + d^2 x_i x_i'$$

In statistical terms, this model can be regarded as a mixed model, with both fixed and random effects. It corresponds closely to the model evaluated by Just and Pope (1979) as having the best properties with respect to reasonable risk criteria.

Equation (2) cannot be estimated by ordinary least squares (OLS), because var(w_{ij}) is not constant. OLS would provide an estimate of b that is consistent but not efficient. To calculate an efficient estimator we must use the generalized least squares (GLS) estimator:

$$\bar{b} = \left(\sum_{i=1}^{N} x_i'(s_i^2 I + d^2 x_i x_i')^{-1} x_i\right)^{-1} \left(\sum x_i'(s_i^2 I + d^2 x_i x_i')^{-1} y_i\right) \tag{3}$$

which can be simplified as

$$\bar{b} = \sum_{i=1}^{T} w_i \bar{b}_i$$

where $\bar{b}_i$ is the estimator of b_i from equation (1) corresponding to the ith time period

$$w_i = \left(\sum_{j=1}^{N} (1/(d^2 + s_j^2/(x_j'x_j)))\right)^{-1} (1/(d^2 + s_i^2/(x_i'x_i))) \tag{4}$$

Hence, if d^2=0, what equations (3) and (4) mean is that $\bar{b}$ is a weighted average of $\bar{b}_i$, the weights being inversely proportional to the variances. If d^2 is large compared to $s_i^2/(x_i'x_i)$, the weights (4) are almost equal, then $\bar{b}$ is close to a simple unweighted average of $\bar{b}_i$. The same will be true if $s_i^2/(x_i'x_i)$ are almost equal.

The parameters to be estimated are b, d^2, and s_i^2(i=1, .., T). Because $d^2$and s_i^2 in equation (4) are unknown, we cannot directly compute the GLS estimator of equation (3). Maddala (1977) suggests using some preliminary consistent estimators for these parameters. To obtain these, we first estimate equation (1) separately for each time period to get $\bar{b}_i$ and the vector of residuals $\bar{u}_i$, after which we can use

$$\bar{s}_i^2 = N^{-1} \bar{u}_i'\bar{u}_i$$

$$\bar{d}^2 = T^{-1} \sum \bar{b}_i^2 - (T^{-1} \sum \bar{b}_i)^2$$

Although both $\bar{s}_i^2$ and $\bar{d}^2$ are biased estimators, from an estimation point of view they are probably the least arbitrary ones.

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SAMENVATTING

KEUZE EN ONZEKERHEID IN DE SEMI-ZELFVOORZIENINGSLANDBOUW. Een studie over besluitvorming in een Filippijns dorp.

Deze studie handelt over de reaktie van Filippijnse boeren op onzekerheden in de landbouwbedrijfsvoering en de daaruit voortvloeiende risiko's. Het risikogedrag van boeren wordt bestudeerd tegen de achtergrond van landbouwintensivering op basis van de introduktie van de zogenaamde 'verbeterd zaad-kunstmest' technologie. Deze technologie is vaak bekritiseerd vanwege de, in vergelijking met de bestaande technologie, hoge benodigde investeringen en de daaraan verbonden risiko's. De aversie van boeren om risiko's te nemen wordt genoemd als één van de faktoren die een trage adoptie van deze technologie veroorzaken. Teneinde de invloed van risiko-aversie op de besluitvorming van boeren te onderzoeken dient een onderscheid gemaakt te worden tussen (1) de bereidheid van boeren risiko's te <u>willen</u> nemen en/of (2) de kapaciteit van boeren risiko's te <u>kunnen</u> nemen. Indien boeren in het algemeen een geringe bereidheid vertonen risiko's te nemen, kan dit leiden tot een ekonomisch suboptimaal gebruik van aanwezige produktiemiddelen en te lage investeringen in nieuwe technologie. Als arme boeren geen risiko's kunnen nemen vanwege een te geringe risikodraagkracht, kan risiko bovendien een onevenwichtige verdeling van de opbrengsten van nieuwe technologie veroorzaken met als gevolg een verbreding van de inkomenskloof tussen arme en rijke boeren.

Konceptuele vraagstukken en praktische problemen betreffende het analyseren van de invloed van risiko en onzekerheid op de besluitvorming van boerenhuishoudens worden besproken in <u>Hoofdstuk 3</u>. Er wordt een kritisch overzicht gegeven van de verschillende theorieën betreffende besluitvorming onder onzekerheid. De algemene konklusie is dat geen van deze theorieën een voldoende raamwerk biedt op basis waarvan het voorkomen van risiko-aversie kan worden bestudeerd en het effekt op de besluitvorming kan worden bepaald.

<u>Hoofdstuk 4</u> beschrijft in een historisch perspektief het proces van landbouwintensivering in relatie tot bevolkingsgroei. Deze analyse geeft aan dat de introduktie van de zogenaamde 'moderne' rijstvariëteiten ontwikkeld door het IRRI (IR-variëteiten) en het, op deze variëteiten gebaseerde, verbouwen van twee opeenvolgende rijstgewassen in één seizoen, een nieuwe fase is in een kontinu proces van landbouwintensivering. Een proces dat reeds begon aan het eind van de veertiger jaren onder invloed van een toenemende bevolkingsdruk op het land. In vergelijking met hun voorganger BE-3 - nu beschouwd als een traditionele rijst variëteit - is de adoptie van IR-varieteiten relatief snel gegaan. Op grote schaal vond deze adoptie echter niet eerder plaats nadat boeren zelf op een suksesvolle wijze de teelt van IR-variëteiten geadapteerd hadden aan regenafhankelijke produktie-omstandigheden.

De nieuwe rijsttechnologie heeft een effektiever gebruik van gezinsarbeid mogelijk gemaakt en heeft het inkomen van individuele boerenhuishoudens verhoogd. Echter, vanwege de door deze technologie geinduceerde veranderingen in het gebruik van arbeid in de rijstbouw en de introduktie van arbeidsbesparende technologie (dorsmachines), nam voor een groeiende bevolking het totaal aantal arbeidsplaatsen in de rijstbouw niet toe. Voorts verminderde de inkomensoverdracht tussen de arme en wat rijkere boeren en verslechterde de positie van vrouwen. In het proces van landbouwintensivering zijn de risiko's die boeren-huishoudens lopen aanzienlijk toegenomen. Het huidige type landgebruik kenmerkt zich door intensieve teeltsystemen op kleine bedrijven, die sterk afhankelijk zijn geworden van externe inputs. Dit betekent dat, in vergelijking met het verleden, er minder mogelijkheden zijn binnen het bedrijf risiko's te spreiden en dat het financiele bedrijfsrisiko toegenomen is.

Het merendeel van de ontwikkelingsprogramma's geinitieerd door de overheid in de zeventiger jaren heeft niet of nauwelijks bijgedragen tot de pogingen van boeren het landgebruik te intensiveren. Integendeel, zij veroorzaakten een sfeer van onzekerheid en druisden vaak in tegen de behoeften en ekonomische ontwikkeling van boerenhuishoudens.

Teneinde de invloed van risiko op de besluitvorming van boerenhuishoudens te onderzoeken, werden huishoudens ingedeeld in vijf kategorieën op basis van hun sensitiviteit ten aanzien van inkomensrisiko's. Twee klassifikatie variabelen werden gebruikt: (1) de zelfvoorzieningsgraad welke de mate aangeeft waarin huishoudens door middel van eigen gewasproduktie een surplus kunnen genereren boven hun basis behoeften en (2) de fase van de gezinscyclus welke de beschikbaarheid van gezinsarbeid bepaalt en daarmee de mate waarin huishoudens adekwaat kunnen reageren op bepaalde produktie-risiko's.

Verschillen tussen kategorieën van huishoudens in het gebruik van bedrijfsproduktiemiddelen, de opbouw van het inkomen en konsumptieve bestedingen worden geanalyseerd in Hoofdstuk 6. Huishoudens verschillen aanzienlijk wat betreft de mogelijkheden om hun levensomstandigheden te verbeteren en hun risiko-nemende kapaciteit te verhogen. In scherp kontrast met de surplus huishoudens bestaat er voor niet-surplus huishoudens nauwelijks ruimte voor het terugdringen van de bestedingen en het kreëren van reserves. Door lage reserves en de noodzaak aan voedselbehoeften te voldoen, zijn jonge niet-surplus huishoudens gedwongen hun schaarse arbeid te investeren in aktiviteiten die direkt inkomen opleveren - bijvoorbeeld in loonarbeid voor andere boeren - ten koste van arbeidsinvesteringen in eigen landbouwaktiviteiten. Vanwege een hogere arbeidsbeschikbaarheid per konsumptie-eenheid is de kategorie niet-surplus huishoudens in het midden van de gezinscyclus in staat veel meer gezinsarbeid in eigen landbouwaktiviteiten te investeren zonder dat daarbij korte termijn inkomensgenererende aktiviteiten in gevaar komen. In feite heeft deze kategorie huishoudens aanzienlijke problemen met het vinden van lukratieve aktiviteiten om hun arbeid in te zetten. De arbeidsmogelijkheden buiten het boerenbedrijf zijn beperkt, terwijl de mogelijkheden meer arbeid te investeren in individuele gewassen ekonomisch marginaal zijn.

In vergelijking met de surplus huishoudens vertonen de niet-surplus huishoudens een lage arbeidsproduktiviteit, die met name veroorzaakt wordt door een laag nivo van 'cash input' investeringen. De noodzaak om krediet te gebruiken voor konsumptie en schooluitgaven vermindert de kapaciteit van niet-surplus huishoudens te investeren in produktieaktiviteiten en noopt hen tot het bewust beperken van het gebruik van krediet. Rentebetalingen van leningen aangegaan in slechte produktiejaren slokken in goede jaren een groot deel van het inkomen op dat overblijft nadat in de basisbehoeften is voorzien. De kategorie huishoudens in het midden van de gezinscyclus moet bovendien fors investeren in het onderwijs van hun kinderen teneinde zich op de lange termijn enige ekonomische zekerheid te verschaffen.

In Hoofdstuk 7 wordt de relatie tussen de risiko-sensitiviteit van het huishouden en de adoptie van een teeltpatroon van twee opeenvolgende rijstgewassen onderzocht. Huishoudens verschillen wat betreft de inschatting van de risiko's verbonden aan dit teeltpatroon. Zij verschillen ook wat betreft de noodzaak tot verdergaande intensivering van het landgebruik. De invloed van de gezinscyclus - een faktor die gewoonlijk niet beschouwd wordt in adoptie studies - op het adoptiepatroon wordt aangegeven. Deze faktor kan ook aanleiding geven tot cyclische veranderingen in het gebruik van bepaalde typen technologieën. Een analyse van het adoptieproces geeft aan dat voor boeren het experimenteren met nieuwe technologie een belangrijk instrument is om onzekerheid met betrekking tot die technologie te verminderen. Bovendien blijkt dat -in tegenstelling tot wat vaak wordt aangenomen - experimenteren niet uitsluitend is voorbehouden aan de wat rijkere boeren.

De besluitvorming van boeren met betrekking tot het gebruik van kunstmest in de rijstteelt wordt behandeld in Hoofdstuk 8. Een poging wordt ondernomen tot een kwantitatieve analyse van de invloed van risiko op kunstmestgiften. De problemen die voorkomen bij het kwantificeren van de verschillende variabelen welke een rol spelen in zo'n analyse (zoals risikodraagkracht, risiko-attitude, percepties van boeren betreffende opbrengstverhoging door kunstmest en risiko-perceptie) worden besproken. Percepties van boeren betreffende kunstmest response blijken verbluffend gelijk aan de empirisch geschatte resultaten. In tegenstelling tot percepties en de bereidheid risiko's te nemen, blijkt de risikodraagkracht een belangrijke verklarende variabele te zijn voor verschillen in kunstmestgiften tussen huishoudens. Percepties en de bereidheid risiko's te nemen zijn echter van belang in het verklaren van verschillen tussen individuele huishoudens.

Een samenvatting van de belangrijkste kenmerken van besluitvormingsprocessen van boerenhuishoudens en een synthese van bevindingen betreffende het risikogedrag van boeren wordt gegeven in Hoofdstuk 9. Als algemene konklusie wordt gesteld dat het gevaarlijk is risiko-analyses te baseren op oppervlakkige observaties en te generaliseren over het risikogedrag van kleine boeren. Ten eerste, dienen veel produktie-strategieën en -technieken, waarvan gedacht wordt dat zij kenmerkend zijn voor het risiko-averse gedrag van boeren, het tweeledig doel de beste ekonomische resultaten te behalen en het risiko zoveel mogelijk te beperken. Zij zijn het resultaat van (1) een meerjarig proces van 'voorzichting optimaliseren' gekenmerkt door geleidelijke aanpassingen aan veranderende kondities binnen het huishouden en externe omgevingsfaktoren, het aktief zoeken naar verbeteringen en het experimenteren met nieuwe mogelijkheden, en (2) sekwentiële besluitvormingsprocedures en risiko-kontrole gedurende het landbouwseizoen, gekenmerkt door adaptatie aan onzekere produktie-beperkingen en -mogelijkheden zoals ze zich in het verloop van het seizoen voordoen.

Ten tweede is het onmogelijk risiko als een eenduidig koncept te definiëren. Risiko beschrijft verschillende typen onzekerheid, terwijl de hoogte van het risiko afhangt van de risikodraagkracht van het huishouden en dus onderhevig is aan veranderingen. Binnen een ogenschijnlijk homogene groep van kleine boerenhuishoudens bestaan er dusdanige verschillen in financiële risikodraagkracht en samenstelling van produktiemiddelen, dat huishoudens opbrengstrisiko's als ook financiële risiko's verbonden aan produktieaktiviteiten verschillend kunnen inschatten. Bovendien kan er voor hetzelfde huishouden een konflikt bestaan tussen risiko-vermindering op de korte en op de lange termijn. Men kan dus niet zonder meer vaststellen of risiko's verbonden aan de adoptie van nieuwe technologieën het keuzegedrag van een bepaalde kategorie huishoudens meer beinvloeden dan dat van een andere kategorie huishoudens. Aangegeven dient te worden welk type risiko het betreft, en wanneer en onder welke omstandigheden een investeringskeuze gemaakt wordt. Met betrekking tot opbrengstrisiko's van individuele landbouwaktiviteiten kunnen boeren niet als risiko-avers of risiko-prefererend gekarakteriseerd worden. Dezelfde boer kan beide typen gedrag vertonen.

Boeren zijn gewend om risiko's te nemen. In het algemeen zijn ze niet erg geinteresseerd in het stabiliseren van gewasopbrengsten als dit een vermindering van hun verwachte inkomen betekent. Het zijn niet zozeer de opbrengstrisiko's in de landbouw die het keuzegedrag van arme boeren beinvloeden, maar de noodzaak te kiezen voor aktiviteiten die direkt een inkomen opleveren en het effekt van financiële risiko's op de bestaanszekerheid van het huishouden beperken. Teneinde het financiële bestaansrisiko op een acceptabel nivo te handhaven, beperken arme boeren bewust het gebruik van krediet en financiële investeringen in de landbouw. Wanneer, vanwege risikofaktoren, non-adoptie van winstgevende technologie optreedt of sub-optimale investeringen in de landbouw voorkomen, moet de oorzaak niet gezocht worden in een risiko-averse houding van boeren, maar in hun geringe financiële risikodraagkracht. Gegeven de kontinue schuldpositie van de niet-surplus huishoudens is het niet kunnen nemen van financiële risiko's een belangrijke oorzaak van sub-optimale investeringen in de landbouw en de verbreding van de inkomenskloof tussen arme en rijke boeren.

CURRICULUM VITAE

Abraham Huijsman was born in Pijnacker, the Netherlands in 1951. He received his secondary education at the Stedelijke Scholengemeenschap 'Hugo Grotius' in Delft and obtained the HBS-B Certificate in 1970. In 1979 he graduated in development economics and the following minor subjects: development sociology, agricultural credit and rural co-operatives in developing countries, and the sociological aspects of development planning in rural areas at the Agricultural University Wageningen. In the period of 1977-78 he participated in the research project 'The Small Farmer and Development Cooperation' of the International Agricultural Centre, Wageningen. During his studies he was involved in an evaluation study concerning smallholder tobacco production for the Lilongwe Land Development Programme, Malawi.

After graduating in 1979, he became a research fellow of the International Rice Research Institute (IRRI) in the Philippines and carried out a research project concerning risk management strategies of farm-households. As a research associate of the Department of Development Economics of the Agricultural University Wageningen (1980-83), he continued working in the Philippines on the above project until June 1982. This thesis is a result of these activities. In 1984 he joined the Rural Development Programme of the Royal Tropical Institute, Amsterdam, as an agricultural economist.

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